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"To the solid ground
Of nature trusts the Mind that builds for aye"—WORDSWORTH

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CENTRAL AND LOCAL GENERAL INFORMATION SERVICES

As the Royal Society Conference on Scientific Information closes, it is not inappropriate to consider the wider questions of the diffusion of information in general. The debate in the House of Commons on May 13 on the Civil Estimates for the Central Office of Information covered a wide field; from one point of view it was of interest on account of the statement which it drew from the Lord President of the Council, regarding information services and publicity organisation of the Government. That statement should do something to dispel the confusion which, as the debate itself indicated, still persists between a fact-finding organisation and that concerned with the dissemination of the information collected. Of the first the Economic Information Unit is typical, being concerned to supply the Government with information on the broad facts of the economic state of the nation and the economic problems of the world in relation to Great Britain.

While the Central Office of Information also deals with economic policy and exposition, working with the chief planning officers of the Central Statistical Office, with the Economic Section of the Cabinet Office and with the economic Departments of State, the research aspect of its work is less pronounced than in the Economic Information Unit, and the emphasis is rather on exposition. There can be no serious question about the need for the research aspect of information or intelligence work: the questions are rather whether there is enough of such fact-finding as a basis for policy, whether the departments are as active in this field as they should be, how best to correlate the work of the individual information units which clearly the departments must possess, and whether the work is of the highest quality and its results made known throughout the whole organisation of government with the swift efficiency that is desirable. It is on the aspect of dissemination that criticism has centred. Is that dissemination sufficiently effective to avoid unnecessary duplication? Does it reach the official who needs it sufficiently promptly? And does it reach the general public in a way that ensures their co-operation and understanding of the issues involved?

On the internal aspects of dissemination little was said in the debate. Criticism centred rather on the weakness of the relatively small amount of Central Office of Information publicity directed towards the general body of the public. Some of the criticism is obviously to be discounted. Every step taken by a party in power to direct and control the sources of public information is naturally watched with healthy suspicion. However anxious a Government may be to avoid using departmental channels of publicity for propaganda, it is never easy to avoid the danger; further, public relations officers can, in the nature of things, easily become a cloud of witnesses for the defence of Ministers.

There can be little doubt that the Central Office of Information justifies its existence, and that the departmental information services and public relations officers are doing valuable work. The importance of such services was well indicated in a recent broadsheet issued by Political and Economic Planning. None the less, they call for friendly but searching scrutiny; while there may be much to praise, there is still room for improvement in the standard as well as the cost of the work, and Mr. Herbert Morrison seemed not indisposed to admit the importance of quality.

It can be taken as common ground, as Sir D. Maxwell Fyfe indicated, that each Minister should be responsible for the information policy of his own department with the aid of a small but highly trained information staff; that there should be adequate means for the co-ordination of both home and overseas information services so as to ensure consistency of policy and presentation; and that a central Government agency should carry out on behalf of departments most of the technical and production functions. What is at issue is rather the use made of these organisations, and the quality of the work. In particular, there is the question how far the work of informing the public, for example, in foreign affairs, should be left to Government publicity organs rather than to the Press. That question may well be the fundamental factor behind much of the criticism directed against the shortcomings of Government publicity organisations, and the criticism would be less sharp were it not for the way the Government's economic policy is cramping the free discussion and reporting of public affairs in the Press.

To complete the picture which the Lord President of the Council gave on May 13, it is necessary to turn to the statement Sir Stafford Cripps made on June 1 giving the membership of the Panel on Technical Information Services and its terms of reference. Under the chairmanship of Dr. A. King, of the Lord President's Office, the Panel is to review existing information services for distributing scientific and technical information, to consider what improvements can be made to ensure a rapid and wide dissemination of such information to industry and to make recommendation to the Committee on Industrial Productivity accordingly. That is only one aspect, and a highly specialized one, of the question, and indeed goes beyond the field of Government publicity in the strict sense; but it will be surprising if the Panel does not comment on the way in which the Government's newsprint policy retards the free dissemination of scientific and technical information through the scientific and technical Press.

It is true that certain concessions have been made and the position is easier than it has been. No scientific man, however, can be satisfied with the present position of the scientific and technical Press in Britain, whether in respect of periodicals or of books. The suspension of periodicals in the fuel crisis of 1947 is only one of a number of Government actions which engender distrust of its good faith in regard to freedom of communication; nor can scientific and technical publications be sharply distinguished from the general body of the Press. It is precisely because the Government has such a poor record in this matter that so much bitterness has been manifest in recent debates on the supply of newsprint and of books.

The Government, in fact, has still to show that it is sincere in the support which it gave at Geneva to freedom of information. The effect of the present situation is well displayed in an article in *The Fortnightly Review* of June by W. C. Andrews. This article deserves to be studied by everyone concerned with the preservation of freedom of communication. Mr. Andrews shows why newsprint cannot be treated as just another material commodity, and some at least of the current criticism of Government information services is inspired by resentment of the apparently lavish supply of paper at their disposal in the face of the drastic curtailment of the space available for public discussion and comment in the independent Press as compared with a decade ago. It cannot be too strongly emphasized that this restriction, even if it is due to economic motives alone, is an effective form of censorship. Important events are reported imperfectly or not at all, and the formation of sound opinion is severely handicapped. Nor is that all. Mr. Andrews indicates how adverse are the repercussions on the functioning of democratic institutions, for example, local government; and the interim report of the Consultative Committee on Publicity for Local Government presented last autumn might well be studied afresh from this point of view. The Committee was agreed that much more needs to be done to stimulate publicity at both national and local levels, and it emphasizes, like Mr. Andrews, that the problem is mainly one of widespread lack of knowledge leading to apathy. The report is, in fact, like his article, a commentary on the aphorism of Junius which Mr. Andrews quotes: "The liberty of the press is the palladium of all the civil, political and religious rights". Local authorities have an undoubted duty to make information public by the most suitable means, and some of them have been justly criticized for failure to do so.

The report suggests that every local authority should review all its channels of communication with the public of its area and consider how these can be improved and extended. It does not advocate the expenditure of large sums on centralized publicity. Rather the Committee believes that local authorities can carry out consistent and effective publicity without elaborate machinery and heavy expenditure. It does hold, however, that much more could be done to educate officials of all grades in the right way of dealing with members of the public, and that the public relations spirit should permeate the whole organisation, members as well as staff. It insists also that one of the main needs is the fullest possible use of the facilities offered by the local Press for supplying regular information to the local people. No policy for improving publicity for local government can, in its opinion, be effective unless every effort is made to secure the co-operation of local newspapers.

This section of the report is of particular interest, for it is here, as Mr. Andrews indicates, that Government policy has proved most hampering and is indeed tending to frustrate the functioning of democracy. Opportunity for public comment and debate is essential to secure action in accordance with the facts of a situation and not on lines dictated by prejudice or vested interest. It is just as true at the local as at the national level that scientific and technical factors must be explained to the public. A closely related matter is the control of nationalized industries. The recent resignation of Sir Charles Reid from the National Coal Board has given warning of the danger that due weight may not be given to the technical factors in the reorganisation of this nationalized industry; unless some means of public discussion are found, there is real danger that a fresh set of sectional interests and prejudices will arise to obstruct the technical reorganisation that the public interest demands.

If the scientific man or technical expert, such as the mining engineer, is to be given the executive authority he needs to carry out the technical functions entrusted to him, the co-operation and support of the public as well as of the other workers in the industry concerned will often be required. For this reason alone the question of the control of nationalized industry and the responsibility of such industries to Parliament is a matter of close concern to him. It is evident that Parliament itself is much exercised over the special status of the boards of nationalized industries, and that while there is no desire to interfere with matters of day-to-day administration, there is a desire for fuller information on policy and for opportunity for public criticism. The Speaker indicated in the House of Commons on June 7 that he was prepared, if it was generally approved, to exercise his discretion to direct the acceptance of questions asking for statements to be made on matters about which information had been previously refused, provided that, in his opinion, the matters were of sufficient public importance. Public importance is one of the tests for motions for the adjournment of the House and was not in his experience an unduly difficult test to apply. This suggestion the Government is prepared to accept; it is probably to be welcomed as affording further time for the whole question of public information and public relations to be re-examined.

What must be remembered, however, is that any such procedure inside the House of Commons will still be insufficient while the newsprint position restricts the Press from reporting such questions and debates at reasonable length. We come back to the point with which we started, that freedom of information and communication are an essential element in the functioning of democracy as well as in the application of knowledge to public affairs and the advancement of science; it is impossible in the presence of a direct censorship or of that indirect censorship which the absence of adequate supplies of paper or print imposes. There are few members of the Government who, despite obvious touchiness in regard to criticism, can fairly be suspected of an illiberal attitude on this question of information and independent comment. None the less, in spite of the work of the British delegates at Geneva on the resolution that freedom of information is a fundamental right of the people and the touchstone of all the freedoms to which the United Nations are dedicated, the Government's attitude on the question of imports of newsprint still gives rise to serious concern. Such resolutions are hypocritical unless they are accompanied by practical evidence of concern to provide the essential means for a free Press, technical and scientific, as well as general, to discharge properly and efficiently its function of keeping men and women informed on advances in knowledge and on the issues involved in every aspect of public affairs. Nor can any Government information service, however efficient and free from party bias, undertake that task without the support of an independent Press which has also the resources for acting as an efficient instrument of information.

THE SEARCH FOR THE GERMAN ATOM BOMB

Alsos

The Failure in German Science. By Prof. Samuel A. Goudsmit. Pp. xiv+260. (London: Sigma Books, Ltd., 1947.) 15*s.* net.

PROF. GOUDSMIT has written a racy account of the part played by the Alsos mission in the investigation by Allied intelligence of the German uranium projects, which makes very good reading. He tells some first-class stories; the one about the radioactive wine dispatched by air to Washington deserves to become a classic; and he has some interesting things to say about the methods used by his unit and about security in armament research. His book necessarily treats only part of the subject, namely, the work of scientists who accompanied the advancing armies from the time of the liberation of Paris until the end of the War. It is to be hoped that it will some time be possible to release an account of earlier investigations, of the extent to which it was possible for military intelligence to keep track of the relevant activities of German scientists, and of the conclusions that were drawn. It was not until the occupation of Strasbourg that the Alsos mission obtained certain proof that the Germans were far from obtaining either an atomic bomb or radioactive poisons; but whether at this or at an earlier stage of the War fear of these developments was a potent motive in Allied strategy, or whether enough evidence existed to show that they were most unlikely, Goudsmit's account does not say.

But to the reviewer by far the most interesting part of the book is the description of Goudsmit's meetings with the German scientists, and his discussion of their motives in working or not working for the German war machine. This is a subject of profound interest and importance, for the question of the relation of the scientific worker to the State is one which every one of us has to face, even though we hope that the problem will not soon be again so acute as it was in the Third Reich. It is of particular importance also in connexion with the re-establishment of normal relations with the scientific workers of Germany. For a German professor invited abroad acquires thereby some prestige in his own country, and it is widely felt in Britain that this prestige should not be conferred where it is not deserved.

But a discussion of the motives of German scientists concerns the actions of living men, who can and do state their side of the case, as has Von Laue recently* and Heisenberg in an article in *Nature*† on the German work on uranium. The subject is one likely to arouse the bitterest emotions, both in Germany and among those in Britain who have suffered personal loss in the War or at the hands of the Gestapo. It is therefore particularly necessary that Allied scientists, if they approach it at all, should do so with all possible objectivity, quoting, if possible, from documents rather than hearsay, and judging a man only on the basis of generally available evidence. In this respect it is possible to offer one criticism of Goudsmit's book. It contains a witty description of the scene among the German scientists interned in England when they heard the news of Hiroshima. First they did not believe it possible; then they saw how it was done, and were ashamed that they had not thought of the method themselves; and finally, he says, they built a rationalization for their failure, by denying that they had ever tried to make an atomic explosive.

How does Goudsmit know all this? Unless it was by questioning the scientists afterwards, it must be assumed that some record of the conversation was obtained. In that case, Goudsmit's conclusions would have been more convincing if the record could have been published, rather than this dramatization of it. Perhaps this is at present impossible; but in the circumstances this record of the motives of the German scientists reads rather like a theory in physics based on unpublished experimental facts, so that it is impossible to judge how valid or fair the conclusions are.

The truth in a matter like this is unlikely to be simple. It is clear that German scientists were by no means so unanimous in their desire to work for the war effort as were the British and Americans. Some, of course, did so; others—a point which Goudsmit makes very well—wished to do so and were prevented by the stupidities of the Nazi organisation; others held aloof as much as possible. There also seems to have been, especially towards the end of the War, a rather cynical desire to obtain from the war machine facilities for scientific projects of fictitious military value, to "use the war to help science". To the men working on the uranium project, as the War drew to an end, it must have been clear, whether or not they realized the potentialities of plutonium or of a fast chain reaction with uranium 235, that no weapon for Germany could come out of their work. At that time it must have been true that the aim of their work was to obtain machines, or prestige, but not bombs. The innocence of the motives with which it was started is, however, less certain; no one who realized that a bomb might result from his researches can say honestly that he did nothing which might have armed the Nazis with atomic weapons.

It is doubtful, however, whether this question of motives in research is of lasting importance for the reputation of German physics. Many of us in Britain can realize only too well the strains to which a German scientist of integrity has been subjected; the conflict between the desire to stay and save from the Nazis something of German culture and the desire to escape to a free country; the reluctance to be an "armourer of Himmler and of Auschwitz", and the desire to strike back at the destroyers of Hamburg and of Dresden. In a few years time, when passions have cooled a little the welcome that a German scientist will find among his colleagues in the West should depend very little on the extent to which, under the stress of war, he worked on weapons. It is to be hoped that it will depend far more on his earlier record, on the opposition that he offered within and outside his university, at the time when opposition was still possible, to the steps that stifled freedom in Germany and made war inevitable.

N. F. MOTT

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[*] *Bulletin of the Atomic Scientists* (April 1948).

[†] *Nature*, 160, 211 (1947).

THE FAEROES

The Atlantic Islands

A Study of the Faeroe Life and Scene. By Kenneth Williamson. Pp. 360+23 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 16*s.* net.

MR. WILLIAMSON has published a notable book on the Faeroe Islands, where he was stationed during the war years. He is the better qualified in that he married a Faeroese wife.

The Faeroes are a group of islands lying in the North Atlantic between Shetland and Iceland. There are more than twenty islands, covering an area of 541 square miles. Seventeen of the islands are inhabited and the population is 30,000, of which more than 5,000 live in the capital, Tórshavn. The people are of Viking stock, with a culture originally brought from Norway when the islands were settled in the tenth century. Even before they were colonized from Norway, the Faeroes were inhabited by Irish Culdees, who in the ninth century had retreats both on these islands and on the Vestmanna, an island group off the south-west coast of Iceland. It is interesting that there should be a Vestmanna in Faeroe also; the name means Isle of the West-men, as the Culdees were named. Many of the Faeroe inhabitants held positions in Denmark in 1939, and when the Germans invaded Denmark in 1940 a full tenth of the island race were cut off from their homeland.

The Faeroe Islands are mountainous, and most of the land lies at a height of between 1,000 and 2,500 ft. It is rough and rugged country, and on their west sides the hills often fall sheer to the sea from a height of more than 1,000 ft.; here are great colonies of sea birds, of considerable economic importance to the people. The moorlands provide grazing for sheep, and have a considerable proportion of peat, the fuel chiefly used. The chief rock is basalt. The annual rainfall is around sixty inches.

In winter the Faeroe hills are grim and desolate, vexed almost ceaselessly by ocean winds; in March come the golden plover, and the oystercatcher (*tjaldur*), which is the Faeroe national bird, the name of which adorns boats and businesses. The oystercatcher which appears often on the decorative needlework on the islands, is, like the whimbrel, only a summer visitor to the Faeroes. The author on page 41 gives a fine, poetic description of the song of the whimbrel above the wild island dales. Another migrant, the red-necked phalarope, is welcomed as being the precursor of the herring and is called (p. 84) "herring hen" for this reason.

When sailing in a boat at sea certain names are taboo (this was formerly the case in the Hebrides also). A knife is always 'the sharp one'; a clergyman is called at sea not a parson but *lundi*, the puffin. The Faeroese are great fishermen, and their smacks (p. 88) go as far as Greenland and Bear Island. During the worst period of the War, Faeroe boats brought no less than 75 per cent of the total catch landed in British waters: although the Iceland fishing boats refused to sail without air escort, the Faeroe boats carried on without it. Nearly one third of the active fleet was lost during the war years.

Mr. Williamson describes not only the bird life, but also the customs and folk-lore of the people. On page 234 is a most interesting story of seals laying aside their seals' coverings and assuming human shape. Almost the same story was at one time well known in the Hebridean island of North Uist, and no doubt was brought there by the Norsemen, who ruled the Hebrides until the Battle of Largs in 1263. Summer and the puffin arrive on April 14: between that date and August 24 no light is, or was, used in the houses in the evening, for 'early to bed and early to rise' is the motto in the Faeroe islands.

The book abounds in interesting bird notes and descriptions. On page 121 the bathing parade of kittiwakes to an inland lake throughout the daylight hours is described. This recalls a similar habit I observed on the island of Unst in Shetland. On page 128 is described what must be an unusual habit of Arctic terns, of collecting small fry dropped by puffins at the entrance to their nesting burrows. The puffins are afraid of the terns and scurry into their burrows when these light-winged birds hover near. This reminds me of the habits of the Lambay jackdaws, which during the guillemots' nesting season fare well on the fry the guillemots drop on their ledges. A patrolling jackdaw sees the gleam of the fry, drops down, and carries it off. The puffin is an article of food on the Faeroes. Upwards of 500,000 puffins are captured and eaten annually (p. 145) on the island group, and more than 100,000 young fulmars. They are mostly salted down for winter use. The fowlers believe that the puffin matures slowly and does not (p. 153) come to land the first summer after it is reared. On page 175 an inland-breeding colony of the puffin is noted. The young birds there when ready to leave the nest enter a small river and are carried on its waters during the night hours to the friendly sea.

There is a gannet colony on the Faeroes, and the author (p. 133) records that a gannet ringed there as a bird in down on August 25, 1944, was caught ten weeks later in a fishing net off Agadir, in Morocco. For thirty-four years a black-browed albatross, which won the name 'King of the Gannets' (p. 135), came to this solan colony at Mykineshólmur with the gannets. This bird of the southern hemisphere was shot on May 11, 1894, and the skin is preserved in the Natural History Museum in Copenhagen. On page 140 is given the record of a kittiwake ringed as a nestling on one of the Faeroe cliffs and recovered rather more than three months later off the coast of Newfoundland.

Leach's fork-tailed petrel arrives at its colony later in the evening, after spending the daylight hours at sea (p. 181), than the storm petrel. On page 183 is noted the habit of cats of taking storm petrels. I have known this happen also in the Hebrides.

I have been able to mention only a few of the good things in this book, which will be a delight to all who love Nature, and also to those who wish to learn something of the customs of a fine race of people, strong and self-reliant, and pro-British almost to a man during the darkest days of the Second World War.

SETON GORDON

NATURAL HISTORY OF BRITISH INSECTS

Insect Natural History

By Dr. A. D. Imms. (New Naturalist Series.) Pp. xviii + 317 + 72 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1947.) 16*s*. net.

AS a medium for the study of natural history the insects have no equals. The number and variety of their species and the diversity of their habits are such that they afford unrivalled opportunities for the collector, the photographer or the mere observer. The appearance of a general introduction to the natural history of insects in Great Britain prompts some reflexions on the aims and purposes of the amateur entomologist. For British entomology has been built up in the past century and a half by the amateur. To-day there are so many professional openings in entomology that the boy with a consuming interest in insects will probably end by joining the profession. Yet the need for amateur entomology is greater than it ever was. For it is common knowledge that many students now graduate into entomology from the laboratory and the lecture room, with no real feeling for the insect as it exists in the field. It is a curious paradox that it is an ignorant use of insecticides of ever-increasing potency which is forcing the applied entomologist to reflect more and more closely upon the way in which insects live among themselves. It is the avowed purpose of the volumes in the New Naturalist Series to bridge the gap between the scientific worker and the lover of Nature; in the sphere of entomology it is the scientific worker who stands in need of education, at least as much as does the naturalist.

Dr. Imms is singularly well qualified to bridge this gap. He does not attempt a systematic survey of the subject but, in true insect fashion, he collects nectar where he finds it. Wings and flight, senses and behaviour, ordinary and extraordinary habits of feeding, gall formation, the curiosities of insect reproduction, means of protection, aquatic insects and social life—these are some of the subjects, chosen because the author finds them interesting; and it is remarkable how much of the cream of the subject he has taken off. Science is not much use unless it can be brought to the understanding of the ordinary man and incorporated into common knowledge; and it is in the integration of classification, morphology, physiology, ecology and anecdotal natural history that the author has been so successful. The reader will find plenty of anecdotes—often with a pleasant turn of phrase, and without the creaking which is apt to characterize the witticisms of some scientific authors. "If a housefly could keep a diary of its doings it would be a most sordid document" is effective by what it leaves unsaid.

A "Documentary Appendix" is added with the object of guiding the reader to specialist works. This serves to emphasize once more how lacking we are in systematic books on the British insects, so that it is almost impossible for the amateur to make much headway except with two or three of the most worked orders. It is unfortunate that this appendix contains almost no references to economic entomology apart from those on biological control.

No review would be complete without some reference to the illustrations—forty plates from coloured photographs and thirty-two in half-tone—which are an outstanding feature of this book. Not all are uniformly good, but most are excellent. The coloured 'close-up' of a Capsid bug about to plunge its stylets into a plant (Plate 37) is particularly successful. Some of the coloured illustrations have that disagreeable aniline quality—but the book should be read only by artificial light; then almost all are wholly delightful, and even Plate 5 of *Libellula depressa* is tolerable.

Some typographical errors there are, but not a great many. On Plate 18 the large white butterfly is called *Pieris rapæ*; in Plate 34*b* surely the yellow larva at the top is the prepupal instar of the gooseberry sawfly. As in the other volumes of this series, the editors state that they have done their best to see that the author has got his facts right, but that he alone is responsible for what he says about them. Is this statement really necessary?

V. B. WIGGLESWORTH

ALGEBRAIC GEOMETRY

Methods of Algebraic Geometry

By Prof. W. V. D. Hodge and Dr. D. Pedoe. Vol. 1. Book 1: Algebraic Preliminaries; Book 2: Projective Space. Pp. viii+440. (Cambridge: At the University Press, 1947.) 30*s*. net.

"THIS volume is the first part of a work designed to provide a convenient account of the foundations and methods of modern algebraic geometry." These words from the authors' preface explain the scope of the present volume and account for the selection of topics treated. It has become increasingly clear in recent years that a rigorous treatment of algebraic geometry must be based, to a much greater extent than the classical accounts of the subject, on algebraic principles. It is therefore no occasion for surprise that more than a third of the volume under discussion is purely algebraic. The first four chapters constitute, in fact, a clear and concise introduction to the theory of algebraic fields, polynomials and matrices (over a ground field which is not necessarily commutative). This account is in itself most valuable, since the modern point of view in algebra is not to be found in many English works, though several accounts have been published in the United States.

The next two chapters deal with the foundations of projective geometry, first on an algebraic and then on a purely synthetic basis. A comparison in detail of these two independent formulations of the theory is full of interest. It will be noticed, for example, that the synthetic treatment is much longer. This is due in part to the fact that it starts from abstract axioms, whereas the algebraic development presupposes a knowledge of fundamental algebraic results; but a second and most significant reason is that in the synthetic treatment it is necessary to consider in detail a rather large number of special cases (in themselves of a somewhat trivial nature) in order to assert the validity of general theorems. It is not always sufficiently realized that the apparent elegance and brevity of a synthetic proof of a geometrical theorem may conceal tacit assumptions as to the generality of the figure under discussion which logically demand examination. A novelty in the present treatment, which otherwise follows classical lines (though with unusual care in matters of detail), is that the assumption of Pappus' theorem is deferred until after the introduction of co-ordinates.

The remaining chapters deal with Grassmann co-ordinates (where one would welcome, if possible, the introduction of a more elegant notation), and with the general theory of collineations and correlations, and the reduction of their equations to canonical forms. The geometrical content of the book thus never leaves the domain of projective geometry; the more general birational theory will presumably appear in the second volume.

This treatise is likely to become a standard work. It is notable for its clarity of treatment and for the rigour of its demonstrations, and will repay careful study even in those parts which deal with matters generally considered familiar. The printing maintains the standard that we have come to expect from the Cambridge University Press.

J. A. TODD

DISTRIBUTION OF TIME IN BRITAIN

British Time

By Donald de Carle. Pp. 199+47 plates. (London: Crosby Lockwood and Son, Ltd., 1947.) 15*s*. net.

MR. D. de CARLE has assembled a great deal of interesting information regarding the standardization and distribution of time in Great Britain. The majority of people take for granted the accurate time available from such sources as the B.B.C. time signals, Big Ben and 'TIM'. After a brief opening chapter on various early forms of time-keepers, the author deals with the history and present constitution of the Royal Observatory, Greenwich; this chapter brings out the astonishing accuracy with which time is measured and distributed over the radio, and further emphasizes the fact that the pendulum clock is giving way to the quartz-crystal clock when the highest possible accuracy is required.

Reference is made to the facilities for testing watches and the issuing of 'Kew certificates', and in Appendix 2 details of the test and specimen performances of watches obtaining various numbers of marks are given.

Chapters 4 and 5 deal with the development of the clock and the clockmaking industry in Britain, the section on Big Ben serving to emphasize what a redoubtable machine it is, both from the point of view of size and accuracy of performance.

The section dealing with electric clocks contains much information, particularly regarding the development of the Shortt clock, but the description of the quartz clock is unfortunately rather poor.

The chapters on the need for time signals and their history, and the evolution of 'TIM' are of particular interest, and the great amount of development work needed to produce the latter excellent service is given due prominence.

Although the style and lay-out of the book might have been better, it contains a range of information which is not collected together in any other publication, and the book can therefore be recommended with confidence to anyone interested in the subject of time and timekeepers.

R. A. FELL

Astronomical Navigation Tables

(Air Publication 1618.) Vol. A: Latitudes 0°–4° North and South. Prepared by H.M. Nautical Almanac Office on behalf of the Air Ministry. Pp. 233. (London: H.M. Stationery Office, n.d.) 7*s.* 6*d.* net.

IN 1936 the Nautical Almanac Office undertook, by agreement with the Admiralty, the preparations of an "Air Almanac" and of "Astronomical Navigation Tables" for astronomical navigation in the air. The "Air Almanac" has always been on sale to the general public; but the "Tables" have been restricted to official use and are now for the first time being placed on general sale.

The complete set of tables comprises fifteen volumes, catering for all latitudes from 79° N. to 79° S. Fourteen of these cover belts of 5° of latitude both north and south of the equator; the fifteenth covers the ten degrees 70°–79°. The tables are designed to facilitate the calculation of the altitude and azimuth of an observed heavenly body. For each degree of latitude and for each degree of hour-angle, the altitude is given to the nearest minute of arc and the azimuth to the nearest degree for each of twenty-two selected bright stars, well distributed over the sky, within the range of altitudes between 10° and 80°, and also for each degree of declination from 28° S. to 28° N., which covers the range of declination for the sun, moon, and planets. The computed altitudes include the effect of refraction at a height of 5,000 ft., but a table of corrections for other heights, from sea-level, for surface navigation, to 40,000 ft., is given.

In order to avoid interpolation with three arguments, the tables are intended to be used with an *assumed* position, corresponding to tabulated values of latitude and of hour-angle. No provision is therefore made for interpolation other than for declination.

The tables are well designed and well printed, and their convenience in practice has been amply proved by their extensive use during and since the War by the Royal Air Force. Though intended primarily for air navigation, they are equally useful for surface navigation, subject to the limitations of accuracy inherent in the tabulations of altitudes to the nearest minute of arc. H. SPENCER JONES

Regions and Nations of the World

By Assoc. Prof. Earl E. Lackey and Asst. Prof. Esther S. Anderson. Reprint. Pp. xix+489. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 26*s.* net.

THE authors have here tried to choose what they think most useful for a course in world geography, to be given in a year, or abbreviated into a semester, in an American college or university. It requires "few if any additional references or assigned reading to be provided by the instructor"; the reviewer would add here 'more's the pity'. The scheme for each region is (*a*) natural features, (*b*) cultural features leading on to urban centres, and sometimes on to a short appraisal of current problems or of prospects. The book has many illustrations and the photographs are often very telling; the maps are of poor quality. Cultural features are usually notes on commercial and political matters; they vary greatly in appositeness but are sometimes quite to the point, though the accounts of cities are so short as often to be trivial. The book has 100 pages given to the United States and 37 to the rest of North America, 60 to South America, about 140 to the whole of Eurasia, 38 to Africa and 30 to Australasia and Antarctica. The aim is to say something about every region and every country and every really big town, and to follow as uniform a plan as possible, all commendable in a certain measure as facilitating reference to a limited extent; but the book needs vitalizing.

Surely a course of this kind should aim at giving a vision of vital change going on everywhere, a vision that would tempt students who are interested to follow the subject for themselves thereafter. One judges from the text that the writers have not much knowledge of what Edinburgh or Zurich, to take two instances, mean in the human story; but it would be unprofitable to go on with hundreds of instances of missing the point. We must be thankful that geography is being increasingly recognized in the United States and hope that its exponents there may improve on this type of book; so many American books have such high quality already. H. J. F.

The Psychology of Ego-Involvements

Social Attitudes and Identifications. By Muzafer Sherif and Hadley Cantril. (Wiley Publications in Psychology.) Pp. viii+525. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 36*s.* net.

THE chief aim of this competent work is to show that the 'ego', or rather the 'ego-involved reaction', is an outcome of social forces impinging upon the individual throughout his life. The authors are deeply versed in the literature of experimental psychology, sociology and social anthropology, and by skilfully weaving together relevant results of research in these fields bring abundant evidence in support of their thesis.

Starting with an analysis of the theory of attitudes and making full use of the important concept of 'frame of reference', they trace the growth of the ego through infancy and childhood and its re-formation in adolescence. This is followed by a valuable treatment of the structural properties of diverse groups in which the participant 'egos' take their shape, and a study of ego pathology in conditions of stress, deprivation and group disintegration. Phenomena brought to light are further illustrated by reference to drama and fiction. Finally, there is a critique of the psychoanalytic theory of the ego, a critique which many readers will think too severe in its conclusions.

The book is a substantial contribution to social psychology. Its robust attention to concrete situations of social life gives it realism without loss of scientific value. As the authors rightly say, scientific objectivity is derived from the methods employed and not from the aloofness of the worker. JOHN COHEN

Bird Life in Cornwall

By B. H. Ryves. Pp. 256+16 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 10*s.* 6*d.* net.

LOCAL ornithologies to be of value must be precise, and they therefore tend to become lists; however, Lieut.-Colonel B. H. Ryves in his volume dealing with bird life in the most southerly counties of England has cleverly avoided this by dividing his book into two parts. The first includes an account of Cornwall and its bird haunts and has chapters on such outstanding Cornish birds as the chough, raven, peregrine, common buzzard and Montagu's harrier. In the second part we have a guide to the birds of Cornwall with notes on behaviour, etc. The whole is admirably illustrated with pen-and-ink sketches by R. A. Richardson, his pintails, showing a duck and drake floating on still water, being a particularly satisfying picture.

As we have said, the early part of the book is that devoted to general observations, and it affords much interesting reading; for example, the account in Chapter 3 of migration movements of sea-birds. The author describes how on March 22, 1932, a warm and sunny day, he watched from Gurnard's Head for five hours an immense stream of birds. "Guillemots and razorbills, the former predominating, kept passing at speed low over the sea in flocks of 100 to 200 birds . . . they were travelling when I came on the scene and still travelling when I was obliged to leave." Gannets, shearwaters and herring gulls also passed, and the author wonders "what was the meaning of this vast 'migrational' movement? The gannets and shearwaters were travelling away from their breeding stations off the Welsh coast." Two other especially interesting chapters are those on the chough—with particular reference to its decrease—and the Montagu's harrier, with its history of the vicissitudes of certain individuals.

FRANCES PITT

The Spell of the Honey Bee

By W. Eric Kelsey. Second edition, revised. Pp. xi+274+49 plates. (London: Chapman and Hall, Ltd., 1947.) 18*s*. net.

THE first edition of this book appeared in 1945 and it was rapidly exhausted. This in itself is a tribute to its merits and that it has fulfilled a need. The author is to be congratulated on the publication of a second edition so soon afterwards and, in his revision, he has taken the opportunity of rewriting the chapter dealing with bee diseases. The book is one of the most attractive bee-keeping manuals we can recall. The essentials of the craft are explained with a freshness of style that is one of the book's special attractions. Also, its value is enhanced by the copious series of half-tone plates, some of which are of exceptional merit. The working drawings of hives and appliances are an additional feature that makes the text easy to follow. Written as a manual for beginners, and with the idea of producing efficient bee-keepers, nevertheless the more experienced will find much that is of interest within its pages. It is obviously outside the scope of the author to discuss the scientific aspects of the bee in any but very general terms and, although he may be a little weak on some parts in this field, the fault scarcely detracts from the merits of the book as a whole.

I Bought a Farm

By Roy Genders. Pp. 112 + 8 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 10*s*. 6*d*. net.

WHEN an author buys a farm and sets about working it for profit, what more natural than that he should proceed to record the ups and downs of his first year's operations for publication. Mr. Genders, released from the R.A.F. after the War, purchased Holly Gate Farm. It was an upland Derbyshire holding of about 78 acres with an ancient but substantial homestead and buildings in a very poor state of repair. In any circumstances a new start in a farm is an anxious business, but the year 1946–47 was a nightmare for any farmer, experienced or otherwise, for one of the wettest harvests on record was followed by a very severe winter. In this book we follow the day-to-day struggle of the author and his two men to make good in the face of great difficulties. A few useful sidelines, such as mushroom growing and dog breeding, made a useful contribution to the enterprise. The story ends on a note of quiet optimism. The account is written in a conversational, almost gossipy style, and will commend itself to the general public, rather than to the body of farmers, who will already be familiar with much of the technical information, and will also have experienced all the hazards, hitches and satisfactions there recorded.

Students' Handbook to Fertilizers and Soils

By L. T. Lowe. Edited by G. H. Purvis. (Published for the Monmouthshire Institute of Agriculture.) Pp. 84. (Worcester: Littlebury and Co., Ltd., 1947.) 7*s*. 6*d*. net.

THIS book aims at giving a simple account of the scientific principles of manuring and of soil science suitable for students at farm institutes. It is always difficult to write simple but accurate books in any science that are acceptable to research workers in that science. The difficulty is particularly great in agricultural science, both because the scientific principles of many practical techniques are not too well understood and also because of the great scarcity of clear accounts of the present-day views held by the research workers themselves. Thus lecturers in soil science and crop nutrition in farm institutes and agricultural colleges can justly complain that they are not well served by the research institutes of Britain, and this book unfortunately illustrates the truth of this complaint.

The book suffers in the first place from a brevity so extreme that the choice of topics mentioned appears to be arbitrary, and statements of apparent facts or theories often lack very necessary qualifications. It also, unfortunately, contains a certain number of false statements or obsolete theories. But there are many places in which it gives a reasonable account of some of our present ideas on fertilizer practice and soil science.

E. W. RUSSELL

Poisons: their Isolation and Identification

By Frank Bamford. Second edition, revised by Dr. C. P. Stewart. Pp. viii + 304. (London: J. and A. Churchill, Ltd., 1947.) 21*s*.

THIS is a book which within a relatively small compass gives a vast amount of information. The distinguishing feature of this information is its usefulness. In too many books describing processes of scientific investigation, one finds that some vital detail of technique is not mentioned, and further research is required before the technique can be successfully used. This is not true of 'Bamford'. The details given are adequate for the working out of the processes described and they bear the marks of the author having used them.

The book, however, is not a mere catalogue of toxicological processes, and much information of general interest is given; a particularly good example of this is the short chapter on drugs of addiction.

There is no mention in the section on alcohols of the effect of the passage of time after death on the concentration of alcohol found in the blood. The book is fairly well up to date, although some of the more modern industrial poisons are missing. It is a little surprising to read that chloral has almost gone out of use in modern therapeutics. This is, however, rather outside the author's true scope; within his scope this is a good book.

EDGAR RENTOUL

DIFFRACTION FROM THE IONOSPHERE AND THE FADING OF RADIO WAVES

By J. A. RATCLIFFE
Cavendish Laboratory, Cambridge

WHEN a wireless wave is received partly or wholly by way of the ionosphere, it is observed to fade. Much of this fading is due to interference effects between waves which have travelled by different paths. Such waves may include the ground wave, singly or multiply reflected ionospheric waves, waves reflected from different ionospheric regions, or the two magneto-ionic components produced by the presence of the earth's magnetic field. It is, however, possible to isolate and observe only one downcoming wave from the ionosphere, for example, by the use of a pulse sender and a circularly polarized receiving aerial or by the use of a special aerial to suppress the ground wave under conditions when the absorption of the downcoming wave is large enough to make second reflexions unimportant. When only one downcoming wave is observed in this way, it is still found to fade at a speed which varies from time to time. Although few detailed observations of this kind of fading have been reported, workers in the subject will probably accept the general statement that the speed of fading is roughly proportional to the fréquency of the wave, and inversely proportional to the distance of the transmitter[1].

It is also known that the fading of a single ionospheric wave received at vertical incidence shows some dissimilarity at two points separated by about one wave-length, and from this fact it may be deduced that the wave is returned by a process of irregular diffractive reflexion from an ionospheric region which is considerably inhomogeneous in the horizontal plane[2,3]. It therefore appears more correct to think of the single wave returned from the ionosphere not as one sharply reflected from a smooth mirror, but as a cone of rays returned to the receiver from a diffuse scattering region in the ionosphere, much as light from a street lamp on a bridge might be reflected from an irregularly rippled stream to an observer standing near by. The consequences of this supposition are being worked out by considering the diffractive reflexion from a completely rough surface, and it appears that useful information may be obtained about the 'degrees of roughness' of the ionosphere in this way. It also appears that the amplitudes of waves successively reflected between ground and ionosphere may not be in the ratio expected for 'mirror-like' reflexions, and this fact may have important bearings on the deduction of reflexion coefficients by the usual methods. It is not, however, the main purpose of this article to develop more fully the ideas of the ionosphere as a diffractive reflector, but to suggest that if the roughness of the ionosphere is supposed to vary in a random manner, then the salient phenomena of the fading of a single wave can be explained. The possible causes of the roughness and variability will not be discussed.

To represent a varying rough ionosphere in a simple manner, we assume that there exist several scattering 'centres' distributed approximately in a horizontal plane and that each scatters the same power from the incident wave. The term 'scattering centre' is here used in the sense common in the theory of diffraction, and no attempt is made to define it more precisely. The 'centres' make up the irregularities which form the roughnesses discussed above, and although related to the scattering centres of Eckersley are not necessarily the same. It is assumed that the 'centres' are in continual random motion in such a way that the velocities v in the line of sight are distributed according to a Gaussian law; so that the number $P(v).dv$ of centres with velocity between v and $v + dv$ is given by

$$P(v) . dv = A \exp(-v^2/2v_0^2)dv, \quad (1)$$

where v_0 is the root mean square velocity of a 'centre'. We consider the case of a receiver placed close to a sender emitting pulses of radio frequency f_0 as in the usual method of exploring the ionosphere at vertical incidence. The reflected wave suffers a Doppler shift of frequency after scattering from each of the 'centres', so that its frequency on returning to the ground is given by

$$f = f_0(1 + 2v/c). \quad (2)$$

The phases of the contributions from different 'centres' may be assumed to be randomly distributed, since the 'centres' are at random distances. Powers, therefore, add at the ground, and the resultant electromotive force consists of components of different frequency, the power $W(f).df$ in each frequency-range being obtained by combining equations (1) and (2) to give

$$W(f)\, df = B \exp\{-c^2(f-f_0)^2/8f_0^2v_0^2\}\, df. \quad (3)$$

For a reason which will be apparent shortly, we may also write this expression as

$$W(f) . df = \frac{\psi}{\sigma\sqrt{2\pi}} \exp\{-(f-f_0)^2/2\sigma^2\}\, df, \quad (3a)$$

$$\left.\begin{array}{l}\text{where } \sigma = 2f_0v_0/c = 2v_0/\lambda, \ \lambda \text{ being the wave-length of the wave}\\ \text{and } \psi = \int_0^\infty W(f) . df = \text{the total power in the wave.}\end{array}\right\} \quad (3b)$$

The fading of the wave is now seen to result from the beating between the component waves of different frequency represented in equations (3). But a series of E.M.F.s with random phases and with powers as given by (3) is *precisely what would result if random noise were passed through a filter the band-pass characteristic of which for power was given by* (3).

Now Fürth and MacDonald[4] have made a detailed analysis of the noise emerging from a filter with a power-pass-characteristic given by equation (3a), which is their equation (12). They have shown first that the amplitude R of the quasi-sinusoidal output E.M.F. is distributed according to a Rayleigh law, so that the probability $p(R).dR$ of finding an amplitude between R and $R + dR$ is independent of the filter and is given by

$$p(R) = (R/\psi) \exp(-R^2/2\psi), \quad (4)$$

the mean amplitude $\overline{R}$ being given by

$$\overline{R} = \sqrt{\pi\psi/2}. \quad (5)$$

They also show that the temporal rate of change of the amplitude depends on the characteristics of the filter in the following way. If the amplitude of the output E.M.F. is plotted against time, and if the time axis is divided up into *short* elements τ, and v_τ represents the change of amplitude which occurs during one of these intervals, then the probability

$P(v_\tau)dv_\tau$ of observing a change between v_τ and $(v_\tau + dv_\tau)$ in any one interval is Gaussian and is related to the pass-characteristic of the filter by their equation (19), which states that

$$P(v_\tau)\,dv_\tau = c \exp\{-(v_\tau/2\pi\sigma\tau\sqrt{\psi})^2\}\,dv_\tau. \qquad (6)$$

On our present theory it follows that the fading E.M.F. received from the ionosphere will have these same characteristics, so that it should be described by expressions (4) and (6). My colleague, Mr. S. K. Mitra, has analysed fading curves obtained by observing a single pulse at 4 Mc./s. reflected from Region F and received on a circularly polarized aerial and has shown that the results agree well with these equations. This agreement encourages us to believe that the explanation is correct, and to use it to deduce the R.M.S. random velocities of the scattering centres in the following way.

A comparison of the experimental results with equation (6) yields the value of the quantity $\sigma\sqrt{2\psi}$, and since equation (5) relates ψ to the mean amplitude of the received E.M.F. we can determine σ, and hence find v_0 from (3b). A typical fading record, analysed in this way, has yielded the value 5 m./sec. for the R.M.S. velocity of the scattering 'centres'.

A little further calculation yields a useful expression for the 'speed of fading'. Fürth and MacDonald[4] define a quantity ε given by

$$\varepsilon = \operatorname*{Lim}_{\tau\to 0}\,(\overline{|v_\tau|}/\tau) = \sqrt{2\pi\psi}.\sigma = 2\overline{R}\sigma = 4\overline{R}f_0v_0/c,$$

where $\overline{R}$ is the average E.M.F. In our case we may use the quantity $\varepsilon/\overline{R}$ as a logical measure of the speed of fading, and may then state the position in words as follows.

Let a fading curve in which the amplitude of the received E.M.F. is plotted as a function of time be divided up into short elements of time τ, and let v_τ represent the change in amplitude during the time τ, and $\overline{R}$ the mean amplitude; then the quantity $\overline{|v_\tau|}/\tau\overline{R}$ tends to a limit as τ tends to zero, and is here called the 'speed of fading', S. It is related to the velocities of the scattering centres by the expression

$$S = \overline{|v_\tau|}/\tau\overline{R} = 4f_0v_0/c = 4v_0/\lambda. \qquad (7)$$

It is at once apparent that the speed of fading is proportional to the frequency of the radio wave, in agreement with the facts mentioned at the start of this article.

If we had to do with only two scattering centres, one of which remained stationary and the other moved in the line of sight with velocity v_0, then we should record a complete cycle of fading in a time t such that $1/t = 2v_0/\lambda$. Equation (7) shows that the 'speed of fading' (S) in the case of several centres moving at random yields a quantity of the same order of magnitude.

In some experiments being made in Cambridge, the phase variations in a single downcoming wave are being studied, and it is of interest to consider what may be deduced from them. These phase variations are likely to be of importance in direction-finding and in radio navigational aids. If the downcoming wave is composed of contributions from several moving scattering 'centres', the phase φ will vary in a random manner, and a record of φ plotted against time may be analysed by dividing it up into short equal intervals τ, in which φ changes by $\Delta\varphi$, and evaluating the quantity $\operatorname*{Lim}_{\tau\to 0}\overline{|\Delta\varphi|}/\tau$, which may be called the 'average rate of change of phase'. We should expect this quantity to be simply related to the corresponding rate of change of phase $(2\pi.2v_0/\lambda)$ produced by reflexion from a single 'centre' moving with the velocity v_0 in the line of sight, and I am indebted to Dr. D. K. C. MacDonald for a proof that, in fact, the two quantities are equal. Dr. MacDonald has also shown how the probability of obtaining a value of $\Delta\varphi$ is related to $\Delta\varphi$ and has provided a theoretical expression with which measurements can be compared.

I have been able to examine records of the phase-variations of a single downcoming wave from Region E made on 2 Mc./s. by Mr. J. W. Findlay and on 100 kc./s. by Mr. K. Weekes, both working in Cambridge. The method used by Mr. J. W. Findlay has previously been described and a sample record illustrated[5]; the only records amenable to analysis are those of the simpler type illustrated in his Fig. 3. Mr. Weekes uses a method which has not yet been described. For both these frequencies I find that the probability distribution of the quantity $\Delta\varphi$ agrees fairly well with the expression of MacDonald. For the frequency of 2 Mc./s., the R.M.S. velocity deduced for the 'centres' is 0·5 m./sec. and for 100 kc./s. it is 1·0 m./sec. These orders of magnitude are consistent with that deduced from Mr. Mitra's analysis of the amplitude of fading on 4 Mc./s.

I have also been able to examine some measurements of the phase and amplitude of the downcoming wave observed at nearly vertical incidence by Mr. R. N. Bracewell on 30 kc./s. and 16 kc./s. These measurements have been made by an extension of the technique described by Best, Ratcliffe and Wilkes[6] and Budden, Ratcliffe and Wilkes[7]. On these frequencies the refined techniques now in use frequently show the occurrence of a relatively rapid variation of phase and amplitude superimposed on a slower variation. If the results are first smoothed so as to remove the more rapid variation (phase changing at the rate of about 2π in 5 min.), it is possible to analyse both the phase and amplitude records in the manner previously explained. Although the smoothed fading is then so slow (phase at the rate of about 2π in 1½ hr.) that the probability distribution cannot be checked in any detail, there is no obvious disagreement with the theory, and the mean values for the speed of amplitude and phase fading both lead to the same value, approximately 1·0 m./sec. for v_0. There appears to be no counterpart, on the higher frequencies, to the more rapid fading observed on these very low frequencies.

We have seen that observations at nearly vertical incidence on frequencies from 4 Mc./s. to 16 kc./s. yield results of the same order for v_0, provided we smooth out the more rapid fading on the very long waves. This agreement is indirect proof of the statement made at the start of this article that the rate of fading is proportional to the wave-frequency. It is next of interest to consider the phenomena associated with oblique transmission through the ionosphere.

By considering how a movement of a scattering centre affects the length of path of waves scattered from it at oblique incidence, it can be shown that the speed of fading should be roughly inversely proportional to the distance of transmission, provided that this distance is greater than the height of the reflecting region. Mr. R. W. McNicol has kindly made an analysis for me of some fading curves of distant broadcasting stations, provided through the courtesy of the B.B.C., and has shown that they can be explained in terms of scattering centres moving with random velocities of the same order as those deduced from the experiments made with vertically incident waves.

Up to this stage in the discussion we have assumed that the Doppler shift in the component waves occurs during backward scattering from moving 'centres' *situated in the reflecting region.* If, however, a wave, reflected from a given region (1), passes through an irregular region (2) below, then it will suffer diffraction at region (2), and if the scattering elements in region (2) are in motion, the diffraction pattern at the ground will vary with time, and an observer at a fixed point will notice that the wave 'fades'. The matter is complicated because the wave traverses the diffracting region twice, once on the upwards and once on the downwards journey; but the nature of this fading can be deduced, to a first approximation, by considering the Doppler shift due to the forward scattering from the scattering centres in region (2), and the results are then somewhat dependent on the assumptions which are made about the motions of these centres. The general trend of the calculations is the same as before, but the Doppler shifts are smaller for the same velocities.

Useful information should be obtainable by making simultaneous observations on the fading of single echoes from Regions *E* and *F*. If the fading of echoes from both regions were due to the movements of reflecting clouds in the appropriate region, then we should expect the application of the analysis given in detail in this article to apply to each echo separately, and to give an R.M.S. velocity v_0 which would probably not be the same for both. If, however, the fading of both echoes were due to inhomogeneities in an absorbing region below both reflecting regions, then the fading of both echoes should be explicable in terms of the same velocities in the absorbing region, provided we used the type of analysis applicable to transmission *through* a diffracting region. If the fading of the echo from Region *E* were due to backwards scattering from moving elements of that region, whereas the fading of the echo from Region *F* were due to the fact that it had passed through the irregular Region *E*, then we should have to use different types of calculation for the two echoes in order to get concordant results for the R.M.S. velocity v_0. These possibilities are being tested.

Although the theory outlined in this article is only meant to be a first approximation to the truth, it is nevertheless thought to contain the essence of the explanation of the fading of a single echo. Obvious extensions of the theory include the consideration of:

(*a*) A steady component of E.M.F. reflected from a constant and uniform part of the ionosphere in addition to that returned from the scattering centres. This will give rise to effects similar to those obtained when a steady E.M.F. is added to the output of a Gaussian filter-passing noise, and the analysis will follow that of Fürth and MacDonald for this case.

(*b*) 'Centres' which do not all scatter equal powers, and 'centres' the scattering effect of which varies with time.

(*c*) Velocities of the centres which are not distributed in a Gaussian manner.

(*d*) Different velocities in the horizontal and vertical directions.

(*e*) The possibility that, if the 'centres' are embedded in a region where the refractive index is considerably less than unity, the Doppler effect will be less than that indicated, so that the value of v_0 will be greater than that calculated here.

In conclusion, it may perhaps be pointed out that there are obvious analogies between the reflexion of a radio wave from randomly moving scattering 'centres' and the radiation of monochromatic light from a series of molecules moving with random heat motions. The broadening of the spectral line in the optical case is analogous to the spread of frequencies in the radio case, and if the light could be observed sufficiently rapidly it would be found to be fading, just as the radio E.M.F. fades.

I am indebted to my colleagues mentioned above, who have kindly put their observations at my disposal. Their researches are supported by a grant from the Department of Scientific and Industrial Research. I am also indebted to Dr. MacDonald for help with the analysis of phase.

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SOME COMPONENTS OF THE LYTIC SYSTEM OF GRAM-POSITIVE MICRO-ORGANISMS

By Prof. M. STACEY and Dr. M. WEBB

Chemistry Department, University of Birmingham

FOLLOWING certain pioneer work and suggestions by our former colleague, Dr. H. Henry, it was apparent that much information regarding the structure of Gram-positive bacteria and their behaviour when acted upon by antibiotics could be obtained from a study of bacterial autolysis. The few detailed studies of autolysis which have previously been made have been mainly confined to the pneumococcus group. Goebel and Avery[1] showed that the autolytic disintegration of pneumococci was accompanied by proteolysis resulting in an increase in both amino-nitrogen and non-coagulable nitrogen, and by lipolysis liberating ether-soluble fatty acids. A non-specific cell-free autolytic enzyme system acted upon heat-killed pneumococci to give results comparable with those from spontaneous autolysis and also brought about the partial lysis of suspensions of heat-killed *Streptococcus viridans*[2].

In confirmation, Dubos[3] further made the significant observation that before lysis of the cells occurred the cocci first became Gram-negative, and this change in the Gram staining reaction was not necessarily associated with complete lysis of cells. It was possible, moreover, to effect this change in the Gram-staining reaction of heat-killed, Gram-positive penumococci by the action both of pancreatic ribonucleinase[4] and a ribonuclease-like 'tissue enzyme' isolated from rabbit leucocytes[5] (cf. Bartholomew and Umbreit[6]).

In our hands, these and other enzymes, for example, from the lower fungi, have been found to render Gram-negative a range of heat-killed Gram-positive micro-organisms. The change in the Gram-staining reaction appears to be brought about only by enzymes of the ribonucleinase type, that is, those which hydrolyse ribonucleic acid to the four mononucleotides[7]. We have found by way of contrast that preparations of intestinal phosphatase and of a phosphatase from dog fæces[8], although able to hydrolyse free yeast ribonucleic acid with the liberation of inorganic phosphate, had no action upon heat-killed Gram-positive cells.

Extension of our investigations to bacterial autolysis has shown that it is possible to divide the cellular disintegration of most Gram-positives into two separate and distinct stages, namely, (*a*) the change from Gram-positive to Gram-negative, and (*b*) the subsequent lysis of the Gram-negative cytoskeletons. We have so far recognized four distinct enzyme systems involved in the cellular disintegration. The extent to which the two stages occur in suspensions of autolysing Gram-positive cells depends sharply upon the *p*H and upon the oxidation-reduction potential of the system. For bacterial autolysis, there appears to be an optimum *p*H for each species which varies from *p*H 5 for certain sarcinæ to *p*H 8 for clostridia and some staphylococci. Our colleague Dr. Henry made the striking observation that, under reducing conditions, only the first stage of autolysis occurs, and this results in the formation of Gram-negative cytoskeletons which do not undergo further digestion at any *p*H less than 7. By carrying out autolysis in the presence of suitable reducing agents, such as hydrogen sulphide or thioglycollic acid, it was found possible to obtain in solution and free from the enzymes concerned with complete cellular disintegration, the enzyme system responsible for the initial stage of autolysis. Detailed studies of the properties of 'initial stage' enzymes from both *Cl. welchii* and *Staph. citreus* have shown that the two are closely similar. They have in common the property of hydrolysing free yeast ribonucleic acid but not deoxyribonucleic acid, while they differ in several respects from the ribonucleinase of animal tissues[4]. Thus they have *p*H optima at 7–8, are inactive at *p*H 4·0, are activated by reducing agents and inhibited under oxidizing conditions. Irreversible loss in activity occurs when the enzyme solutions are heated at 80° for 30 min., whereas at 60° any inactivation is dependent upon the *p*H and the time of heating, the enzymes being most stable at *p*H 8.

Although the enzymes from *Cl. welchii* and *Staph. citreus* both have the property of hydrolysing free ribonucleic acid, they are species specific, and indeed to some extent strain specific, in their action on heat-killed Gram-positive cells. Thus, the enzyme from *Cl. welchii* readily converted heat-killed Gram-positive *Cl. welchii* to Gram-negative cytoskeletons, but had no action on heat-killed Gram-positive *Staph. citreus*, *Staph. aureus* or *Lactobacillus helveticus*. Similarly, the enzyme from *Staph. citreus* exhibited no action on the Gram complex of heat-killed Gram-positive *Cl. welchii* or even of *Staph. aureus*, but was active against a rough variant isolated from an aged culture of *Staph. aureus*. As the smooth–rough transformation is known to involve the loss of the ability to synthesize certain bacterial polysaccharides, the latter observation suggested that the specificity of these bacterial enzymes was in some way connected with the specificity of the polysaccharides of the cell.

Recent studies on the action of lysozyme[9] have shown that ribonucleic acid and the specific polysaccharides of Gram-positives are presumably in combination at the cell surface. When heat-killed Gram-positive cells are incubated with lysozyme, certain carbohydrate linkages are disrupted, the Gram staining reaction becomes negative and undegraded ribonucleic acid and polysaccharides are released into solution.

Further, specific polysaccharides of staphylococci and of *Cl. welchii*, isolated by procedures which did not destroy cellular structure, also were found to be hydrolysed to a small but definite extent by the action of lysozyme.

Since these same polysaccharides were not acted upon by the initial stage bacterial nucleinases, the latter appeared to be essentially free from lysozyme. However, it was shown that, during the action of these enzymes in the autoconversion of Gram-positives to the Gram-negative cytoskeletons, a small percentage of reducing groups was released and specific polysaccharides were liberated in an apparently undegraded state into solution (cf. a similar observation by Dubos[10] during pneumococcus autolysis). We conclude that the initial stage in the autolysis of Gram-positives involves an enzyme, highly specific in its action, which breaks the relatively labile linkage joining the specific polysaccharide and the ribonucleic acid. Such enzymic activity is probably possessed by most preparations of animal ribonucleinases, and renders the Gram ribonucleoproteins[11] of the cells susceptible to the subsequent action of ribonucleinase. The latter breaks down the ribonucleic acid component to the mononucleotide stage, but does not disrupt the Gram-negative cytoskeleton.

All procedures which were found to inhibit the change in the staining reaction of Gram-positives to Gram-negatives also inhibited the ribonucleinase activity of the enzyme solution, and the variation in the activity of different enzyme preparations against killed cells was accompanied by a parallel variation in ribonucleinase activity. However, the fact that ribonucleic acid removed from one Gram-positive organism by extraction with sodium cholate may be replated on to the reduced Gram-negative cytoskeletons of a second extracted Gram-positive cell[11] would suggest that the bacterial ribonucleic acids themselves do not show any fundamental structural differences. This may account for the less specific nature of ribonucleinases, and suggests that the marked degree of specificity shown by the bacterial enzymes responsible for the conversion of Gram-positives to Gram-negatives is due to a 'polysaccharide-releasing' enzyme.

When the autolysis is rapid and less carefully controlled[12], the linkage between the nucleic acid and protein of the cytoskeleton may not be broken, and a certain proportion of the Gram-positive ribonucleoprotein is released into solution[12], so that the linkage between the nucleic acid and the protein, probably involving —S—S— linkage[11], is essentially firmer under certain conditions.

When a suspension of suitably prepared Gram-negative cytoskeletons is adjusted to *p*H 8, complete lysis rapidly follows. We have succeeded in isolating closely similar lytic enzymes from the cytoskeletons of *Staph. albus* and *Staph. citreus*. From both, preparations of two proteolytic enzymes were isolated, one of which hydrolyses casein but not peptone, and a second which hydrolyses peptone but not casein.

It was shown that the initial disintegration of the cytoskeletons is due to the action of the casein-hydrolysing enzyme. The protein fragments which result from this cellular disintegration appear to be further hydrolysed by the action of the peptone-hydrolysing enzyme.

In contrast to the enzymes responsible for the first stage (*a*) of bacterial autolysis, these proteolytic enzymes are not specific in their action and readily dissolved the Gram-negative cytoskeletons of all Gram-positives examined and also heat-killed true Gram-negative bacteria. They had no action on heat-killed Gram-positive cells, and it was concluded that these proteolytic enzymes do not play any part in autolysis until the cells have become Gram-negative.

In extension of these studies[13], we have shown that some *Actinomyces* cultures under certain conditions possess a system composed of a lipoidal bactericidal substance, a ribonucleinase and proteolytic enzymes. We have obtained evidence that such a system is also present in a culture filtrate of *Pseudomonas pyocyanæ* and in certain moulds which are antagonistic to bacterial growth. It would appear, therefore, that such a system may be of fundamental importance in the general phenomenon of bacteriolysis and may also have some bearing on the nature of phagocytosis. In the latter case, it will be recalled that leucocytes are known to contain an enzyme which hydrolyses ribonucleic acid[5] as well as proteolytic and other enzymes.

The precise role of lipases[1] and deoxyribonucleinases[14], said to be present also in Gram-positives, is under investigation.

We are grateful to Dr. H. Henry and Dr. A. S. Jones for considerable help and to the Medical Research Council for a grant.

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SOIL CONSERVATION

THE Food and Agriculture Organisation of the United Nations Organisation has recently published a beautifully produced booklet entitled "Soil Conservation—an International Study" (Washington, D.C.). It comprises 190 pages, of which about half are occupied by pictures. Thus the problems of world soil conservation are covered in about a hundred pages of text. The idea behind the publication appears to be to appeal to politicians, administrators and publicists without whose co-operation the urgent need for soil conservation may be overlooked until too late. These will get the impression that soil conservation is an American invention. It is not an entirely false impression, but there are countries—for example, Japan and Java, and, for that matter, Great Britain and others—in which soil conservation is so highly perfected that the 'problem' of soil conservation scarcely exists, and the achievements of these countries in adapting their methods of land utilization to the environment have consequently been overlooked. The authors of the booklet admit that "much attention has been given to China and the United States of America"; but it would be more accurate to say that the United States gets 75 per cent of the space, China 10 per cent, and the rest of the world 15 per cent. It is worth quoting all that this leading international agricultural authority has to say on physical losses from the mismanagement of farm lands in the world outside the United States, China and Latin America. Under the heading "Other Countries", it is stated: "All over the world, wherever man has cultivated sloping land, there has been soil erosion in some degree. In the Mediterranean region of Europe, in Asia, in North Africa, in tropical Africa and South Africa, and in India its results have been described, but little measurement has been made of its extent or severity." One of the results in India that "have been described" is far more human misery than soil erosion has caused in the whole of the United States. Australia and New Zealand are other countries that appear to have been overlooked.

There is some justification for this one-sided approach. Modern methods of soil conservation used all over the world and the principles of planning land utilization to suit the land have nearly all been developed in the United States, which are in advance of most other countries not only in the application of mechanical measures and in the adaptation of land utilization to soil conservation, but also in appreciation of the social and economic consequences of the adoption of soil conservation. But the achievements of soil conservation in the United States tend to blind people there to the lesser, but certainly not negligible, achievements of countries which have not the money, the men or the means to accomplish what the United States have done. The book leaves the impression that the authors have used the material immediately available in Washington, but have not troubled to look further afield. Something better is expected of an international study with the imprint of the Food and Agriculture Organisation.

The fact that about the only reference to soil conservation in the British Empire is the statement that British settlers have given much attention to pasture development suggests that there were not many representatives of Empire agriculture available in Washington while the book was being prepared. The countries of the British Empire have less to show in the conservation 'shop window' than the United States, but they have a lot in the 'shop' itself. The forest and agricultural departments of India did a magnificent piece of work in face of tremendous difficulties in checking the devastating erosion in the foothills of the Himalayas and elsewhere, much but not all of which was of recent origin. India has a problem of peculiar difficulty—over-population. This has led to a growing recognition of the fact that the welfare of the land is a communal rather than an individual responsibility, and to communal schemes of integrated soil conservation. The successful adaptation of the *taungya* system, to which the Food and Agriculture Organisation book only refers in passing, to purposes of soil conservation had already reached a high degree of development some decades ago. The Indian Forest Service has a reputation second to none for applying soil-conservation measures.

Australia, New Zealand and South Africa have learnt much in recent years from the United States, and with varying success have adapted American principles of soil conservation to their particular circumstances. The mechanics of soil conservation—that is, the prevention of water and soil from running downhill—are essentially the same everywhere; but environmental and social conditions in different regions require that soil-conservation measures should be integrated in different patterns. The art and science of soil conservation consist in building up a pattern of land use that will fit the physical, economic and social environment. All three Dominions have adopted the idea of the American soil-conservation district as the social unit for soil-conservation planning, but in different forms. It is still too early to say with how much success their plans will ultimately be crowned, but these embryonic experiments in applied human ecology deserve most careful attention.

In the British Colonial territories, too, the problems of soil conservation peculiar to tropical conditions are being tackled with increasing vigour and imagination. Whereas until recently most territories relied mainly on mechanical methods of erosion control, there is to-day a general awareness that these are only a means to an end, and that soil conservation must be integrated into systems of husbandry that will enhance the fertility of the soil. A few years ago the goal of many Colonial agricultural policies was at best to maintain soil fertility. Now it is to increase fertility; and with increased fertility should come increased stability, both of the soil and of society. This latter goal is still far from attainment; but those who control British Colonial policy seem to be gradually awakening to the importance of fundamental scientific studies for the conservation of the tropical environment. The work of W. S. Martin, who showed that grass fallows could have a dramatic effect on the restoration of soil fertility, the improvement of soil structure and resistance to erosion, promises to revolutionize the basis of arable agriculture in East Africa. Attention is also being paid to methods for improving pastures and controlling grazing, and to the proper rôle of fire in tropical agriculture. Many of these problems require expert knowledge of the structure of native societies for their solution.

To be effective, conservation measures in the tropics, as elsewhere, have to be applied on a regional scale, which involves co-operative or communal action, and may involve drastic modifications in land utilization. One of the great difficulties in the Colonies has been to secure co-ordinated action throughout a region. Responsibility for the welfare of the land is divided among many authorities whose interests do not always coincide. There is, indeed, need for conservation education and propaganda not only among native and European farmers, but also at high administrative levels. Native peoples, in Africa at any rate, often have a tradition of communal land ownership that should facilitate the enforcement of legislation designed to secure effective co-operative action in the control of soil erosion.

Several British Colonies and Protectorates have already enacted legislation to enforce soil-conservation measures or to regulate land use and conditions of land tenure for the purpose of conserving the soil. The trend of recent legislation has been towards the setting-up of regional authorities on the pattern of the American soil-conservation districts. Indeed, the invention of the soil-conservation district is probably America's greatest contribution to the promotion of soil conservation throughout the world. The authors of the Food and Agriculture Organisation booklet, with unnecessary modesty, make little reference to it; though they do state the astonishing fact that within the last ten years more than 1,000,000,000 acres—more than half the total land area of the United States—have been brought under the control of soil-conservation districts.

G. V. JACKS

THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, PORT OF SPAIN, TRINIDAD, B.W.I.

IN 1945 Sir Robert Robinson and Prof. J. L. Simonsen, acting on behalf of the Colonial Products Research Council, paid a visit to the West Indies to acquaint themselves with the tasks in which scientific research could assist these and other tropical territories of the Commonwealth. From the observations they made in the Colonies which they visited, they concluded that almost every branch of science could be called upon to take a share in raising the prosperity of these lands; but that a special claim could be made for microbiology, of which only the most urgent medical aspects had been receiving attention in the past.

The Colonial Office accepted their conclusions and made funds available for the foundation of a Colonial Microbiological Research Centre to be situated within the tropics.

Port of Spain, Trinidad, was decided on as a suitable location. It was approved that the centre should devote its energies to fundamental research in microbiology; to the application of the results of its investigations; and to assisting agricultural and other industries in improving their products. Further, it was approved that the new Institute should form a centre for postgraduate training in microbiology. Afterwards, it was decided that a branch of the new centre should devote itself to the maintenance of a collection of micro-organisms which could be made freely available to interested institutes and to research workers in tropical and temperate climates.

To meet the needs of the new centre a building was designed, which, in addition to a library, comprises six laboratories, three for microbiological and one for biochemical research. One laboratory is reserved for the type culture collection, and one for the preparation of culture media.

A special room is provided for the cleaning and sterilization of glassware. Adjoining, and communicating with, the biochemical laboratory is a balance room; another room is provided for photomicrographic work, in which an electron microscope may eventually be set up, should this prove desirable. For the cultivation of micro-organisms requiring temperature of 18° C. and below for maximum growth, a special room has been provided, which is maintained constantly at this temperature. In addition, the building houses three offices, a cafeteria, a first-aid room and a store-room.

The whole building is air-conditioned and will be maintained at a temperature of 25·5° C. (78° F.) and a relative humidity of 60 per cent. The air-conditioning plant is housed in a penthouse on the roof of the one-storied laboratory building.

Since some of the investigations which the new centre is expected to undertake may eventually be adopted by industry, it was felt to be important to incorporate a pilot plant in the design of the institute. The pilot plant, when completed, will house, in addition to a complete fermentation plant of 400 gallons capacity with a separate distillation unit, a boiler house, a gas plant, an air compressor unit and a machine shop. From the pilot plant, gas, steam and compressed air will be supplied to the various laboratories, through underground pipe systems. All equipment for the pilot and air-conditioning plants are of British design and manufacture.

In view of the acute housing shortage throughout the West Indies and in Port of Spain in particular, it was agreed that housing facilities should be provided for the scientific staff within the grounds of the Institute. To this end a block of four flats has been erected within the six acres of grounds belonging to the Institute. A bungalow for the engineer has also been erected there.

The construction of the various buildings was commenced early in 1947 and has by now progressed so far that the Institute is to be opened officially on July 5, when Lord Hankey, chairman of the Colonial Products Research Council, has consented to perform the ceremony in person.

Invitations to attend the ceremony have been sent to Governments of the various Colonies, to Governments with Colonial possessions in the tropics and to the Governments of the neighbouring Central and South American States.

It is hoped to make the opening an occasion for informal discussions, among the delegates, of microbiological problems, particularly such problems as are met with under tropical conditions.

OBITUARIES

Prof. W. T. David

THE sudden death on May 22 of Prof. W. T. David has removed from the University of Leeds a man of real distinction with a vivid personality. For twenty-six years he was professor of engineering and administrative head of the Engineering Departments.

David was born in Laugharne in 1886 and was educated at St. David's County School. After a brilliant career at University College, Cardiff, he went to Trinity College, Cambridge, where he specialized in a study of infra-red radiation from flame gases and related combustion phenomena under the inspiration of the late Prof. B. Hopkinson. This field of research ultimately became his abiding interest. In 1912 he was appointed H.M. Inspector of Schools on the technological side; during the First World War he became inspector of gun ammunition with headquarters at Woolwich Arsenal and later director of dilution of labour at the Ministry of Munitions. In 1920 he was appointed to the chair of engineering at University College, Cardiff, and in 1922 he succeeded the late Prof. John Goodman in the chair of engineering at Leeds.

David was no narrow scholar, and was a strong advocate of education in the true university sense. He was a man of high integrity and sound judgment, and his brilliance, kindness and wisdom endeared him both to colleagues and students. He freely gave to all students and encouraged them to high endeavour by his inspiring teaching and the impact of his personality. In his lectures he would stress the importance of grasping the fundamental principles of engineering science, revealing the basic concepts in brilliant flashes, and would carefully lead the student in some branch of the subject on to the very frontiers of knowledge. David frequently likened this method of lecturing to students to taking them to the top of Mount Pisgah to view 'the promised land', so that with few words he would excite and fire the imagination of the students and make a lasting impression upon their minds.

In the field of research David directed his efforts mainly towards the problems of combustion phenomena and the related problems of internal combustion engines. At Cambridge he took special interest in heat loss from gaseous explosions, and he became intrigued with the problem of 'missing-pressure' in internal-combustion engines. This resulted in a comprehensive study of explosions of inflammable gaseous mixtures at a time when the lack of reliable thermal data handicapped his investigations. His intuition, however, led him to believe that flame gases were not really normal hot gases but possessed energy in excess of that of normal gases. The development of quantum mechanics and afterwards the provision of thermal data have made it possible to confirm his early ideas concerning flame gases. No one was more devoted to his subject or to his students.

Outside the University of Leeds, David was known in engineering circles in Yorkshire and elsewhere; was a member of the Institutions of Civil and of Mechanical Engineers, and was chairman of the Yorkshire Association of the Institution of Civil Engineers for the session 1928–29.

David was a man whose views were highly valued in any assembly and his contributions to discussion, often brief and pungent, were commonly wise. He possessed an independent mind and a forceful character, "it's dogged that does it" being his motto. He will be sorely missed for his clear judgment, store of good humour and warm sympathy, especially at a time like the present, when the transition to peace and the expansion of the University of Leeds are raising so many problems. R. H. EVANS

Dr. A. E. Jones

DR. ARTHUR EMRYS JONES, lecturer in mathematics at the Imperial College of Science and Technology, London, was killed in a lift accident on May 7 at the age of twenty-seven. A scholar of St. John's College, Cambridge, he secured a first class in Part II of the Mathematical Tripos in 1939, and honours in Part III in the following year. During the War he worked in the Ballistics Section of the Armaments Research Department, and was associated with J. R. Womersley in his pioneer work on the application of statistical methods to the control of variability in gun-cordite. In 1945–46 he worked at Rothamsted Experimental Station on the design of grazing experiments, and thereafter entered the Statistics Section of the Mathematical Department at Imperial College.

A thesis on continuous stochastic processes and autocorrelation theory brought him his doctorate in 1946. He had also published, in *Biometrika*, vol. 33, Part IV, a paper on the routine estimation of dispersion from large samples. At the time of his death he was working on the effects of autocorrelation on experimental design and estimation. A paper on this subject, by him, will be published shortly by the Royal Statistical Society.

What advances in mathematical statistics Dr. Jones would have made, had he lived, cannot be known. What is certain is that they would have been considerable. He leaves a wife and daughter.

We regret to announce the following deaths:

Jacques Cochon de Lapparent, *Correspondant* of the Section of Mineralogy of the Paris Academy of Sciences, on May 18, aged sixty-five.

Mr. C. A. Malcolm, C.I.E., during 1928–34 chief conservator of forests, Central Provinces, India, on June 8, aged sixty-eight.

NEWS and VIEWS

Imperial College of Science and Technology: Sir Richard Southwell, F.R.S.

In September 1948, Sir Richard Southwell relinquishes the rectorship of the Imperial College of Science and Technology, London, after a period of tenure of six years. This step he has decided to take in order to be free to carry through various research projects concerned with the methods of relaxation that have become so closely associated with his name. Six years is but a short time in which to leave an imprint on the policy and development of an institution of the magnitude and scope of the Imperial College; but there is no doubt that his influence has left its distinctive mark. During this period detailed plans have been produced for the reconstruction of the three constituent colleges on a formidable scale; and if, for reasons of national exigency, these plans will not mature during this quinquennium, they are at least ready to be transformed into reality as soon as the opportunity arises. Not unconnected with this has been the celebration of the centenary of the first beginnings of the College, and the opportunity it presented of establishing a fund that will make possible many ventures of a social and educational nature that would have been otherwise cramped or completely frustrated. Moreover, a commencement has been made with the extension of hostel accommodation for students by the foundation of Selkirk Hall. In this period also the representation of the staff on the governing body has been enlarged, so that members of the teaching staff are involved to a much greater extent than heretofore in the determination of College policy. In this connexion also Sir Richard Southwell has been responsible for the extension of deanships to the three constituent colleges, a move that has made for much closer co-ordination and collaboration than hitherto. On the side of educational policy, he has been mainly responsible for the distinct shift in the incidence of College studies, whereby further developments in advanced study and research are coming into prominence while some of the more elementary preparatory work is fading out. Finally, he has unquestionably built up a tradition of social life that is not usual or easy to develop in a college situated in the metropolis. Sir Richard Southwell can now withdraw from the hurly-burly of the administration of the College with the sure knowledge that during his six years he has helped to determine much of its future character.

Chemistry at Birmingham: Sir Norman Haworth, F.R.S.

Sir Norman Haworth, who has held the Mason chair of chemistry and the directorship of the Chemistry Department in the University of Birmingham since 1925, is to retire from office at the end of the present session. He studied at the Victoria University of Manchester and, after periods spent in Germany and at the Imperial College of Science and Technology, London, he proceeded to St. Andrews as lecturer in organic chemistry. From there he went to Armstrong College, Newcastle (University of Durham), as professor of organic chemistry (1920), and five years later he was elected to the Mason chair at Birmingham in succession to Sir Gilbert Morgan. Under Haworth's leadership the research school at Birmingham rapidly became the chief centre for structural investigation in the carbohydrate group, and the importance of his contributions in this field was recognized by the award of the Nobel Prize for Chemistry (1937). In addition to the direction of a large research school which has attracted workers from all over the world, Sir Norman Haworth has contributed greatly to developments in teaching methods and to the organisation of his department. He has held office as dean of the Faculty of Science and as vice-principal of the University of Birmingham and has served on many Government boards and committees. He is a Longstaff medallist of the Chemical Society, of which he was president during the years 1944–46. He is now a vice-president of the Royal Society, from which he has received both the Davy Medal and a Royal Medal.

In the earlier part of Sir Norman's period of office, the work of the Birmingham school was directed mainly to the determination of the structures of the simpler sugars and their derivatives. For example, the difficult problem of the ring structures in sucrose was solved, and an elegant method, involving oxidation to the aldonic acid, followed by methylation, was developed for determining the structure of reducing disaccharides. Studies were made also of acetone derivatives, sugar carbonates, anhydro sugars, partially methylated sugars and other important reference compounds; and, on the broad and firmly established basis thus laid down, the investigations were extended to the naturally occurring polysaccharides. There followed the elucidation of the general type of structure present in the macromolecules of cellulose, starch, glycogen, inulin, xylan, mannan and certain levans, and the introduction of methods for the assay of terminal groups enabled still further insight to be gained into the detailed molecular architecture of the polysaccharides. Along with these developments should be noted the determination of the structure of vitamin C and its synthesis, and the elucidation of the structures of glucosamine and chondrosamine. More recently the attention of workers in the Birmingham school has been directed towards biochemical problems, and important discoveries have been made concerning the enzymic degradation of the components of starch and their synthesis from glucose 1-phosphate. Investigations are in progress also into the structure of the highly important bacterial polysaccharides.

Prof. H. W. Melville, F.R.S.

Prof. H. W. Melville, who will succeed Sir Norman Haworth at Birmingham, has made many valuable contributions to our knowledge in the field of reaction kinetics. His early work consisted in the examination of the various explosion limits in such mixtures as phosphine and oxygen. The implications of the free radical in such reactions led him to explore the mechanism of a number of photochemical reactions in which radicals are found, and here he first introduced the device of the rotating sector which has permitted us to obtain life-times of transient species with remarkable accuracy.

Some fifteen years ago when deuterium and its compounds became readily available, Melville examined a number of gas reactions in which hydrogen could be replaced by deuterium in order that the relative importance of mass and zero-point energy could be evaluated, thus throwing light on the detailed mechanism. With this background Melville felt that he was in a position to take up the suggestion that the study of the more complex processes of polymerization and macromolecular condensation might, if carried out in the gaseous phase, yield valuable information on the nature of the chain reactions involved. He threw himself into this work, both in the Department of Colloid Science at Cambridge and later at the University of Aberdeen, with his characteristic energy, and the continuous stream of papers in this field coming from these laboratories bears witness to his versatility and ingenuity in unravelling the complexities of these reactions. The School of Physical Chemistry which he created at Aberdeen combined in a characteristic manner the experimental with the theoretical. Birmingham is to be congratulated in its choice.

Genetics at Birmingham: Dr. K. Mather

Dr. Kenneth Mather, who has been appointed to the chair of genetics now established in the University of Birmingham, is known for his, in some respects, revolutionary outlook on this subject. Dr. Mather derives this outlook from a fusion of several of the main streams of thought in biology. He went from Manchester in 1931 to work at the John Innes Horticultural Institution, where he obtained a thorough grasp of the chromosome theory of heredity as it was being developed there at the time. In 1933 he went for a year to Sweden, where he gained a great deal from studying the methods of plant breeding used at Svalöv and by that notable sugar beet breeder, Dr. J. M. Rasmusson. In 1934 he took a post with Prof. R. A. Fisher, under whom he became familiar both with the breeding of mice and the still rapidly developing technique of statistical genetics, to which he began to make serious contributions. In 1937 he spent a year with Morgan and East in the United States. Finally, in 1938 he returned to take up the post of head of the Genetics Department at the John Innes Institution. There he has remained for ten years carrying out (with a success that has now been recognized) the very definite purpose and programme that he had in mind when he went there—that of combining biometry and genetics into a single efficient tool for the study of evolution, the practice of plant and animal improvement and the understanding of biology as a whole. During these years, however, Dr. Mather, like other workers in this field, has been painfully conscious of the widening gap between the advances of genetic research and the status of genetic teaching in the universities. In his new post he will have an opportunity of narrowing this gap and of rendering a great service to the University of Birmingham.

British Jute Trade Research Association

The British Jute Trade Research Association has acquired premises on the Dundee Industrial Estate to replace the temporary accommodation at present occupied in Bellfield Street, Dundee, following negotiations with the Scottish Industrial Estates, Ltd., and various Government committees. The new buildings will be utilized for future research and development in connexion with the activities of the Association, and it is hoped to be in occupation early in 1949. When completed, the Laboratory Section will cover an area of approximately 6,500 sq. ft., and will contain physical and chemical laboratories, photographic and physical dark rooms, a room where constant temperature and humidity can be maintained, machine rooms, library and administration. A separate Engineering Development Section will in the first instance cover an area of some 2,000 sq. ft., and the personnel in this Section will work in very close collaboration with the Laboratory scientific staff. The remaining space of 14,000 sq. ft. will be devoted to the Processing Section, in which will be installed a complete range of all jute processing, weaving and finishing machinery. The building will be the first industrial research laboratory of its kind to be set up in Scotland for co-operative research, and is supported by practically the whole of the jute interests. The importance of scientific research to the industry is being realized more and more, and the support for the project illustrates the desire of the industrialist to utilize every possible means to increase efficiency and quality of product.

Science and Technology in China

The Natural Science Society of China has recently inaugurated a new bulletin, *Science and Technology in China*, of which two numbers of the first volume have already appeared. It is very well printed and produced and contains many interesting articles. In the April issue, Dr. Mao I-Sheng writes on the present position and outlook of research in the engineering sciences in China; Dr. Li Ching-Yuan on current mineral exploration in China; and Dr. Jen Mei-O on the progress of land utilization surveys in the south-west part of the country. The work of the Scientific Office of the British Council in China is reviewed at some length, and the rest of the bulletin consists of research reports similar to the correspondence columns of *Nature*, together with abstracts of papers read at the February 1948 meeting of the Chinese Chemical Society at Nanking. While China has had for many years its chief scientific journal analogous to *Nature*, namely, *Ko-Hsueh*, this has always been and will continue to be published in the Chinese language. There has therefore been room for a periodical, perhaps of a smaller character but in the English language, and the new venture deserves every success. The chief editor is Dr. Wu Hsueh-Chou (director of the Chemical Institute of Academia Sinica), and inquiries and subscriptions should be addressed to him at that Institute, 320 Yoyang Road, Shanghai. Foreign subscribers may also communicate with Mr. S. H. Doo, 7137 Pennsylvania Avenue, Pittsburgh 8, Pa., U.S.A. The annual subscription is 2.00 American dollars per annum, or its equivalent.

Cambridge University Educational Film Council

The Cambridge University Educational Film Council was formed in February 1947 "to promote the use of films in higher education and for the purpose of academic research". The ultimate aim of the Council is the establishment by the University of Cambridge of a Film Centre with adequate facilities for the production, projection and storage of educational films; meanwhile, it is collecting information about educational films and film strips already in existence, giving technical advice to university departments wanting to make or project films, encouraging professional film units to consult with university teachers on the films required and their economic distribution, and arranging for the exchange of films with academic bodies of all kinds in Great Britain and other countries. Membership is open to members of the University, and all Faculties and Departments at Cambridge are automatically members of the Council. The General Board of Faculties and the Cambridge University Press appoint representatives to its executive committee. A memorandum on the provision of cinematograph facilities at Cambridge has been submitted by the Council to the General Board. The Council has already produced for distribution within the University a list of sources from which films suitable for use in university education can be procured, and obtained particulars of films made in Cambridge; it has also set up a library of film catalogues from Great Britain and abroad, and collected information regarding the use of films in a number of university departments outside Cambridge. At the suggestion of the Council, a conference on the use of films in universities was convened by the British Film Institute and the Scientific Film Association in November 1947, and a Universities Film Council for the British Isles has been established.

Televizing the Museum

The Cleveland Museum of Natural History has again shown commendable enterprise in extending its educational influence to a much larger public than habitual museum visitors (*The Explorer*: Bulletin of the Cleveland Museum of Natural History, 94; 1948). Through the courtesy of the American broadcasting station, W.E.W.S., it is now presenting a monthly television programme called "Your Museum of Natural History". Two general programmes have already been televized, one dealing with the timely subject of the Navaho Indians and the other with the recent gift to the Museum of the works of John J. Audubon, including the famous early nineteenth-century English prints of Havell. There is also a regular weekly television programme built round the Museum's explorers clubs for children; subjects so far presented include the Apache Indians, fur-bearing mammals, care of pets, bird migration and signs of spring.

Maps of Svalbard

Norges Svalbard og Ishavs-undersökelser, now known as Norsk Polarinstitutt, has begun the issue of a detailed map of Svalbard in folded sheets, each covering about 1,300 kilometres. The scale is 1 to 100,000. The map is based on a network of trigonometrical points and constructed from aero-photograms taken by oblique photography. It is in black for moraines, glacier limits and lettering, blue for seas, streams, lakes and glacier contours, brown for form lines and contours, and green for glacier slopes. In addition to the old place names in their accepted Norwegian forms, a number of new names have been added. The first sheet (price 3 kroner) covers the little-known Sörkapp area as far north as Hornsund and is numbered C.13.

Canadian National Research Council Scholarships

Scholarships have been granted by the National Research Council of Canada to 169 graduates for postgraduate studies during the academic year 1948–49. There are twenty-five fellowships at 900 dollars, sixty-three studentships at 750 dollars, seventy-five bursaries at 450 dollars tenable at Canadian universities, and ten special scholarships ranging in value from 500 to 1,000 dollars awarded for study abroad. The nominal value of all scholarships for the year is 107,900 dollars. Thirty departments of science are represented in the applications approved this year. Chemistry in its several branches is represented by 65 and physics by 62. The remaining awards are widely distributed in the other sciences as follows: agricultural bacteriology, 1; anatomy, 3; applied mathematics, 1; biology, 2; communications engineering, 2; dental bacteriology, 1; entomology, 1; experimental medicine, 1; genetics, 1; geology, 6; mathematics, 4; mathematical statistics, 3; medical research, 1; metallurgy, 1; mineralogy, 2; physiology, 3; physical metallurgy, 1; plant pathology, 1; and zoology, 7.

Conference on Civil Engineering Problems in the Colonies

A Conference on Civil Engineering Problems will be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, during July 19–23, at which a number of papers on subjects of importance in Colonial development will be read and discussed. Mr. A. Creech-Jones, Secretary of State for the Colonies, has consented to open the Conference on July 20, at 10.15 a.m. Among the topics to be discussed are: development planning with special reference to physical development, the East African groundnuts scheme, road improvement in Jamaica, railway gauge in tropical Africa, railways and roads in Malaya, problems of labour and material in West Africa, Colonial housing, and engineering aspects of tropical hygiene. The Conference is open to members of the Institution, to engineers and to other officers specially interested who are employed in the Colonial Service, and to other engineers who are otherwise engaged in civil engineering work in the Colonies. Application forms can be obtained from the secretary of the Institution of Civil Engineers.

Unione Matematica Italiana

The third national congress of the Unione Matematica Italiana is to be held at Pisa during September 23–36. The congress will be devoted to a comprehensive review of the Italian contributions to mathematics during the last few years, and particularly in so far as they are linked up with the mathematical activities of other countries during the same period. In addition to papers on pure and applied mathematics, special sections will deal more particularly with analysis, geometrical mechanics, mathematical physics, actuarial mathematics and probability, geodesy, astronomical and astrophysics, mathematics applied to engineering, the history of mathematics and didactics. The Unione Matematica Italiana cannot offer any financial assistance to visitors; but it is expected that expenses for the stay at Pisa will be low. All inquiries relating to the Congress should be sent to Prof. Luigi Berzolari, Università di Bologna, Bologna, president of the Unione Matematica Italiana, who is acting as secretary to the Congress.

British Thomson-Houston Summer School

The British Thomson-Houston Co., Ltd., Rugby, is holding a summer school in electrical engineering during July 12–16. Sir Henry Tizard is to open the school, which will consist of lectures and discussions on such topics as electronic control of motors, magnetic sheet steel, examination of large forgings, high-power pulse generation, power system analysis, switchgear problems, betatron developments, electric discharge and fluorescent lamps, etc. Tours of the Company's works have also been arranged. The purpose of the school is to enable engineers in academic posts to obtain first-hand knowledge of the more important recent advances in electrical engineering; attendance is by invitation of the Company. Further particulars can be obtained from the Manager, Publicity Department, British Thomson-Houston Co., Ltd., Rugby.

Seventh International Congress of Food and Agricultural Industries

The Seventh International Congress of Food and Agricultural Industries will meet in Paris during July 12–18 at the invitation of the French Government. Among the subjects for discussion are: the role of vitamins, hormones and trace-substances, ionic exchanges in sugar-refining, fermentation, homologization of malt, bread-making qualities of wheats, rational use of the combined harvester, improvements in the dairying and canning industries, advances in the feeding of livestock, digestibility of fats and oils, destruction of organic matter in waste waters, standardization of statistical methods, and technical instruction. Further details can be obtained from the Commission Internationale des Industries Agricoles, 18 Avenue de Villars, Paris.

University of London

The following appointments in the University of London have been announced: Dr. G. C. McVittie, to the University chair of mathematics tenable at Queen Mary College as from October 1; since 1936 he has been reader in mathematics at King's College, but during the War was engaged on work at the Government Communications Headquarters. Dr. Sidney Smith, honorary professor of Near Eastern archæology at the Institute of Archæology, London, to the University chair of ancient Semitic languages and civilizations tenable at the School of Oriental and African Studies, as from October 1.

The title of professor emeritus of physics in the University has been conferred on Dr. Frank Horton, professor of physics at Royal Holloway College during 1914–46 and vice-chancellor of the University during 1939–45. The title of professor emeritus of chemistry in the University has been conferred on Prof. T. S. Moore, professor of chemistry at Royal Holloway College during 1914–46.

The degree of D.Sc. has been conferred on Dr. Adrien Albert (School of Pharmacy), Louis Essen and A. E. J. Went.

The Night Sky in July

New moon occurs on July 6d. 21h. 09m., U.T., and full moon on July 21d. 02h. 31m. The following conjunctions with the moon take place: July 5d. 16h., Venus 8° S.; July 5d. 18h., Mercury 8° S.; July 9d. 06h., Saturn 4° S.; July 11d. 16h., Mars 3° S.; July 18d. 01h., Jupiter 4° N. Mercury is too close to the sun in the early part of the month to be observed, but in the middle of the month the planet rises an hour before sunrise and attains its greatest westerly elongation on July 16. At the end of the month Mercury rises at 3h. 16m., about an hour before sunrise. Venus rises about a quarter of an hour before the sun on July 1 but can be observed later in the month, rising at 2h. 28m. and 1h. 41m. on July 15 and 31, respectively. The planet attains its greatest easterly elongation on July 16 and its greatest brilliancy on July 31, when its stellar magnitude is −4·2. Mars sets at 23h. 10m., 22h. 30m. and 21h. 45m. at the beginning, middle and end of the month, respectively, and can be seen for a short time in the western sky after sunset. Jupiter, in the constellation of Ophiuchus, is visible during the early part of the night, setting at 2h. 40m., 1h. 36m. and 0h. 33m. at the beginning, middle and end of the month, respectively. Owing to its large declination south, nearly 23°, the planet is not very well placed for observation in high northern latitudes. Saturn sets about an hour before Mars and cannot be observed very long after sunset; at the end of the month it sets a little more than half an hour after the sun. No occultations of stars brighter than magnitude 6 take place in July. The earth reaches aphelion on July 4, when its distance from the sun is 94,561,000 miles.

Announcements

Dr. Julian Huxley has been elected *Correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences.

The honorary degree of D.Sc. of the University of Oxford has been conferred on Dr. Isaiah Bowman, president of Johns Hopkins University, and president during 1931–34 of the International Geographical Union; and on Prof. Linus Pauling, professor of chemistry and director of the Gates and Crellin Chemical Laboratories, California Institute of Technology, who is now George Eastman visiting professor at Oxford.

Mr. E. I. R. MacGregor has been appointed assistant civil air attaché at the British Embassy, Washington, in succession to Mr. N. Bicknell, who is entering the Foreign Service. Mr. MacGregor took first-class honours in physics at the Queen's University, Belfast, and after a short period on television research with Electric and Musical Industries, Ltd., he entered the R.A.F. Education Service (1936). During 1941–46 he served on the British Air Commission and R.A.F. Delegation at Washington.

A new exhibit of Protozoa in the Zoological Department of the British Museum (Natural History) has been opened to the public. It adjoins the Coral Gallery, which was reopened a few weeks ago. Owing to the minute size of these organisms, all but a few of the larger marine forms are displayed either by means of enlarged glass models or by tinted line drawings.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Carbon Monoxide Affinity of Chlorocruorin and Hæmoglobin

CHLOROCRUORIN, the green-red respiratory blood pigment of certain marine annelid worms, is the only known substance built on the same plan as hæmoglobin. Like most kinds of hæmoglobin, chlorocruorin has a higher affinity for carbon monoxide than for oxygen[1]. This property, valueless to animals, is utilized in experimental work to eliminate the possible respiratory activity of these pigments and so to test their functional significance[2,3]. The relative affinity of chlorocruorin (*Ch*), or of hæmoglobin, for the two gases in the reversible reaction

$$O.Ch + CO \rightleftharpoons COCh + O_2$$

is given by the equilibrium constant K in the equation

$$K = [COCh]/[O.Ch] \times p\,O_2/p\,CO,$$

from which it is seen that when the pigment is 50 per cent in the carboxy state and 50 per cent in the oxy state, K becomes the ratio of oxygen to carbon monoxide.

Krogh[4] was the first to show that different kinds of animals have different values of K. For the hæmoglobin of human blood, K has been found to be 235 or 246 (Douglas, Haldane and Haldane)[5], 240 (Killick)[6] or 490 (Anson *et al.*)[7]. The values for certain other hæmoglobins have been found to be as high as this or higher. For yet other hæmoglobins the values of K are low, that of horse muscle hæmoglobin (myoglobin)[8,9] being 14–51, of the hæmoglobin of leguminous root nodules[10] 37, and of the larva of the horse bot-fly (*Gastrophilus*)[11] 0·67. With these very considerable known differences in the relative affinity of hæmoglobins for carbon monoxide and oxygen, it was of interest to find the values of the equilibrium constant for several invertebrate hæmoglobins and for a chlorocruorin.

The blood of each kind of animal was diluted in $M/20$ phosphate buffer at pH 7·3 and then centrifuged and filtered to give a limpid solution. Some of this was put into a modified Thunberg tube with a 2 cm. optical cell, and the concentration was adjusted to give an optical density ($\log_{10} I_0/I$) of about 1·5 at the α-band, measured with a Hilger – Nutting visual spectrophotometer. After equilibration at 20° C., with air in the case of hæmoglobin, or oxygen for chlorocruorin (which cannot be saturated with oxygen at atmospheric partial pressure[1]), the densities were determined at wave-lengths 561 and 578 mμ for hæmoglobin, or 590 and 606 mμ for chlorocruorin. Previous plotting of the absorption curves of the oxy and carboxy compounds had shown that the two wave-lengths mentioned are those at which the light absorption differs most. The Thunberg tube was then evacuated, filled with an appropriate mixture of oxygen and carbon monoxide to obtain about a half-and-half mixture of the two compounds of the pigment, and the solution equilibrated with the gas by rotation for half an hour in a water thermostat at 20° C. in dim light, after which the changed densities were determined at the same two wave-lengths. (Although both carboxy compounds are dissociated by light[12,1], there was no progressive change in the spectrophotometer readings, even when the solution was left exposed to the lamp for a quarter of an hour; doubtless measurable changes only occur in thin layers.) The third step was to evacuate the tube anew, fill it with pure carbon monoxide, re-equilibrate and again measure the two densities. From the six density measurements the relative concentrations of the oxy and carboxy compounds in the solution in equilibrium with the gas mixture can be calculated by a formula given by Keilin and Wang[11], and from this the value of K in the equation above is directly deducible.

The following are the values of K which were obtained, in decreasing order of magnitude, the first being that of chlorocruorin, the remainder all of blood hæmoglobins: *Branchiomma vesiculosum* (Montagu), 570; *Chironomus dorsalis* Mg., 400; horse, 280; man, 230; *Arenicola marina* L., 150; *Tubifex* sp., 40; *Planorbis corneus* L., 40; rabbit, 40. From five to eleven determinations were made for each of the different animal forms. The values of K obtained for each of them varied considerably, and as there were not enough values to give standard errors, the means have been rounded to the nearest 10. There are several surprises in the results. The values differ greatly. The figure for man is virtually the same as those previously found by Douglas, Haldane and Haldane[5], and by Killick[6], which are given above. Anson *et al.*[7], who obtained a much higher value for man, agree with me in placing the horse a little above man and the rabbit much lower. The highest hæmoglobin value is that of the bloodworm, the larva of a midge, *Chironomus*. But chlorocruorin has a far higher value than any hæmoglobin. The lowest values which I found, namely, those of the oligochæte worm *Tubifex*, of the pond snail *Planorbis* and of the rabbit, are about the same as for the muscle hæmoglobin of the horse and the hæmoglobin in the root nodules of leguminous plants.

It is not possible at present to correlate the diverse values of K with other properties of these hæm pigments. *Chironomus*, with the highest value of K for any hæmoglobin, has also the highest oxygen affinity of a blood hæmoglobin[13], but chlorocruorin, with a still higher K, has an oxygen affinity much lower than any hæmoglobin[14]. The hæmoglobin in the muscle of the horse has a higher oxygen affinity than that of the blood, but a much lower K. The highest value of K in a hæmoglobin (*Chironomus*) and the lowest value (*Gastrophilus*) are both in the Insecta, in which class hæmoglobin is extremely rare. Keilin and Wang[11] have shown that there is no relation between K and span (difference between wave-lengths of oxy and carboxy α-bands) as was once thought. It is for future biochemical and physicochemical research to find the meaning of the very diverse values of K.

My sincere thanks are due to Prof. D. Keilin and Dr. E. F. Hartree for advice and help.

H. MUNRO FOX

Molteno Institute, Cambridge.

May 14.

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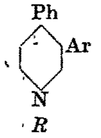
Synthetic Analgesics

ATTEMPTS to prepare new analgesics have, for many years, been based almost exclusively on the morphine molecule, the peripheral groups of which may be modified considerably with relatively little effect on the biological activity. The synthetic drug 'Pethidine' (ethyl 4-phenyl-1-methylpiperidine-4-carboxylate) has several structural features in common with morphine, and there is a considerable body of evidence which relates analgesics of the piperidine type to the morphine model[1–4]. The recently discovered 'Amidone' (*dl*-2-dimethylamino-4 : 4-diphenylheptan-5-one) is also a potent analgesic. We have examined three types of compound for analgesic, antispasmodic and local anæsthetic action. Although none of these compounds is closely related to morphine, several have an analgesic potency equivalent to or approaching that of 'Pethidine'.



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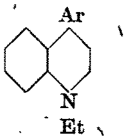

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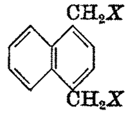

III

The synthesis of compounds of type I has already been reported[5]. Compounds of type II (in which Ar=Ph, or p-MeO.C_6H_4—) have been prepared by hydrogenation of the oximes of ethyl β-(2-keto*cyclo*hexyl)-β-arylpropionates, and the *p*-methoxy compound has also been demethylated to the corresponding *p*-hydroxy derivative[6]. The preparation of our compounds of type III has not previously been described. 1 : 4-*Bisdiethylaminomethylnaphthalene hydrochloride* (X = —NEt) was obtained as colourless needles, m.p. 229–230°, by condensing 1 : 4-bischloromethylnaphthalene[7] with diethylamine. (Found: C, 63·3; H, 8·4; N, 7·0. $C_{20}H_{32}N_2Cl_2.\frac{1}{2}H_2O$ requires C, 63·1; H, 8·7; N, 7·3 per cent. The *picrate* formed yellow needles, m.p. 203–204°. Found: C, 50·65; H, 4·6; N, 14·9. $C_{32}H_{36}O_{14}N_8$ requires C, 50·8; H, 4·8; N, 14·8 per cent.) 1 : 4-*Bis*iso*thiocarbamidomethylnaphthalene hydrochloride* (X = —SC(=NH)NH_2) was obtained as colourless plates, m.p. 270–272°, from the bischloromethyl compound and thiourea. (Found: C, 44·8; H, 4·6; N, 14·5. $C_{14}H_{18}N_4Cl_2S_2$ requires C, 44·6; H, 4·8; N, 14·8 per cent. The *picrate* formed yellow needles, m.p. 219–220°. Found: C, 41·2; H, 3·0. $C_{26}H_{22}O_{14}N_{10}S_2$ requires C, 41·0; H, 2·9 per cent.)

The L.D.$_{50}$ in mgm./kgm. was determined by intraperitoneal injection in white mice. Of the N-alkyl-3 : 4-diarylpiperidines (type I), increase in the length of the alkyl chain decreased toxicity from 90 mgm./kgm. for 3 : 4-diphenyl-1-methylpiperidine to 250 mgm./kgm. for 3 : 4-diphenyl-1-*n*-butylpiperidine. In group II, 1-ethyl-4-(*p*-hydroxyphenyl)decahydroquinoline (120 mgm./kgm.) was less toxic than the unsubstituted 4-phenyl compound (80 mgm./kgm.). In group III, the thiourea derivative (61 mgm./kgm.) was much more toxic than the diethylamino derivative (370 mgm./kgm.). The Straub tail phenomenon was present in greater or less degree in mice poisoned with various members of each group. Compounds of types I and II mainly produced motor excitement (as does 'Pethidine'); group III was depressant.

TOXICITY AND ANALGESIC ACTIVITY

Name	Relative analgesic potency (mice)	L.D.$_{50}$ (mgm./kgm.) intraperitoneal injection, mice
3 : 4-Diphenyl-1-methylpiperidine HCl	stimulant	90
3 : 4-Diphenyl-1-ethylpiperidine HCl (*A* isomer)	0·6	100
3 : 4-Diphenyl-1-ethylpiperidine HCl (*B* isomer)	0	130
3 : 4-Diphenyl-1-*n*-butylpiperidine HCl	0·6	250
4-Phenyl-3(*p*-methoxyphenyl)-1-ethylpiperidine HCl	0·4	150
4-Phenyl-1-ethyldecahydroquinoline HCl	0·6	81
4-(*p*-Methoxyphenyl)-1-ethyl-decahydroquinoline HCl	0·7	100
4-(*p*-Hydroxyphenyl)-1-ethyl-decahydroquinoline HBr	0	120
1 : 4-Bisdiethylaminomethyl-naphthalene HCl	1·0	370
1 : 4-Bis*iso*thiocarbamidomethyl-naphthalene HCl	1·0	61
'Pethidine'	1·0	150

Drugs in group I were irritant when placed in the conjunctival sac of rabbits, and neither group I nor group III showed any evidence of local anæsthetic properties. Group II drugs were less irritant than group I and had some effect as anæsthetics. The most powerful, 1-ethyl-4-(*p*-methoxyphenyl) decahydroquinoline, had a potency of 10 per cent of cocaine hydrochloride. The compounds were tested for antispasmodic activity against barium chloride (5 mgm.), histamine base (1 μgm.), acetylcholine (1 μgm.) in a 75 ml. bath. None of the compounds was highly specific, but all had some antispasmodic activity. Group I compounds were most active, 3 : 4-diphenyl-1-ethylpiperidine having 1/33 the activity of benadryl against spasm induced by histamine; against acetylcholine, 1/250 the activity of atropine sulphate; against barium, 1/6 the activity of 'Pavatrine'. Group II and group III were of a similar order of potency against barium-induced spasm, but much less active against histamine and acetylcholine. The analgesic potency was estimated according to the method of Davies *et al.*[8], except that mice were used instead of rats. Group III drugs were found to be equal in potency to 'Pethidine'. Groups I and II showed lesser and varying degrees of potency, and 3 : 4-diphenyl-1-methylpiperidine is a stimulant. The considerable analgesic activity of 1 : 4-bisdiethylaminomethylnaphthalene is of interest, as this is a new class of compound to exhibit pronounced activity.

G. M. BADGER*
J. W. COOK
G. M. S. DONALD
J. D. P. GRAHAM*
T. WALKER

Departments of Chemistry
and of Materia Medica,
University of Glasgow.
March 24.

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* I.C.I. Research Fellows.

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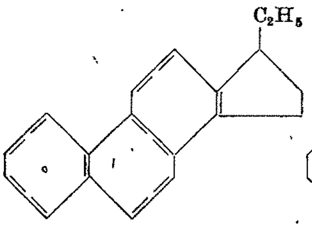
Constitution of Conessine

PREVIOUS work has shown that the alkaloid, conessine, is a ditertiary base, $C_{24}H_{40}N_2$, containing three N-methyl groups and one ethylenic linkage, and our work now establishes a relationship with the growing class of steroid bases. The absence of oxygen is noteworthy; this is uncommon in the alkaloids, and the natural occurrence of an oxygen-free steroid derivative has not been reported previously.

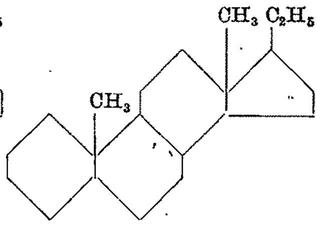
The first indication of the structure came from an examination of the selenium dehydrogenation products of the hydrocarbon mixture, $C_{21}H_{30}$, obtained by pyrolysis of conessine dihydriodide[1]. Careful fractionation of the products yielded a crystalline hydrocarbon, $C_{19}H_{18}$, m.p. 78–79°, which showed many similarities with synthetic[2] 3′-ethylcyclopentenophenanthrene (I), m.p. 84·5–85·5°.

Although the hydrocarbons and their derivatives with nitrohydrocarbons gave no depression in melting point on admixture, it was not possible to raise the melting point of the hydrocarbon obtained from conessine, even after recovery from the nitrohydrocarbon complexes; and, as some discrepancies were observed on comparison of the ultra-violet absorption spectra and X-ray photographs of the two hydrocarbons, the identity was not convincingly established.

By subjecting conessine to successive degradations by the Hofmann and Emde processes, Späth and Hromatka[3] obtained a hydrocarbon, $C_{21}H_{30}$, which gave a hexahydroderivative, $C_{21}H_{36}$, m.p. 56–58°. In our hands this reduction has yielded approximately equal amounts of two isomeric hydrocarbons, $C_{21}H_{36}$, m.p. 56–58° and 83–84° respectively. The former is presumably identical with the hydrocarbon obtained by Späth and Hromatka, and the isomer, m.p. 83–84°, is identical, chemically and physically, with *allo*pregnane (II), prepared from progesterone by described methods[4].



I



II

The carbon atoms of conessine are therefore accounted for by the *allo*pregnane structure (II) and the three N-methyl groups, but the positions of the ethylenic linkage and the points of attachment of the basic centres are still uncertain. Structural investigations on conessine and its relatives are being developed in several directions, and a full account will be published elsewhere.

R. D. HAWORTH
J. MCKENNA
NAZAR SINGH

Department of Chemistry,
University, Sheffield 10.
March 22.

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[1] Siddiqui and Sharman, *Proc. Ind. Acad. Sci.*, 6 A, 191 (1937).

[2] Riegel, Gold and Kubico, *J. Amer. Chem. Soc.*, 65, 1772 (1943).

[3] *Ber.*, 63, 126 (1930).

[4] Butenandt and Fleischer, *Ber.*, 68, 2096 (1935). Marker, Kamm, Oakwood, Whittle and Lawson, *J. Amer. Chem. Soc.*, 60, 1066 (1938).

Quantitative Electron-Density Contour Delineation in the Electronic Fourier Synthesizer for Crystal Structure Analysis

THE electronic Fourier synthesizer for crystal structure analysis reported earlier from this laboratory[1] has been modified so that contour lines of projected electron densities from one cell on any desired lattice plane can be accurately delineated.

It was originally intended that a pattern corresponding to a Bragg photographic synthesis be presented on a cathode ray tube screen; and the remark was made in the early report that such a presentation should not be considered as a replacement for accurately calculated contour maps, due to obvious limitations on linearity and range of screen response. This inexactness is removed by triggering coincidence circuits, set at predetermined voltage levels, directly from the voltage signal formerly applied for intensity modulation to the cathode ray tube grid. The circuits produce 1 microsec. pips each time the synthesized signal crosses one of the preset voltage levels, and these are applied to the cathode ray tube grid in place of the entire synthesis signal.

Fig. 1

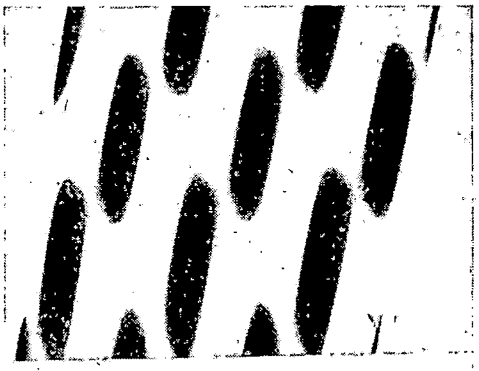
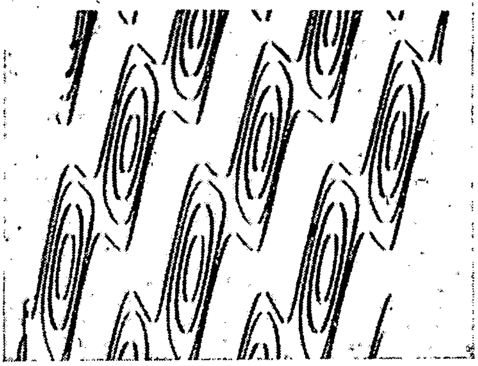


Fig. 2



The contouring technique has been applied to the model synthesizer which was demonstrated at the Annapolis meeting of the Crystallographic Society of America on March 20, 1947[2]. Fig. 1 shows an intensity-modulated pattern corresponding to the superposition of (2, 0, 3) and (1, 0, $\bar{3}$) fringes, for a c-axis projection of a monoclinic cell with $a : c \approx 1 \cdot 0 : 1 \cdot 1$ and $\beta \approx 81°$. Fig. 2 shows a four-line contour map of the same projection. (It may be recalled that the axial ratio and angle of a projection can be adjusted at will on the synthesizer[1].) These photographs are obtained directly from the presentation tube.

The apparent difference in contours of some peaks in Fig. 2 is due to non-linearity of sweep in the model synthesizer. In the large synthesizer for a 20 by ± 20 matrix of terms, construction of which is in progress, these and other imperfections are removed. Co-ordinate lines (of controllable intensity) are also available in the large device, so that accurate location of peaks is possible. The size and conditions of operation of the final synthesizer will be such that as many contour lines as are desired can be accommodated. The zero-level of electron density can be set in through adjustment of the overall D.C.-level of the synthesized signal.

Development of the electronic Fourier synthesizer is supported by the Office of Naval Research, Navy Department, Washington, D.C., under Contract No. N7onr-377.

The simple contouring procedure grew out of conversations with Prof. A. L. Patterson, of Bryn Mawr College. The long-standing interest, support and valuable suggestions of Prof. Patterson in this entire development are much appreciated.

R. PEPINSKY
D. SAYRE

Alabama Polytechnic Institute,
Auburn, Alabama.
March 11.

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[1] Pepinsky, R., *J. Appl. Phys.*, 18, 601 (1947).

[2] Pepinsky, R., *Amer. Mineralog.*, 32, 693 (1947).

Low-Angle X-Ray Diffraction Pattern of Collagen

IT is generally accepted that the low-angle X-ray diffraction pattern of collagen is unidimensional in the direction of the fibre axis with a fundamental period of 640 A. [1]. Variations in the water content of the fibre, effected by a control of the ambient relative humidity during the X-ray exposure, alter this spacing from 628 A. at 2 per cent relative humidity to 672 A. at 100 per cent relative humidity. This continuous increase in spacing is accompanied by drastic fluctuations in the relative intensities of the various orders.

If the uptake of water by the collagen produced a uniform extension of the molecule, no change in the intensities of the orders in the diffraction pattern would be observed. The intensity variations of the reflexions which do occur can only be explained by a non-uniform alteration in the electron density. As the most significant intensity changes occur in the low-order reflexions, the increase in spacing brought about by water absorption could be interpreted as water entering between the collagen molecules, thus influencing molecular packing. Any non-uniform change in the molecular configuration, such as an alteration in the spacing of certain atomic groups, would occur over relatively short distance in the molecule and would affect the intensities of the high-order reflexions accordingly. Perutz[2] has observed similar effects in the variations in the intensities of reflexions in the X-ray diffraction patterns of crystalline proteins.

The source of collagen used for this X-ray diffraction study was kangaroo tail tendon, since a high degree of orientation is present in the natural state of the material. By staining all the samples with an unbuffered 1 per cent solution of phosphotungstic acid, the intensity of all the reflexions was increased (thus reducing the required exposure time), with no apparent alteration of the diffraction pattern.

INTENSITY OF ORDERS

Relative humidity	100%	100%	90%	55%	30%	20%
Order number						
2	2	1	6	13	7	9
3	21	24	21	16	13	17
4	5	6	13	12	9	14
5	58	53	36	13	14	12
6	14	13	28	26	24	39
7	30	31	22	12	12	13
8	14	18	18	12	10	12
9	29	29	27	18	13	14
10	5	4	4	2	2	1
11	8	9	9	6	3	4
12	8	8	4	3	3	3
13	5	4	5	5	3	2
14	2	3		2		2
15	5	6		3		2
16	2	2		2		1
17	4	4		4		2
18	4	4		3		
19	4	5				2
20	4	5				
21	3	1				
22	3	3				
23	1	1				
24	2	1				
25	2	3				
26	2	3				
27	2					
Fundamental spacing in A.	672	666	655	646	636	630

The accompanying table indicates the humidities at which the diffraction patterns were photographed, the corresponding fundamental spacings, and the intensities of the various orders as measured by densitometric methods. Accurate comparison of these films is not possible because of variations in sample thickness and in film development. Recently, a second series of diffraction patterns has been photographed in which the same sample was used throughout, and all films were processed simultaneously. This procedure permits the desired accurate comparison of intensities. Further experiments are now in progress.

BARBARA A. WRIGHT

Research Division,
United Shoe Machinery Corp.,
Beverly, Mass.
Feb. 20.

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[1] Bear, R. S., *J. Amer. Chem. Soc.*, 66, 1297 (1944).

[2] Boyes-Watson, J., Davidson, E., and Perutz, M. F., *Proc. Roy. Soc.*, A, 191, 83 (1947).

X-Rays and the Eigen-Vibrations of Crystal Structures

IN evaluating the effect of the atomic movements in a crystal on the propagation of a beam of X-rays through it, such of these movements as may be identified with the elastic modes of vibration of the solid may be taken up first for consideration. Each of these modes presents a distinctive pattern of nodal surfaces, the frequency of the oscillation being the same everywhere and the phase being opposite in every pair of adjacent cells in the pattern. The configuration of the nodal surfaces in any given mode is determined by various *macroscopic* factors, namely, the form of the crystal, the external boundary conditions and the elastic anisotropy, besides being dependent on the frequency of the mode. Hence, it would bear no particular relation to the atomic architecture of the crystal and would also be different for each of the numerous possible modes. These circumstances have important consequences in relation to the optical aspects of the problem. Each atom in the track of the X-ray beam may be considered as a source of secondary radiations of frequencies ν, $\nu + \nu^*$ and $\nu - \nu^*$, ν being the frequency of the X-radiation and ν^* that of the elastic vibration under consideration, and their effects have to be summed up over the illuminated volume. Since the amplitudes and phases of the radiations of modified-frequency depend on the amplitudes and phases of the atomic movements, they would vary from atom to atom in a manner determined by the configuration of the nodal pattern, and hence would be different for each different ν^* and in no case would be definitely correlated with the internal architecture of the crystal. It follows that these scattered radiations cannot possibly give rise to any geometric diffraction pattern exhibiting an observable relationship to the structure of the crystal.

It remains to consider the possible vibrations in the solid which cannot be described as elastic modes, but which, on the other hand, are specifically related to the structure of the crystal and may therefore be designated as its eigen-vibrations. That such vibrations exist is proved by spectroscopic investigations, and their number and nature have been investigated by me[1] with results which have found experimental confirmation in various cases[2]. Since these eigen-vibrations are specifically related to the structure of the crystal, the secondary radiations of modified frequency resulting therefrom should be capable of giving rise to geometric diffraction patterns having a recognizable relationship to the internal architecture of the crystal. Theoretical considerations thus lead us to recognize the fundamental connexion between the eigen-vibrations of crystal structures and the dynamic X-ray reflexions exhibited by them. The existence of such a relationship and the possibility of the eigen-vibrations being excited even in the absence of thermal agitation first become apparent from the experimental facts discovered in the case of diamond by the present writer and Dr. P. Nilakantan[3].

C. V. RAMAN

Indian Institute of Science,
Bangalore.
March 14.

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[1] *Proc. Ind. Acad. Sci.*, A, **18**, 237 (1943).

[2] *Proc. Ind. Acad. Sci.*, A, **26**, 339 (1947).

[3] *Current Science*, **9**, 165 (1940).

Observations of Scatter Clouds

THE observations made recently by P. Millman and his colleagues in Canada[1] are of particular interest to me. I have made many observations of these scatter clouds on waves of about 8 or 9 Mc./s. Thousands of photographs have been obtained, and an explanation of the effect of the clouds upon long-distance transmission has been given[2].

Although there is strong evidence that ultra-short-wave radar transmission is connected with meteors, the results of Millman and his colleagues show very clearly that scatter clouds are not only produced by meteors. I have shown that there is a large increase in these scatter clouds before a Dellinger fade (see Figs. 1 and 2). In Fig. 1 we see a number of scatter clouds which are not associated with visible meteors. The visible meteors are shown by marks at the edge of the film. In Fig. 2 we see a number of scatter clouds which occurred just before a Dellinger fade.

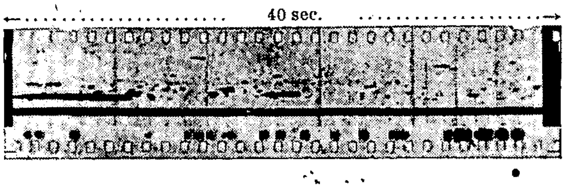


Fig. 1. G.M.T. 0130–0200, Nov. 15, 1937. ONGAR, GOX, 32·35 M.

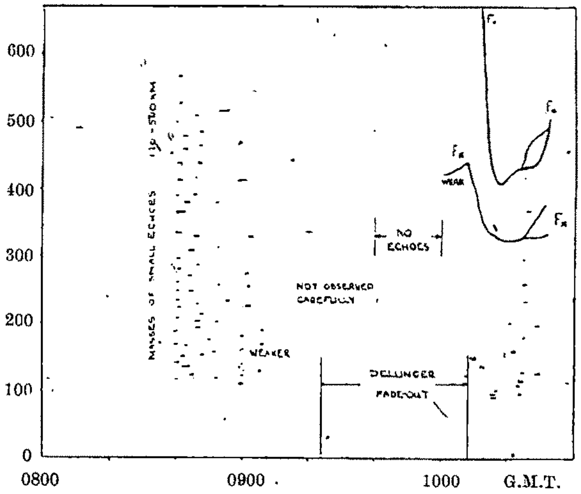


Fig. 2

The mechanism I conceive of the production of scatter clouds in Dellinger fade conditions is as follows. There is a disturbed condition of the sun before, during and after Dellinger fades, with a large amount of ultra-violet radiation from it. This will produce photo-ionization in the particles of cosmic dust suspended at about 100 km. height. Before a Dellinger fade, such particles will produce showers of photo-electrons, and these will produce localized scatter clouds.

There are four main effects observed by Millman and his colleagues, and they can all be explained by the theory of the evaporation of meteors[3], the conditions obtaining during Dellinger fades and the physics of scatter clouds. They are:

(1) The absence of correlation of scatter clouds with meteors. They can equally well be associated with Dellinger fades.

(2) The presence of two types of scatter cloud in and above the *E* layer. This implies that there must be two different types of particle. These are the evaporated meteors and the unevaporated meteors. Meteor effects are exaggerated on high frequencies.

(3) The inadequacy of the explanation of height constancy obtained geometrically when the line from the transmitter cuts the meteor orbit at right-angles. The height constancy is a definite consequence of my theory of scatter clouds, and is produced by the range of penetration of the molecules from the particles evaporated. In the Dellinger fade theory, it depends upon the range of the photo-electrons.

(4) The effect of wave-length. The wave-length effect can best be understood by referring to the mathematical form of the intensity of the waves scattered from a cloud. This is:

$$\delta\nu^2 (\lambda/a)^4 \exp\{-f(h)\},$$

where ν is the critical frequency corresponding to the density of the cloud, a is the radius of the cloud, and $f(h)$ is a function of the height of the cloud above the earth.

This has three factors, which show that the biggest effect is produced by a large number of particles, that the wave-length λ reduces the effect at a given height in proportion to λ^4, and that there is an attenuation factor which is dominant. This attenuation factor has much more effect than the λ factor, and we get observations when the attenuation is small and the λ^4 factor does not matter so much.

Observations show that the only wave-lengths on which scatter clouds are wholly associated with meteors, and not with Dellinger fades, are the short ones. On all others they may equally well be associated with either. A comparison between the results of long-wave and short-wave experiments is interesting.

My picture is this: Meteor clouds and meteors penetrate rather deeply into the atmosphere and can only be observed when the attenuation factor is small, that is, when sufficiently high frequencies are used. The result is that sufficiently short radio waves select the meteor-produced clouds. Those produced at a constant height, as in Dellinger fade effects, are not selected, and require long waves to disclose them.

Fig. 14 in my paper referred to earlier[2] shows that the field scattered from a cloud is proportional to λ^4. This is a complete experimental confirmation of the theory of scatter clouds.

T. L. ECKERSLEY

"Weatheroak",
Danbury,
Essex.
April 19.

[1] *Nature*, **161**, 278 (1948).

[2] *J. Inst. Elect. Eng.*, **86**, No. 522, 548 (June 1940).

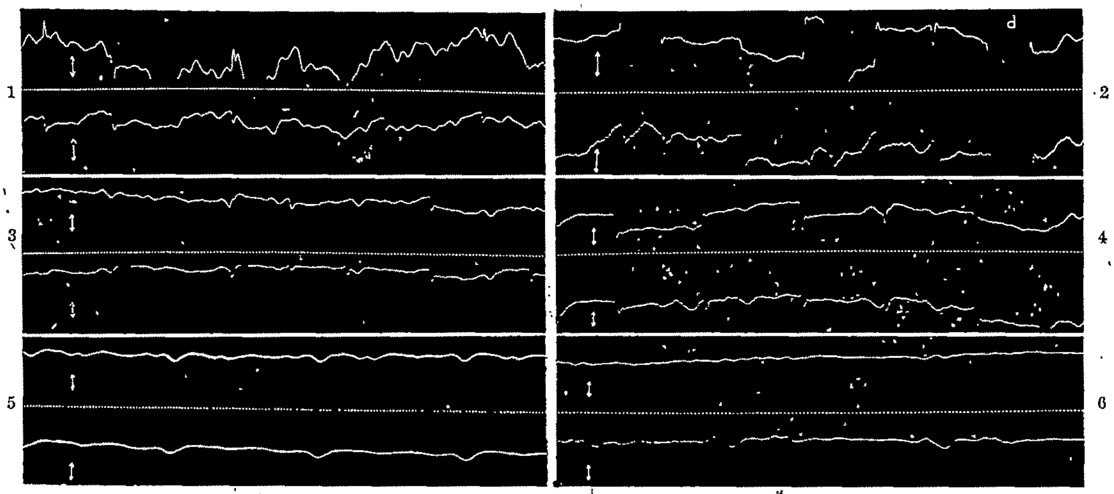
[3] *Nature*, **160**, 91 (1947).

Eye Movements During Monocular Fixation

A METHOD of recording small eye movements during monocular fixation has been described by one of us[1], in which a beam of ultra-violet radiation (λ = 3650 A.) is incident on the cornea in such a direction that the fraction of the light transmitted through the cornea falls on the subject's blind spot when some test object is fixated by the illuminated eye; the subject is then, in effect, only aware of the fixation target. Part of the radiation, however, is reflected at the cornea; this reflected beam strikes a half-aluminized mirror and is there divided so that one part falls on a vertical straight edge and the other on a horizontal one. In each case, more or less of the radiation passes the straight edge as the eye moves, the fraction passed being focused on to an electron multiplier photocell. The output of each multiplier is amplified and fed to a cathode ray oscillograph, the time base of which is suppressed. The two oscillograph beams are in this way arranged to give vertical traces only, which are photographed simultaneously on a continuously moving film travelling in the horizontal direction. The eye movements can then be deduced from the two records on the film. The system is sufficiently sensitive to detect eye movements of 1 minute of arc; deflexions due to noise from the multipliers do not, in general, correspond to more than half a minute of arc.

To reduce head movements, the subject is placed in the prone position with the head resting on a firm foundation and partially supported in a sling. He also bites on a dental impression mouthpiece suspended above him from an adjustable mounting. Slight head movements, however, persist; their effect on the corneal reflex, apart from compensating eye movements, was first found by recording the reflexion from an artificial cornea supported on a spectacle frame just above the live cornea. Afterwards, a more rigid attachment of the artificial cornea to the skull was obtained by mounting it on an aluminium strip, the other end of which was fixed to a dental regulation band clamped round one of the front teeth of the upper jaw. This method, however, presents difficulties in the case of observers with closely set teeth.

Head movement records for W. D. W. are shown in Fig. 1, as obtained by the tooth attachment method. The movements are seen to be periodic and are evidently related to the beating of the heart. The longitudinal movements are appreciably greater than the sideways displacement; but, even so, the greatest movement shown in the record corresponds to a displacement of the head of only 0·01 mm. Subject M. P. L. was unable to use the tooth attachment, but her steadiest eye movement records show



1. HEAD MOVEMENTS OF W. D. W. 2. HEAD MOVEMENTS OF M. P. L. (DERIVED). 3 and 5. EYE MOVEMENTS OF W. D. W. FIXATION TARGET, BRIGHT SPOT ANGULAR DIAMETER 3 MINUTES: 4 and 6. EYE MOVEMENTS M. P. L. FIXATION TARGET, BRIGHT CROSS, ANGULAR WIDTH ARM 1 MINUTE, ANGULAR LENGTH ARM 20 MINUTES. TIME MARKED BY DOTS, 50 PER SECOND. AMPLITUDE SHOWN AT SIDE; HEIGHT OF ARROWED LINE REPRESENTS 10 MINUTES OF ARC. UPPER RECORD GIVES EYE MOVEMENTS IN VERTICAL PLANE, LOWER RECORD IN HORIZONTAL PLANE

a periodicity similar to that occurring in the head movement records of W. D. W. From a study of several of her steadiest records, it was thus possible to deduce her head movements indirectly, as shown in Fig. 2.

Records 3 and 4 show typical eye movements for each subject during monocular fixation, when the subject was at his steadiest. The main feature which distinguishes the eye movements from the head movements is the rapid flick lasting 0·02–0·03 sec. and indicating a momentary angular movement of the eye of amplitude ranging from about 3 to 14 minutes of arc, and an average frequency of about 2 per sec. for W. D. W. and 3 every 2 sec. for M. P. L.

Between these flicks most of the recorded movement could be attributed to head movements, although in the absence of simultaneous head and eye movement records this is not certain. After each flick, the records suggest that the eye may take up a slightly different fixation direction displaced some few minutes of arc from the previous direction. This effect might be due to slight irregularities building up on the corneal surface; however, after-image experiments, for example, observation of the after-image of a bright annulus during fixation of a point source of light, seem to confirm the first interpretation.

On the majority of occasions, however, it was impossible to obtain records as steady as those in Figs. 3 and 4, random eye movements of 10 or 20 minutes of arc commonly occurring, as shown in Figs. 5 and 6. The gap at P in record 5 is due to a blink and indicates obstruction at the centre of the cornea lasting for 0·2 sec., in general agreement with data presented recently by Lawson[2]; in this, as in most cases, little subsequent disturbance in fixation direction has been produced.

Tests made with various fixation targets showed no significant variation in fixation ability, relative to the day-to-day variation in ability to fixate on a given target. There is little evidence of any fine vibratory movements having a period of the order of 0·02 sec. as reported by Adler and Fliegelman[3] and discussed at length by Jones and Higgins[4] in connexion with the resolving power of the eye.

We wish to acknowledge with thanks the financial support of the Medical Research Council in this work, and also the help of Mr. J. Baird in connexion with the dental regulation band.

MARY P. LORD
W. D. WRIGHT
Technical Optics Section,
Imperial College of Science and Technology,
London, S.W.7.
March 12.

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[1] Lord, *Proc. Phys. Soc.* (in course of publication).

[2] Lawson, *Nature*, **161**, 154 (1948).

[3] Adler and Fliegelman, *Arch. Ophthalmol.*, **12**, 475 (1934).

[4] Jones and Higgins, *J. Opt. Soc. Amer.*, **37**, 217 (1947).

The Fundamental Colour Sensations

IF pressure, sufficient to be thoroughly uncomfortable, is maintained by the fingers on the eyeball, numerous violet dots will eventually appear in among the other entoptical phenomena. Each dot lasts a second or so. If the pressure is suddenly released, all the entoptical phenomena disappear except the violet dots, which are left for a few seconds against a dark background. They are fairly uniformly distributed over the field of view, and may number anything up to, say, 100. From the fact that all the violet dots are of exactly the same hue, saturation and intensity and of approximately the same size, one is probably justified in assuming that they are the fundamental violet sensation. By looking at a spectrum with the other eye (light-adapted) it is possible to match their hue against a spectral hue. They match 440·5 mμ, the standard deviation of each observation being ± 5 mμ and that of the mean being ± 0·5 mμ. They are considerably more saturated in colour than spectral violet. Their apparent angular diameters are of the order of 10′. From the tritanopic isocolour chart given by Pitt[1], which depends on a description by König of five pathological cases of tritanopia, one can deduce that the fundamental violet sensation is equivalent to the sensation produced by 435 mμ, except that it is more saturated. Considering the inadequacy of the data available to Pitt, the discrepancy between 440·5 mμ and 435 mμ is not significant.

Gentler pressure will, in suitable circumstances, produce a uniform green colour of low intensity throughout the field of view. If one continues with this pressure for a minute or so, a green patch of greater luminosity but of about the same saturation appears, usually in the temporal field. By suitable adjustment of the pressure, it may be made to grow into a broad elliptical halo surrounding the macula, which by comparison looks black. The horizontal axes of the halo are about 1·3 times the vertical, the inside horizontal axis subtending about 7° and the outside about 30°. Both measurements are very variable, and occasionally the hole in the centre of the halo is green and is surrounded by darkness. The halo is slightly more saturated than any spectral green and matches 555 mμ, the standard deviation of each observation being 3 mμ and that of the mean being 0·7 mμ. This does not agree with the value 505 mμ obtained from Pitt's colour triangle for the hue of the green fundamental sensation, nor is it sufficiently saturated. It seems, indeed, to be a most improbable value for a fundamental sensation on any trichromatic theory which disallows negative stimulation. As the halo gets fainter, it appears to become slightly bluer in the same way as spectral 555 mμ does, but it is doubtful whether it ever becomes as blue as 505 mμ. Hence, in terms of trichromatic theory, it is probably a mixture in fairly constant proportions of the red and the green fundamental sensations only.

Reddish spots can also be made to appear. They are apparently of two or more different kinds, the smallest being very much smaller than the violet dots. All types are so fleeting that it is difficult to match them against the spectrum, or even to see whether they are alike.

No colourless entoptical phenomena appear as a consequence of pressure. This result and the occurrence of the violet dots at approximately the position in the colour triangle predicted by Pitt are rather more readily explained on classical trichromatic theory than on Granit's[2] theory of dominators and modulators.

All the above results were obtained on one observer (male) with normal colour vision.

A. H. S. HOLBOURN
Department of Natural Philosophy,
Marischal College,
Aberdeen.
March 3.

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[1] *Proc. Roy. Soc.*, B, **132**, 101 (1945); chart on p. 107 wrongly labelled protanopic.

[2] "Sensory Mechanisms of the Retina" (Oxford Univ. Press).

Basque Blood Groups

We have determined the full *ABO*, *Rh* and *MN* blood groups of 167 Basques. The persons examined were selected as being of unmixed Basque descent, mostly by the Rev. Prof. J. M. de Barandiaran. None of the persons examined was known to be a blood relation of any of the others. The accompanying tables give a summary of our results.

ABO Groups

Group	Number	Frequency observed	Frequency expected	Gene frequencies
O	85	0·5090	0·5071	A_1 0·2343
A_1	67	0·4012	0·4002	A_2 0·0248
A_2	6	0·0359	0·0359	B 0·0288
B	7	0·0419	0·0418	O 0·7121
A_1B	2	0·0120	0·0135	
A_2B	0	0·0000	0·0014	
	167	1·0000	0·9999	1·0000

MN Groups

Group	Number	Frequency observed	Frequency expected	Gene frequencies
M	55	0·3293	0·3068	M 0·5539
MN	75	0·4491	0.4942	
N	37	0·2216	0·1990	N 0·4461
	167	1·0000	1·0000	1·0000

Rh Groups

Rh phenotype frequencies

Reactions with antisera Anti– C	D	E	c	e	Commonest genotype in each phenotype	Number	Frequency observed	Frequency expected
−	−	−	+	+	cde/cde (rr)	48	0·2874	0·3275
+	+	−	+	+	CDe/cde (R_1r)	79	0·4731	0·3904
+	+	−	−	+	CDe/CDe (R_1R_1)	13	0·0778	0·1246
−	+	+	+	+	cDE/cde (R_2r)	13	0·0778	0·0795
+	+	+	+	+	CDe/cDE (R_1R_2)	10	0·0599	0·0487
+	−	−	+	+	Cde/cde ($R'r$)	3	0·0180	0·0180
−	+	−	+	+	cDe/cde (R_0r)	1	0·0060	0·0064
−	+	+	+	−	cDE/cDE (R_2R_2)	0	0·0000	0·0047
+	−	−	−	+	Cde/Cde ($R'R'$)	0	0·0000	0·0002
						167	1·0000	1·0000

Frequencies of gene combinations

cde	(r)	0·5723
CDe	(R_1)	0·3376
cDE	(R_2)	0·0688
Cde	(R')	0·0157
cDe	(R_0)	0·0056
cdE	(R'')	0·0000
		1·0000

The high frequency of *Rh*-negative (*D*-negative) persons (30·5 per cent) and of the *d* gene (58·8 per cent) are in agreement with the findings of Etcheverry[1] and support the views recently put forward by one of us[2] regarding the history of the *d* gene. The low frequency of *cDE* is another notable feature. The excess of *Dd* heterozygotes and the deficiency of *MN* heterozygotes are clearly due to unavoidable errors of sampling. For this and other reasons steps are being taken to examine more persons. The combined results and a full discussion of them will be published elsewhere.

We should like to thank Prof. de Barandiaran and the members of the Basque delegations in London, Paris and Bayonne for their highly efficient organisation which alone made the collection of the specimens possible. One of us (J. N. M. C.) is in receipt of a Government Grant for Scientific Investigation through the Royal Society, and a grant from the Slater Fund at St. George's Hospital Medical School.

J. N. Marshall Chalmers
Department of Pathology,
St. George's Hospital,
London, S.W.1.
Elizabeth W. Ikin
A. E. Mourant
Blood Group Reference Laboratory,
c/o Lister Institute of Preventive Medicine,
Chelsea Bridge Road, London, S.W.1.
March 15.

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Evolution of Hydrogen from Ferrous Hydroxide

It is generally supposed that ferrous hydroxide in aqueous suspension can decompose, according to the equation

$$3Fe(OH)_2 = Fe_3O_4 + 2H_2O + H_2.$$

The experiments of Schikorr[1] suggest that this can occur, but only in presence of metallic iron or excess of ferrous salt in solution.

The matter is important in connexion with the attack of iron by pure oxygen-free water. Warner[2] showed that a reaction such as

$$Fe + 2H_2O = Fe(OH)_2 + H_2$$

is permissible on grounds of energy; it might, however, be precluded on grounds of geometry if a continuous film of ferrous hydroxide were built up, separating the iron from the water. Possibly this protection might fail if the hydroxide were converted to anhydrous magnetite (a denser substance, commonly produced in granular form).

Actually, Murata[3] found that oxygen-free water acting on iron powder evolved hydrogen for a month, yielding ferrous hydroxide crystals; but Thompson[4], also using iron powder, reported the formation of magnetite on the glass apparatus; Corey and Finnegan[5], starting from iron rods, obtained non-adherent magnetite. Gould[6], working in this laboratory, observed no granular magnetite when water at the boiling point acted on steel with exclusion of oxygen; hydrogen was evolved at first, but attack soon became negligible, evidently owing to the formation of a protective film. In other experiments, where oxygen was intentionally admitted, a mass of magnetite and rust was found adhering to the metal at a few points only; it was probably formed by secondary oxidation of the ferrous hydroxide, mainly at a distance from the metal; its removal revealed deep corrosion-grooving. There is no necessary inconsistency between these various results, but it is clearly important to decide under what conditions Schikorr's reaction can occur; hence some new experiments have been carried out.

Ferrous hydroxide, pure enough to be almost colourless, was precipitated by mixing ferrous chloride and potassium hydroxide solution in an atmosphere of hydrogen. These solutions were prepared by the electrolysis of a de-aerated potassium chloride solution between a platinum cathode and a pure iron anode; the design of the apparatus was such that premature mixing of anodic and cathodic products did not occur and that the two solutions could be mixed in any desired proportions. The de-aeration was carried out by boiling followed by the passage of hydrogen through the solution. After precipitation, the ferrous hydroxide and supernatant liquid were left in a flask connected to a manometer, so that any evolution of hydrogen might be detected by a pressure increase. No hydrogen evolution was detected under these conditions, even with ferrous chloride in excess.

Further experiments were then performed, following more closely those of Schikorr[1]. Here the ferrous hydroxide was prepared by precipitation from a ferrous sulphate solution with sodium hydroxide. Under these conditions Schikorr reported evolution of hydrogen at room temperature, when ferrous sulphate was in excess, but not when alkali was in excess. However, in our experiments, no evolution of hydrogen was observed even when the reactants were heated to 100° C.

It was nevertheless found that hydrogen was evolved at room temperature, in the presence of excess ferrous sulphate, if certain additions were made to the solution before precipitation with alkali. These additions included platinum chloride, colloidal platinum, nickel sulphate, nickel powder and copper powder. A smaller evolution was also produced by the addition of sodium sulphide. It is as yet uncertain whether these metals themselves or their ions in solution are the true catalysts, and no views on the mechanism of the reaction are here offered.

No hydrogen has yet been obtained after the addition of manganese sulphate—a matter of obvious importance in connexion with steel.

U. R. Evans
J. N. Wanklyn

Department of Metallurgy,
University, Cambridge.
March 9.

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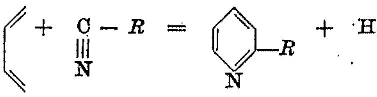
Reaction of Cyanogen and Related Compounds with Butadiene

Cyanogen and butadiene have been found to react at moderately high temperatures (400°–700° C.), forming as the main product 2-cyanopyridine. It has also been established that this behaviour of cyanogen may be generalized for the simple 1,3-dienes[1,2].

The present communication presents the results of some calculations and experiments with nitriles of the type R—CN, where R is H,CH_3,C_6H_5, as well as CN. In each case, the free-energy change for the reaction:



(1)

has been calculated over a range of temperatures in order to obtain information useful as a guide in the experimental investigation. These results are summarized in Table 1. The thermodynamic functions for 2-methylpyridine, 2-cyanopyridine and benzonitrile were calculated statistically, the vibrational frequencies of these compounds being assigned on a semi-empirical basis involving a consideration of the assignment for pyridine and benzene, and also the frequencies associated with the vibrations of the methyl and cyano groups. The functions for 2-phenylpyridine were estimated by a method of increments from the functions of 2-methylpyridine and benzene.

TABLE 1

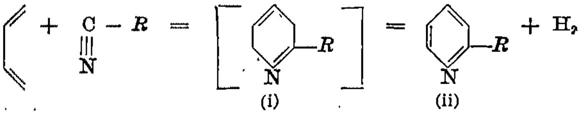
Reaction 1 with R as:	Product	ΔF (kcal.) for the reaction			
		T° K. 400	600	800	1000
H	Pyridine	−23·9	−20·9	−17·8	−14·7
CH_3	2-Methylpyridine	−18·9	−14·5	−11·1	−4·66
C_6H_5	2-Phenylpyridine	−7·07	−5·37	−4·05	−3·05
CN	2-Cyanopyridine	−30·1	−27·2	−25·6	−20·6

It is seen that the calculated free-energy change is quite favourable over the temperature range in question in each case; but since these results refer to equilibrium in ideal gaseous systems, a quantitative correlation with the experimental work has not been attempted. In Table 2 the data for three comparable vapour-phase experiments are given. The experiments were carried out at atmospheric pressure in an unpacked quartz reaction vessel, using continuous flow technique. The product in each case was identified by its known physical constants, and the melting point and analysis of the picrate. The yields are calculated on the amount of nitrile converted.

TABLE 2

Reaction 1 with R as:	Product	Temp. °C.	Contact time	Mol. ratio RCN/C_4H_6	Yield of product
H	Pyridine	595±5°	30 sec.	1·1/1·0	5–6 %
CH_3	2-Methylpyridine	599±5°	30 ,,	1·7/1·0	5–6 ,,
C_6H_5	2-Phenylpyridine	591±5°	31 ,,	1·7/1·0	12–16 ,,

These reactions may be explained as proceeding by a Diels – Alder mechanism in which the (—C≡N) has the role of the dienophilic component of the dienophile:



The intermediate (i) has not been observed among the products, and it would seem that it undergoes spontaneous dehydrogenation at these temperatures to form the thermodynamically more stable pyridinic product (ii).

A fuller account of this work is to be published elsewhere. The investigation is being continued.

We wish to thank Prof. C. K. Ingold and Dr. Albert Wasserman for helpful discussions, and Imperial Chemical Industries, Ltd., for some of the chemicals necessary for this investigation.

G. J. Janz
(I.C.I. Research Fellow)
P. J. Hawkins

Sir William Ramsay and
Ralph Forster Laboratories,
University College,
London, W.C.1.
Feb. 28.

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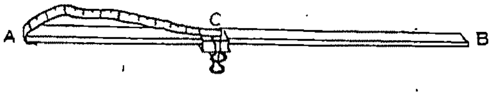
Rapid R_F Measurement in Chromatography

THE device described here has proved very useful for the rapid measurement of R_F values on paper partition chromatograms[1]. In the figure, AB is an aluminium strip 20 in. × ½ in. × ⅛ in., AC is a piece of white elastic 9 in. × ½ in. attached to the end A of the strip by sewing through a hole in the strip. The other end of the elastic C is attached to a small 'bulldog' clip. A scale (divided into 100 parts) is marked on the elastic. For use, the zero of the scale is placed at the origin line or spot and the 100 mark stretched out to coincide with the position reached by the solvent front. The R_F values of the spots can then be read off directly on the scale. While α-amino-acids can be recognized simply from their relative positions on a chromatogram, the device allows a quick check on isolated or unknown spots or the spread of a spot. A smaller apparatus on the same expanding-scale principle can be used for measuring the R value[2] of substances on a column where the ratio, movement of band/movement of sample of liquid in unpacked part of the column above, is employed.



D. M. P. PHILLIPS

Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.
March 12.

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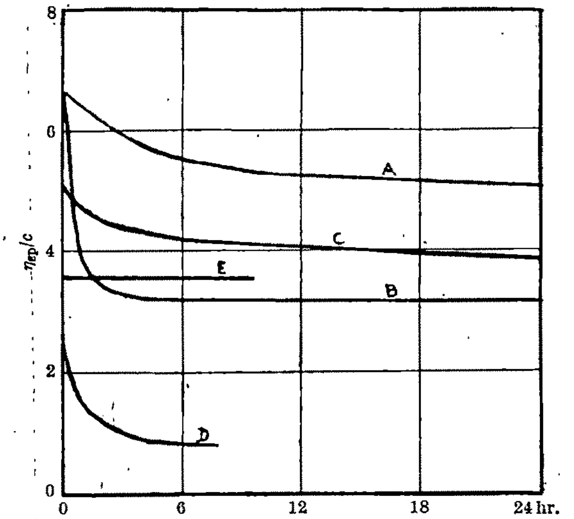
Degradation of a Vinylidene Chloride Copolymer in Solution

SOME observations have recently been made on the changes in viscosity of solutions of a copolymer containing approximately 85 per cent vinylidene chloride, 13 per cent vinyl chloride and 2 per cent acrylonitrile (by weight). The polymer was soluble in hot, but not in cold, tetrahydrofuran: once it had been dissolved by heating in the solvent at 60–65° C. for 2–3 min., the solution could be cooled to room temperature without gelling or precipitation.

Copolymer solutions of different concentrations, made up in redistilled tetrahydrofuran by heating as above, were aged in sealed glass tubes in contact with air for varying times at 50° C. and 75° C. Typical curves showing the changes in η_{sp}/c (where η_{sp} is specific viscosity and c is concentration in monomoles per litre) of the solutions with time are reproduced herewith (Curve A, 50° C., Curve B, 75° C.).

Investigation showed that the tetrahydrofuran used contained peroxides, and further work showed that: (*a*) a similar fall in η_{sp}/c was observed in cyclohexanone at 75° C., and in dioxane at 85° C., both in air (Curves C and D); (*b*) a slight reduction in η_{sp}/c took place in *peroxide-free* tetrahydrofuran at 75° C. in air; (*c*) little or no reduction in η_{sp}/c took place in *peroxide-free* tetrahydrofuran at 75° C. in nitrogen; (*d*) no reduction in η_{sp}/c took place in *o*-dichlorbenzene at 130° C. in air (Curve E).



AGEING OF VINYLIDENE CHLORIDE COPOLYMER SOLUTIONS

A. In tetrahydrofuran at 50° C.
B. ,, ,, ,, 75° C.
C. ,, cyclohexanone ,, 75° C.
D. ,, dioxane ,, 85° C.
E. ,, *o*-dichlorbenzene ,, 130° C.

These observations are consistent with the view that the viscosity decrease in these polymer solutions is due to a degradative attack on the long-chain molecules, not by oxygen directly, but by peroxides formed from the solvent and atmospheric oxygen. Tetrahydrofuran, cyclohexanone and dioxane are all known to peroxidize in the presence of oxygen (presumably with the formation of hydroperoxides at the carbon atoms adjacent to the ether oxygen or carbonyl group), while *o*-dichlorbenzene would not be subject to such an attack. Degradation of this type has previously been found to occur in the presence of oxygen[1–5], but the role of the solvent does not appear to have been appreciated.

That the changes in viscosity are most likely to be caused by polymer chain scission, rather than by any physical changes in the solution (breakdown of polymer aggregates, solvation[6], etc.) is also indicated by the fact that copolymer from a solution in tetrahydrofuran aged at 75° C. for 5 hr. (isolated by precipitation, washing and drying) could readily be redissolved in tetrahydrofuran at 25° C. to give solutions of η_{sp}/c identical with that of the *aged* solutions. Further, calculations of the approximate overall activation energy of the process, based on rates of change in η_{sp}/c of a solution in tetrahydrofuran at 50° C. and 75° C., gave a value of about 24 kcal. Neither of these observations is conclusive in itself, but, taken in conjunction with the results already quoted, they inevitably suggest that primary valency bonds are being broken.

Sufficient evidence is not yet available for a discussion of the mechanism of this degradation, but a study of the rate of change of peroxide content in tetrahydrofuran, in contact with air, both with and without dissolved copolymer, has given some indication that the initial attack on the polymer may be by a radical produced during solvent autoxidation reaction[5], or by hydroperoxide fission.

The number of points in the copolymer molecule at which attack is possible may be limited, because copolymer isolated from solutions which have been aged to constant η_{sp}/c value at a particular temperature, when redissolved in fresh solvent containing peroxide, undergoes little or no further change when aged at the same temperature.

One of the objects of publishing these results is to direct attention to the possibility of error arising during viscosity and other measurements performed on solutions of polymers in solvents able to form peroxides by autoxidation. Detailed results will be published elsewhere at a later date.

We acknowledge helpful discussions with Dr. H. P. Staudinger and Mr. C. E. Hollis in the course of this work.

D. L. C. JACKSON
W. S. REID
Research and Development Department,
The Distillers Co., Ltd.,
Great Burgh,
Epsom, Surrey.
March 22.

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Trichothecin: an Antifungal Metabolic Product of *Trichothecium roseum* Link

ANTAGONISTIC activity to other fungi by *Trichothecium roseum* Link (syn. *Cephalothecium roseum* Corda) has been reported by Whetzel[1], Boning[2], Koch[3] and Greaney and Machacek[4]. Culture filtrates of *T. roseum* have been shown to inhibit germination of *Botrytis allii* conidia[5]. We have isolated the substance responsible for this activity in crystalline form in yields of 20–30 mgm. per litre of culture filtrate. The name 'trichothecin' is suggested for the active substance.

The most satisfactory yields have been obtained by growth of the fungus for a period of 28 days at 25° C. on a modified Czapek–Dox medium, in which sodium nitrate was replaced by the equivalent quantity of ammonium tartrate. The medium contained 5 per cent of glucose and was supplemented by the addition of 1 per cent of corn-steep liquor. The development of antifungal activity was followed by means of a spore-germination assay using *Penicillium digitatum* conidia. Maximum concentration of trichothecin (40–50 mgm./l.) was attained after about 28 days.

Trichothecin was extracted from the culture filtrate with ether or chloroform and purified by chromatographic methods on activated alumina. It was finally recrystallized from light petroleum (b.p. 60–80°) and formed long, slender, colourless needles, m.p. 118°, which were optically active $[\alpha]_D^{18}$ + 44° (*c*, 1 in chloroform). It contains neither halogens, sulphur nor nitrogen. Microanalyses (Weiler and Strauss), found: $C = 68 \cdot 5, 68 \cdot 7, 68 \cdot 8$ per cent; $H = 7 \cdot 2, 7 \cdot 3, 7 \cdot 4$ per cent; mol. wt. (Rast) = 278. $C_{15}H_{20}O_4$ requires: $C = 68 \cdot 2$ per cent; $H = 7 \cdot 5$ per cent; mol. wt. = 264. $C_{15}H_{18}O_4$ requires: $C = 68 \cdot 7$ per cent; $H = 6 \cdot 9$ per cent; mol. wt. = 262. The compound is neutral and only slightly soluble in water (*c*. 400 mgm./l. at 25°) but readily soluble in most organic solvents. The molecule contains one ketonic group and one ethylenic group. These observations are supported by the ultra-violet absorption spectrum of trichothecin, which also suggests that the two groups are conjugated. No other functional groups have been detected. Methyl attached to carbon determination (Weiler and Strauss), found: $(C)CH_3 = 16 \cdot 4$ per cent; $3 \times (C)CH_3$ groups require $17 \cdot 0$ per cent. There is no evidence of an aromatic nucleus.

At a concentration of 400 mgm./l. and *p*H 7·0, trichothecin was inactive against *Staph. aureus*, *B. subtilis* and *Bact. coli*. Its antifungal activity is exhibited against Fungi Imperfecti, Zygomycetes and Ascomycetes. The growth of each of some twenty-five species belonging to the above classes was inhibited to a greater or lesser degree. *P. digitatum* is the most sensitive species so far examined; germination of conidia was completely inhibited by 1·25 mgm./l. of trichothecin, and 50 per cent germination took place at a concentration of 0·30 mgm./l. The corresponding data for *Botrytis allii* spores are 6·25 and 3·12 mgm./l. Growth of the following fungi on beer wort agar was completely suppressed by the trichothecin concentrations given in parentheses: *P. digitatum* (0·64 mgm./l.), *Fusarium graminearum* (16 mgm./l.), *Paecilomyces varioti* (80 mgm./l.), *Saccharomyces carlsbergensis* (16 mgm./l.), and *Mucor erectus* (80 mgm./l.). *T. roseum* showed a partial reduction of growth at a concentration of 80 mgm./l.

Aqueous solutions of trichothecin were stable at *p*H 1 to *p*H 10 for at least 48 hours at 20°. At *p*H 12 the antifungal activity was rapidly destroyed even at room temperature. Aqueous solutions at *p*H 7 were maintained for at least one hour at 100° without detectable loss of activity.

Full accounts of the preparation and chemical and biological properties of trichothecin will be given elsewhere.

G. G. FREEMAN
R. I. MORRISON
Imperial Chemical Industries, Ltd.,
Explosives Division,
Research Department,
Stevenston, Ayrshire.
March 15.

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Role of the *Y*-Chromosome in the Determination of Cell-size in *D. melanogaster*

I have already pointed out[1] that in wild stocks o *D. melanogaster*, Gaiano (Parma), Luino (Varese) Civate (Como), the unicellular hairs of the upper win surface, counted in a standard surface of 298 μ^2 fo each wing, show frequency differences. Furthermore there are sex differences of different kinds in the thre stocks, being highest in Gaiano, intermediate i Civate and lowest in Luino. This shows the possibilit of an action of the *Y*-chromosome, already proved b Mather[2] for the chætæ also in *D. melanogaster*.

For this purpose I considered the Oregon *R* stock which showed a very strong sex difference in additio to another cell character, namely, the eye corneolæ The surface was measured directly[3] in ten ommatidi of one eye (either the right or the left one, bot being significantly similar) in each individual, an the mean was calculated. (The complex of th corneolæ of one eye was prepared after treatment i potassium hydroxide of the entire eye, and mounte in glycerine; the wings also were mounted i glycerine.) The following figures are the mean fo thirty flies; the standard errors are indicated.

Oregon *R*:	*hairs*	♀ $16 \cdot 06 \pm 0 \cdot 58$	♂ $20 \cdot 60 \pm 0 \cdot 60$	Diff. 22·50% (significant)
	corneolæ	♀ $847 \pm 20 \cdot 7 \mu^2$	♂ $732 \pm 14 \cdot 9 \mu^2$	Diff. 13·70% (significant)
Luino:	*hairs*	♀ $21 \cdot 25 \pm 0 \cdot 28$	♂ $21 \cdot 83 \pm 0 \cdot 75$	Diff. 2·70% (not significant)
	corneolæ	♀ $681 \pm 30 \cdot 0 \mu^2$	♂ $697 \pm 29 \cdot 0 \mu^2$	Diff. 2·30% (not significant)
Gaiano:	*hairs*	♀ $15 \cdot 61 \pm 0 \cdot 24$	♂ $17 \cdot 43 \pm 0 \cdot 57$	Diff. 10·45% (significant)
	corneolæ	♀ $732 \pm 15 \cdot 30 \mu^2$	♂ $689 \pm 20 \cdot 05 \mu^2$	Diff. 5·90% (not significant)

The sex differences of the hair frequencies tested with Fisher's *Z* test are significant for Oregon and Gaiano, but not for Luino. The corneolæ are significantly different only in Oregon. Males from Luino and Gaiano were mated successively to Oregon females and the heterozygous males back-crossed to Oregon females for six subsequent generations, in order to make the stocks isogenic; they become in this manner 'oregonized', except for the *Y*-chromosome, if no crossing-over between *X* and *Y* occurred. This procedure was repeated twice, and every factor of the environment capable of inducing phenotypical variations (food, temperature, bottle volume, number of flies) was kept constant.

The mean values for both independently 'oregonized' stocks of Luino obtained from thirty individuals for each sex are:

Hairs	♀	(I) $17 \cdot 70 \pm 0 \cdot 59$	♂	(I) $18 \cdot 50 \pm 0 \cdot 51$	Diff. not significant
		(II) $17 \cdot 40 \pm 0 \cdot 29$		(II) $17 \cdot 80 \pm 0 \cdot 36$	,, ,, ,,
Corneolæ	♀	(I) $830 \pm 19 \cdot 0 \mu^2$	♂	(I) $801 \pm 19 \cdot 0 \mu^2$	,, ,, ,,
		(II) $783 \pm 14 \cdot 7 \mu^2$		(II) $744 \pm 16 \cdot 7 \mu^2$	,, ,, ,,

The results for Gaiano are intermediate between Oregon and Luino, also after the 'oregonization'. It is interesting that the sex difference for the corneolæ (♀ 847 ± 26; ♂ 744 ± 45) of Gaiano is significant in this stock only after 'oregonization'. Both characters were measured in subsequent 'oregonized' generations, and only insignificant differences were found.

The data may be summarized as follows. Both characters are similarly influenced by the *Y*-chromosome, because the amount of the sex difference remains of the same order of magnitude, even when the euchromatin has been profoundly rearranged by the crosses. The *Y*-chromosomes of Oregon and Gaiano make the cells of the females larger, whereas the *Y*-chromosome of Luino does not induce any appreciable difference. On the other hand, the values obtained before and after 'oregonization' are different, and both characters in Luino are nearer to the Oregon ones in the latter stage. This proves the participation of the euchromatic chromosomes in the determination of the cell size.

These results agree with those obtained by Mather, and make it possible to go further in the functional interpretation of the heterochromatin. Actually, owing to the type of the characters considered, a connexion is established between the *Y*-chromosome and cell size, that is, between heterochromatin and cellular growth. This connexion is the same as that pointed out by Caspersson[3] using a quite different method. In fact, my experiments prove genetically that heterochromatin has a role of the same kind as direct observations of the cellular polynucleotides permit one to infer[4].

CLAUDIO BARIGOZZI

Istituto di Zoologia e Anatomia Comparata
dell'Università di Parma.

Feb. 2.

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Seaweed Culture

COMPREHENSIVE culture experiments of algal spores and ova have been carried out, and still more are in operation as part of the programme of research of the Scottish Seaweed Research Association. The principal object of this work is to ascertain the minimum requirements for the development and healthy growth of zoospores and zygotes of the brown algæ, yet at the same time departing as little as possible from natural conditions.

In the last experiment to be completed, zoospores of *Laminaria Cloustoni* were added to thirty small tanks containing either natural or artificial sea water, well aerated and circulated. Additional nutrients were dissolved in some tanks, light restricted in others, water remained unchanged in some cases and changed in others.

Among the many interesting results, it was found that the zoospores showed their greatest development when disodium hydrogen phosphate, sodium nitrate and sodium bicarbonate were added in combination to natural sea water unchanged during the experiment. Two embryo sporophytes, which have developed from the zoospore through the gametophyte to the sporophyte stages in the above solution in 28 days, are shown in Fig. 1. Up to 32-cell stages were found after 36 days.

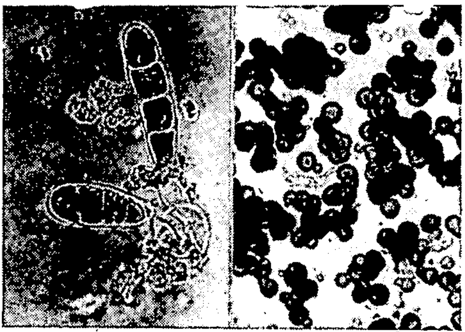
Fig. 1 Fig. 2

Fig. 1. SPOROPHYTE EMBRYOS OF *Laminaria Cloustoni*. 28 DAYS IN SEA WATER WITH ADDED PHOSPHATE, NITRATE AND BICARBONATE. × 350

Fig. 2. DEVELOPMENT OF *Laminaria Cloustoni* ZOOSPORES IN SEA WATER WITH ADDED URANIUM NITRATE. × 350

The surprising result of zoospore development of *L. Cloustoni* during the same experiments, when uranium nitrate was added to natural sea water unchanged during the experiment, is shown in Fig. 2. What was thought to be a precipitate of uranium proved to be a most prolific growth. More zoospores developed in this tank than in any of the others. The zoospores appear to have begun to develop into gametophytes at a rate far outstripping the normal. The nuclei in some cases have divided without subsequent development of the cell wall. The result is probably more 'cancerous than polyploid'. The nuclei are more conspicuous and take up a central position within the cell. The cell walls were hardened by the end of a month and the cells were killed at some time during this period, although their initial growth by division was stimulated. No living bacteria or protozoa were seen in this tank, although both were found active in most other tanks.

During the extensive seaweed survey of the Scottish coast[5] it was noticeable that the growth of Laminariæ was poor where *Ascophyllum nodosum* was abundant. It is also known that *A. nodosum* will ultimately dominate virgin substrata initially colonized by *Fucus vesiculosus*. The senior author has long considered it a probability that *A. nodosum* might exude something which inhibits the development of competitive algæ, and to test this, zoospores of *Laminaria Cloustoni* were grown in natural sea water with a piece of living, mature *A. nodosum*. The water of this particular tank was noticeably clearer than any of the others, and inspection after 28 days showed the zoospores to be completely decolorized. (Of the marine aquaria maintained in the laboratory, the water of one containing *A. nodosum* sporelings always remains the clearest.)

From this, three points emerge: (1) *A. nodosum* produces an antibiotic; (2) the effects of this antibiotic in decolorizing the chlorophyll serves a useful means for more easily studying the nuclei of *L. Cloustoni*, which unfortunately are structurally minute; and (3) is the zonation of the littoral Fucaceæ due to 'chemical claws'?

The nuclei of the normal spores, the spores grown with uranium nitrate and *A. nodosum* appear visually similar. They comprise two small stainable masses within a sac of clear material.

Full details will be published elsewhere with full bibliography.

F. T. WALKER
MARGARET McL. SMITH
Institute of Seaweed Research,
Musselburgh, Midlothian.
March 15.

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Growth of *Phytophthora infestans* (Mont.) de Bary on Artificial Media

IT appears from the literature on *Phytophthora infestans* that many workers have had difficulty in growing this fungus and in obtaining a supply of sporangia. The fungus grows and fructifies well on potato leaves and tuber slices, but such cultures require frequent renewal. Recently Snieszko *et al.*[1] in the United States described various media which supported growth, particularly a cereal grains – peanut hull mixture upon which the fungus spored freely. Peanut hulls are not readily available in Great Britain.

In this laboratory, media for the culturing of *P. infestans* have been made from germinated oats, wheat, maize and pea and from dried leaves of potato and tomato. At its best the dried potato leaf medium was much superior to all other materials tried. Sporulation was sometimes so abundant that cultures had a powdery rather than a downy appearance. Unfortunately, as with oat, wheat, maize and tomato, this medium was unreliable, often giving poor growth and sporulation. A reliable medium made from pea-flour has now been evolved. It is felt worth while to publish the information, although the method is by no means perfected.

This medium contains 2·5 per cent pea-flour, 2·5 per cent sucrose, 1 per cent agar and distilled water. The sucrose, agar and half the water are sterilized at 15 lb. pressure for 15 min., and to this is then added the pea-flour in the rest of the water heated to 40° C. After rapid and thorough mixing, the medium is tubed and plugged. The tubes are left at laboratory temperature for 18–24 hr., sterilized at 10 lb. pressure for 6 min. and sloped.

The pea-flour is made from garden peas grown in sand under glass. When the plants are 2–3 in. high, their leaves and stems are chopped up and dried on glass sheets in an electric oven at 55–60° C. The time taken for drying varies from two to three hours. The dried material is ground with a hand-mill and stored in screw-capped bottles in the dark.

This pea-flour medium has been in use for more than a year, and in no instance has the fungus failed to grow or sporulate on any batch of it. Some isolates of *P. infestans*, however, grow more rapidly and spore more freely than others. In test-tubes (6 in. by $\frac{5}{8}$ in., 5 ml. medium) at 18° C. the fungus usually covers the agar in a week and sporing begins in two to three weeks. Sporulation is greater if the cultures are stored in closed jars. The danger of mould contamination arising from these damp conditions can be avoided by exposing the cultures once weekly to room humidity for a few hours and replacing them in clean, dry jars. If the fungus is grown in boiling tubes (7 in. by 1 in., 15 ml. medium), good sporulation will take place even if the cultures are not kept enclosed. It is advisable, however, to keep them in jars until the fungus is well established.

Some isolates of the fungus survive longer in culture than do others. Test-tube cultures kept at 18° C. require subculturing every four to five weeks; at 10° C. every ten to twelve weeks. In boiling tubes, some cultures have remained alive for as long as seventeen weeks, whereas others have lasted only ten to twelve weeks.

Spores produced by *P. infestans* on this pea-flour medium have infected potato seedlings, tubers and adult leaves. The effect of continuous cultivation on the pathogenicity of the fungus is under investigation.

SYDNEY DICKINSON
School of Agriculture,
Cambridge.
MARGARET A. KEAY
Commonwealth Potato Station,
Cambridge.
March 22.

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Hysteresis in the Swelling of Gels

HYGROSCOPIC natural fibres generally show sorption hysteresis, such that the vapour pressure at any given moisture content is higher on adsorption than on desorption, whereas no hysteresis is found in true solutions.

In 1942 I suggested[1] that sorption hysteresis in gels could be explained in terms of their plastic properties. This deduction is based on the fact that the vapour pressure of a gel is determined by the hydrostatic stress acting on it as well as by the moisture content. It can be shown[2] that, if either anatomical or molecular restraints oppose the free swelling and introduce plastic flow under shear stresses, the hydrostatic component p of the stress system, and therefore also the vapour pressure h, will be higher on adsorption than on desorption at any given moisture content m.

If, between adsorption and desorption, the difference in hydrostatic pressure is Δp, this must produce a change in volume of the gel: $\Delta V = -V\Delta p/k$, where k is the bulk modulus; while the value of

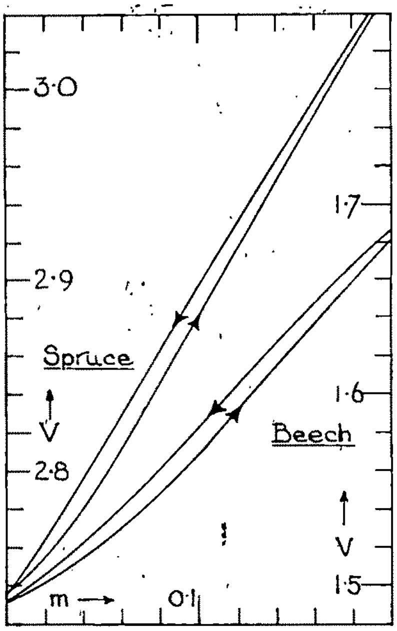
Units : $k \doteq 10^{10} \times$ dynes/sq. cm. ; V = c.c./gm. dry weight ; m = gm. water/gm. dry weight.

	Solid fibres V (dry) = 0·0661 k 0·86		Spruce V (dry) = 2·731 (75·3% void space)				Beech V (dry) = 1·492 (54·8% void space).			
m	s_p	ΔV (calculated)	s_p	k	ΔV (calculated)	ΔV (observed)	p	k	ΔV (calculated)	ΔV (observed)
0·05	0·73	0·0045	1·58	2·55	0·020	0·016	0·833	3·37	0·0144	0·0081
0·10	0·90	0·0016	1·74	1·20	0·048	0·015	1·041	1·80	0·0253	0·0105
0·15	0·95	0·0008	1·62	0·70	0·054	0·008	1·087	1·05	0·0216	0·0119
0·20	0·98	0·0003	1·50	0·55	0·042	0·000	1·071	0·82	0·0185	0·0027

Δp can be obtained from the vapour pressures, h' on adsorption, and h'' on desorption, from the approximate relation $\Delta p = -(RT/Ms_p) \log (h'/h'')$, in which $s_p = (dV/dm)_p$ the differential volume swelling of the gel. Thus, if the origin of sorption hysteresis lies in plasticity, the volume swelling should show hysteresis if plotted against the moisture content, such that the volume will be smaller on adsorption than on desorption.

Calculations of ΔV can be compared with experiment by using the measurements of Hermans[3] on solid fibres of regenerated cellulose, or those on beech[4] and spruce, made in this Laboratory. Approximate values of k may be taken from calculations made here. In the case of the solid fibres these are incomplete, since the variation of k with m is not known and a single mean value must be used for all moisture contents.

The table gives these estimates of ΔV. For the solid fibres all values of ΔV (except at $m = 0·05$, where k is most in doubt) lie below the limit of accuracy claimed by Hermans (0·002 c.c./gm.) and will therefore not be detectable. This agrees with Hermans' own statement that no volume hysteresis is found. For spruce and beech the values of ΔV lie well above the limit of accuracy and a hysteresis of this order of magnitude is found experimentally, as can be seen in the accompanying graph.



So far as I am aware, this graph records the only experiments so far made which show volume hysteresis in the swelling of gels. This is no doubt because in most solid gels, such as Hermans', k is large and the hysteresis is too small for easy detection ; whereas in porous gels such as wood, k is much smaller and the hysteresis therefore more prominent.

The above calculation has tacitly assumed that the gel is plastic to shear stresses and elastic to the hydrostatic stresses. It can be shown both by theory and experiment[2] that some plasticity to Δp occurs in complex porous structures such as wood, so that some relaxation in Δp is to be expected. This effect would be more marked at the higher moisture contents where the wood is more plastic, and would account for the observed fall in ΔV to very small values in this region.

A full discussion of this subject is given in an internal unpublished Laboratory report, No. P.82 (1948).

W. W. Barkas

Forest Products Research Laboratory,
Department of Scientific and Industrial Research,
Princes Risborough, Buckinghamshire.
Feb. 10.

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Fine Structure of the He II Line λ = 4686 A.

According to the Dirac theory of the energy states in hydrogen-like spectra, levels of the same principal quantum number n which have the same value of the quantum number of total angular momentum j should coincide. Lamb and Retherford[1] have shown that in the second quantum state of the hydrogen atom the 2 $^2S_{1/2}$-level lies 0·03 cm.$^{-1}$ above the 2 $^2P_{1/2}$ term. Bethe[2] has tried to explain this discrepancy by an interaction of the electron with the radiation field. His preliminary calculations show complete agreement with experiment for the hydrogen atom. For the He II spectrum he predicts a shift of the 3 $^2S_{1/2}$-level with respect to the 3 $^2P_{1/2}$-level by 0·13 cm.$^{-1}$.

We have investigated the fine structure of the He II line λ = 4686 A. ($n = 4 \rightarrow n = 3$) with a Fabry-Perot interferometer and have found that the 3 $^2S_{1/2}$-level lies 0·137 ± 0·015 cm.$^{-1}$ above the value given by the Dirac theory. Greater accuracy has not yet been possible because of the breadth of the lines.

H. Kopfermann
W. Paul

Zweites Physikalisches Institut,
Göttingen.
March 5.

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THE CYTOLOGY OF THE HONEY BEE, *APIS MELLIFICA* L.

By Dr. ANN R. SANDERSON
AND
DAVID W. HALL
Zoology Department, University College, Dundee

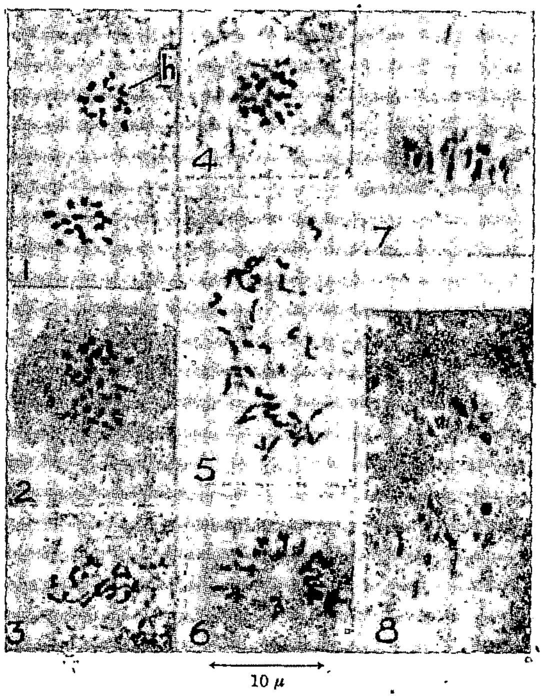
THE cytology of *Apis mellifica* L. has been investigated by Petrunkewitsch[1,2], Doncaster[3,4], Mark and Copeland[5], Meves[6], Nachtsheim[7,8], and Jegen[9]. Nachtsheim figures the chromosomes as spherical in shape, 16 in number in spermatocytes and oogonia, and reduced to 8 in the ootid. In his interpretation of the chromosome constitution of the male and female he resorts to a theory of "*Sammelchromosomen*", in which some chromosomes are said to be "*einwertig*" and others "*doppelwertig*". His cytological findings are so exceptional and the results of the workers mentioned above are so anomalous that they are open to criticism (see Sanderson[10]). Furthermore, on the basis of Nachtsheim's work, a theory that the drone bee is a diploid organism with a haploid germ tissue has been recently advanced by Whiting[11]. The problem obviously required re-investigation and this we have undertaken, using improved modern methods of fixation and of smear technique on abundant material.

The accompanying photographs of our material clearly show the chromosome number in male and female to be 16 and 32 respectively, and also the chromosomes to be mostly rod-shaped, not rounded as depicted by Meves, Doncaster and Nachtsheim.

Smears of larval testes fixed and stained in aceto-carmine or aceto-orcein yield convincing counts of gonial plates (Fig. 1). In these one chromosome is hooked and somewhat larger than the rest (Fig. 1, *h*); it is very striking in late anaphase. In oogonia two similar hooked chromosomes can be distinguished. These findings agree with the work of Granata[12,13] on the spermatogenesis of the carpenter bee, *Xylocopa violacea* L., where the 16 chromosomes are hooked and separate. In the honey bee we have never found the chromosomes lying in pairs in either male or female and we therefore suggest that the apparent pairing of chromosomes and formation of "*Sammelchromosomen*" found by Nachtsheim were due to the technique employed. Oogonial counts can be obtained from queen larvæ and pupæ (Fig. 4), and plates showing the same number, 32, can also be obtained from worker larvæ before the ovaries degenerate.

With regard to the abortive division of the spermatocytes, we confirm the observations of former workers that the chromosome number is not reduced during maturation, but we have not been able to confirm currently accepted views on bud formation.

Our investigation of egg maturation is still incomplete, but examination of some twenty spindles in smeared unfertilized eggs shows that maturation follows the usual method found in arrhenotokous saw-flies and other groups of insects. The first spindle lies near the margin in the broad end of the egg; in aceto-orcein squashes the chromosomes in metaphase and early anaphase appear to be viscous (Fig. 7); about 16 bivalents can be counted on the equator and, later, 16 chromosomes travel towards each end of the spindle; the daughter groups line up on two other spindles which appear to arise immediately, and some of these chromosomes already show chromatid formation (Fig. 8).



PHOTOGRAPHS OF MALE AND FEMALE TISSUES OF HONEY BEE, ALL TO SAME SCALE. FIG. 4 IS FROM A SERIAL SECTION STAINED WITH IRON HÆMATOXYLIN; ALL OTHERS FROM ACETO-ORCEIN SMEARS

Fig. 1. TWO SPERMATOGONIAL PLATES; 16 CHROMOSOMES; *h*, HOOKED CHROMOSOME

Fig. 2. DIPLOID PLATE IN MALE FOLLICLE CELL; 32 CHROMOSOMES

Fig. 3. MALE BLASTODERM CELL; ABOUT 16 CHROMOSOMES

Fig. 4. OOGONIUM; 27 CHROMOSOMES SHOWN

Fig. 5. FEMALE BLASTODERM CELL, LATE PROPHASE; ABOUT 32 CHROMOSOMES

Fig. 6. FEMALE BLASTODERM CELL, METAPHASE; 31 CHROMOSOMES SHOWN

Fig. 7. EGG MATURATION, FIRST SPINDLE METAPHASE; ABOUT 13 BIVALENTS IN FOCUS

Fig. 8. EGG, SECOND MATURATION SPINDLES; 15 CHROMOSOMES SHOWN IN LOWER METAPHASE PLATE, AND 15 CHROMOSOMES IN UPPER METAPHASE PLATE (3 DISPLACED TOP LEFT)

Regarding evidence of somatic numbers, male and female blastoderm smears distinctly show 16 and 32 (Figs. 3, 5 and 6), and here the chromosomes by comparison with those of germ cells are much longer and thinner, so that size differences are more apparent. Though further work is necessary, our material gives the impression that blood and muscle cells in the pupæ show normal numbers. Somatic polyploidy does occur in hypodermal, malpighian and tracheal cells, and follicular epithelium cells of testis and ovary. In the male, follicle cells with 32 (Fig. 2) or more commonly occur; in the female, follicle cells with the gonial number are rare, but the actual degree of polyploidy is not yet determined. Likewise, embryonic serosa cells frequently become polyploid. In contrast to the non-social Hymenoptera, where the male is conspicuously smaller than the female, the drone and queen honey bee do not show such disparity; the relation of body size to polyploidy in the bee therefore requires further investigation. It is also necessary to ascertain in what particular tissues polyploidy arises.

Our evidence establishes beyond doubt that the male is haploid, at least at the beginning of cleavage, in blastoderm stages and in the larval testis. Whiting, basing his theory on Nachtsheim's figures, considers that the male and female honey bee are somatically diploid and tetraploid respectively, the haploid number being 8. Nachtsheim's results do not agree with those of Petrunkewitsch, who found 16 chromosomes in the oocyte, nor of Meves, who demonstrated 16 in the second spermatocytes, nor with our findings, especially those relating to oogonia and egg maturation. Furthermore, Nachtsheim's results have long puzzled cytologists, but since our new evidence clarifies the situation, Whiting's views on polyploidy in the bee appear inacceptable.

Our conclusions have been reached after a study of a wealth of material which permits us to stress the following points on honey bee cytology: (1) the well-defined shapes and individuality of the chromosomes; (2) their discrete arrangement at all times; (3) the haploid-diploid constitution of the male and female, the male having 16 and the female 32 chromosomes in gonial and in normal somatic cells; (4) the invalidity of Nachtsheim's evidence regarding "*Sammelchromosomen*"; and (5) the inacceptability of Whiting's theory on somatic polyploidy in the honey bee.

We wish to acknowledge indebtedness to Mr. D. Robb for the use of an observation hive, to Mr. D. Gauld, and to many other local beekeepers for their ready co-operation in supplying suitable material, and to Mr. H. R. Ness for invaluable help with the photography. Prof. A. D. Peacock, in whose department this work has been carried on, has throughout given helpful advice and criticism.

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VENEREAL DISEASE CONTROL IN POLAND

POLAND is at present faced with a venereal disease problem against which the state of affairs in Britain appears insignificant. The incidence of venereal diseases has increased enormously over the war years and the number of fresh infections with syphilis is now calculated to be about 150,000 per year. There is a decrease in live births of about 40,000–50,000 per year, the mortality-rate from syphilis being about 11 per cent. The reason for this state of affairs is not far to seek. The Germans spared little attention for the Poles whether they were in Poland or displaced to other countries. Venereal diseases were prevalent among displaced persons, and although plans were formulated before D-day for the treatment of infected persons before they were repatriated, nothing was, in fact, ever done for them.

The Ministry of Health in Warsaw has now prepared a permanent programme for venereal diseases control and a temporary programme for immediate operations. The basic units are consultation centres for skin and venereal diseases in health centres distributed throughout the country, and there are, of course, clinics in the hospitals of the major cities.

The basis is a network of medical facilities free to all. The principle of the legal basis is that every citizen with venereal disease can, if necessary, be compelled to submit to treatment. Sources of infection are to be discovered and put under treatment. Auxiliary measures include periodic surveys of persons susceptible to infection; obligatory pre-marital examination; obligatory serum tests for syphilis in pregnant women; training of medical personnel; propaganda; control of prostitution and vagrancy; control of alcoholism; and collection of statistics. Every physician, regardless of his status, is required to determine, and report to the nearest centre, all the sexual contacts of his patients during the infectious period. Persons so named are requested to attend the centre within seven days, and if there is no response a health visitor is to be sent. If this is still unavailing, compulsion is used. Mobile ambulance units are to be used in isolated districts for treatment, propaganda, mass observation, training, etc. Training courses, to be attended at least once a year by the medical men in centres, are to be held in the main provincial centres and will include diagnostic methods, modern treatment and management of complications, control and organisation, and propaganda organisation. Propaganda will consist in popular lectures, films and slides, posters and pamphlets and anti-alcohol appeals.

This programme is directed to the rapid treatment of syphilis during 1948. The old long-term treatment is discarded in early syphilis because of the high rate of default and possibility of continuing infectiousness. Use of penicillin reduces treatment to about two weeks and the infectious stage to about the same period; but there is a risk of infectious relapse in 15 per cent of cases.

It is proposed to do sample surveys of fifteen groups of a thousand people in various areas to gain information on prevalence and distribution of disease.

The importance of accurate serological examinations is recognized and a standard (flocculation) test is to be used throughout the country. Private laboratories are to be checked each year to ensure efficiency. Serological examination is to be routine on first diagnosis of pregnancy, and for military recruits, students and workers.

In the rapid treatment scheme every doctor, in public or in private practice, is to be employed. High standards in diagnostic technique are required.

Rapid treatment is to be given to all cases of symptomatic early syphilis and to cases of asymptomatic early syphilis (up to three years from date of infection) which have not previously been treated or which have received less than one standard course of arsenic and bismuth. The treatment is to consist of 3,000,000 units of penicillin in oil-beeswax suspension given in doses of 300,000 units each day for ten days. 0·2 gm. bismuth subsalicylate is to be given on the first, fourth, seventh and tenth days of treatment. The bismuth is omitted in pregnant women. Children are to receive 200,000 units penicillin per kilo body weight.

Intensive propaganda on the necessity for early treatment and systematic follow-up and on the availability of free treatment facilities is to be carried on by posters, newspaper articles, radio and films.

The rapid treatment method is only intended for use in the early stages of syphilis, early cases of latent syphilis, in pregnant women at any stage of disease, and in congenital syphilis, inadequately treated, up to the third year. Diagnosis is to depend on the finding of *Treponema Pallidum* by dark-ground examination, a positive serum test in the presence of clinical signs, or two positive serum tests in the absence of clinical signs if the history suggests an infection of less than three years duration.

Drugs are always available at centres; but a private practitioner receives supplies only after notifying a case and sending a requisition form. This will inevitably lead to delay in starting treatment in many cases. Private practitioners may charge a fee for treatment, but have to inform the patient that the drugs are supplied free.

Follow-up after treatment consists in clinical and serological examinations once a month for the first six months, every three months in the second six months, and each six months in the second year. The cerebro-spinal fluid is examined six months and two years after treatment. Failures after rapid treatment are to receive four courses of arsenic and bismuth on the long-term plan.

The examining physician must obtain from the patient particulars of all his contacts from the time of contracting the disease (eight weeks before the first sign in the case of syphilis) until the time of diagnosis. The patient is asked to try to bring for examination all such contacts; but methods of compulsion can be used as a last resort if persuasion is unsuccessful.

The theoretical basis of this plan is excellent, embodying as it does the latest features of Anglo-American practice. It is complicated in practice by the necessity for a formidable amount of documentation on the patient, treatment, drugs, follow-up, contacts, statistics, etc. Indeed, the paper-work will consume more man-hours than diagnosis and treatment, as was the case in the Services during the War.

The choice of treatment schedule has been influenced, no doubt, by considerations of time and availability of drugs. I do not consider, personally, that the addition of 0·8 gm. bismuth subsalicylate will increase the 'cure' rate. I believe it will do no more than delay the appearance of signs of relapse in cases which will fail. There is nothing to show that bismuth and penicillin are synergistic in action. The effect of penicillin during a rapid treatment would be more likely to be enhanced by the addition of arsenic (as an arsenoxide for preference) to the schedule. This idea has, no doubt, been discarded because of the slight risk of arsenical toxic effects and because of its technical difficulties. Arsenicals have to be administered intravenously, and it is probable that Poland at the present time lacks the skilled personnel necessary to cope with these added difficulties in the vast numbers of cases to be treated.

The choice of 3,000,000 units as the total dose of penicillin is again, no doubt, governed by circumstances; but it is a minimal effective dose and ought to be doubled as soon as supplies are available. With an infectious relapse-rate estimated (conservatively in my opinion) at 15 per cent, the follow-up programme must be very carefully carried out and failures re-treated without delay if an end state worse than the original is not to follow an initial apparent success.

The Polish medical authorities are to be congratulated on a carefully prepared and ambitious plan which seems to cover the immediate needs and make a basis for a useful service in the future. The statistical service may prove of great value in the rapid assessing of any treatment schedule, and it is to be hoped that if it is a success the system will be used for comparative experiments in treatment.

JAMES MARSHALL

DECARBOXYLATION OF OXALACETATE BY BLOOD

By PETER M. NOSSAL

Department of Biochemistry, University of Adelaide

EVOLUTION of carbon dioxide from oxalacetate by washed rabbit erythrocytes at *p*H 7·4 has been reported previously[1]. Because of the solubility of carbon dioxide at that *p*H, this could at best be only a qualitative indication of the decarboxylation Working in either phosphate or 2*M* acetate buffer and measuring carbon dioxide formation by the standard Warburg technique, the process has been thoroughly investigated.

The process is found in the following constituent of rabbit blood, either freshly drawn or stored fo periods (up to several days) on ice: whole blood erythrocytes, erythrocyte hæmolysate, plasma and acetone powder extracts of all the aforementioned Hæmolysates were usually the most active, whole blood, erythrocytes and plasma roughly equall active, and acetone powder extracts all slightly less active.

At *p*H 6·5, no decarboxylation of either α-keto glutarate or pyruvate was observed, whereas oxal-acetate decarboxylation was considerable; thus the system seems to be specific for that substrate.

Dialysis for 20–24 hours against distilled wate caused reduction in activity. Whereas neither manganous ions (Mn^{++}) nor magnesium ions (Mg^{++}) ha any influence on the decarboxylation by any of the above preparations prior to dialysis, partial restoratio of activity in dialysed extracts was observed by fairl high concentrations (10^{-3} *M*–10^{-2} *M*) of manganou ions, and, less markedly, magnesium ions. Thiamine does not feature in the process under the experimenta conditions employed. Added pyruvate in no wa affects carbon dioxide output, so that the reactio does not seem to be a Krebs condensation to *ci* aconitate. The process is not markedly reduced b submersion of the enzyme in water baths at 70–75° C for periods of 1–4 min.

It must be noted that oxalacetate itself undergoe a quite rapid autodecomposition under the experimental conditions. This is very sensitive to *p*H an varies somewhat for each different oxalacetate solution, so that all experiments were invariably run wit duplicate blanks containing only the appropria buffer and the substrate. Influence of *p*H on autodecomposition of oxalacetate is shown below, that *p*H 7 being taken as 100 for comparative purposes

*p*H	3·5	4·0	4·5	5·0	5·5	6·0	6·5	7
Decarboxylation	300	280	250	180	150	150	130	1

All references made to decarboxylations are to be taken as *increases* above the autodecomposition rat obtained after duly correcting for autodecompositio blanks.

It is suggested from the following experiments that two different mechanisms (*apart* from autodecomposition) may operate in blood under certain conditions.

Examination of the effect of *p*H showed that decarboxylation occurred for the full range tested, namely, *p*H 8·4–3·5. No experiments were carried out at *p*H values lower than 3·5. It was seen that, at the latter *p*H, very great activity is still obtained in both hæmolysates and plasma. Actually, that of the hæmolysate is definitely greater at *p*H 3·5 than at any other *p*H tested, in spite of the very large correction due to the autodecomposition, whereas plasma seemed to show optimal activity between *p*H 4 and 5. Since it seems almost certain that an enzyme of this type would not have a *p*H optimum at 3·5 (or even below this value), the existence of a second, non-enzymatic mechanism is suggested under conditions of very low *p*H. This suggestion is very strikingly supported by the following experiments in which the system was first boiled at a certain *p*H, and the decarboxylative activity afterwards determined at the same *p*H (after readjustment, if necessary).

Boiling acetone powder extracts or diluted hæmolysates at *p*H 6·5 for less than 1 min. causes almost complete cessation of the ability afterwards to decarboxylate the substrate. However, boiling the same hæmolysate or plasma samples at *p*H 3·5–4·0 not only failed to cause such reductions in activity, but usually, especially in the case of hæmolysates, a *more rapid* decarboxylation for the boiled sample was observed when compared with an unboiled control.

To account for these consistent, unusual results, the following hypothesis is suggested. At physiological *p*H, decomposition of oxalacetate is brought about by an enzymatic, heat-labile process, in which manganous ions and, to a less extent, magnesium ions, but not thiamine, are involved. The system may thus be similar to the enzymes in pigeon liver described by Evans *et al.*[2] and in bacteria by Krampitz and Werkman[3]. In more strongly acid solutions, however, a heat-stable decarboxylation appears which is due to the liberation of some substance previously not present in a free state. *This liberation is definitely accelerated by boiling in acid solution*, so that boiled samples show a more rapid evolution of carbon dioxide than the corresponding unboiled controls.

The spontaneous decomposition of oxalacetate was then further investigated in order to throw some light on this second, non-enzymatic mechanism. It was found that both manganous ions (Mn^{++}) and magnesium ions (Mg^{++}) at concentrations of 10^{-2} *M* considerably increase the autodecomposition of oxalacetate at *p*H 6·5, the former up to 75 per cent, the latter up to 40 per cent. At a final concentration of 10^{-3}, however, these effects were much less pronounced. Ammonia, considerable amounts of which are undoubtedly released during boiling at strongly acid *p*H values, did not affect the process in concentrations of 10^{-3} *M*–10^{-2} *M*, and therefore does not feature in the second process. These experiments also were carried out at *p*H 6·5. Finally, it was thought that iron, which may well be formed from hæmoglobin at low *p*H values, might account for the increases observed. It was found that, for both ferrous and ferric ions at final concentrations of 10^{-2} *M*, increases of nearly 100 per cent over a period of one hour occurred. Ferric iron appeared to be the more active of the two, and dilution of both to 10^{-3} *M* did not reduce the effect nearly as greatly as was found with magnesium and manganous ions.

It thus appears that inorganic ferric iron may account for at least a part of the second, non-enzymatic decomposition of oxalacetate observed at very low *p*H values. However, other metals or factors, such as Breusch's heat-stable tissue extract[4], cannot as yet be excluded.

Full details of this work will appear in the *Australian Journal of Experimental Biology and Medical Science*, and further work in connexion with both mechanisms is still in progress.

I wish to express my gratitude to Prof. J. G. Wood for a generous supply of the substrate, to Prof. M. L. Mitchell for continuous advice, and to M. Wellby for technical assistance.

[1] Nossal, P. M., *Aust. J. Exp. Biol. Med. Sci.*, **26**, Part 2 (in the press).

[2] Evans, E. A., Vennesland, B., and Slotin, L., *J. Biol. Chem.*, **147**, 771 (1943).

[3] Krampitz, L. O., and Werkman, C. H., *Biochem. J.*, **35**, 595 (1941).

[4] Breusch, F. L., *Biochem. J.*, **33**, 1757 (1939).

AMERICAN PHILOSOPHICAL SOCIETY

ANNUAL REPORT

THE yearbook for 1947 of the American Philosophical Society, Philadelphia, Pa., covering the year January 1–December 31, 1947, is a useful reference work, with its list of officers and committees, as well as of members, biographical memoirs (including those on Joseph Quincy Adams, Irving Fisher, M. Ganberg, P. Janet, H. S. Jennings and M. Planck) and reports of meetings. A brief history of the Society by E. G. Conklin, and the charter and laws are also included.

The report of the Committee on the Library records further accessions of more material relating to Benjamin Franklin and refers to progress during the year in the American Indian linguistic projects. At a conference called on October 18, 1947, to co-ordinate a programme in American archæology with that in linguistics, it was decided to restrict the area to be studied to the Iroquois and allied groups, and to compile a union list of Indian manuscript material as well as a manual for the use of amateur archæologists for the Iroquois area.

The report of the Committee of Publications gives some details of the foreign exchange list at December 31, 1947, revision of which has continued. In addition to the European libraries, a list is being drawn up of institutions in Latin America which should be placed on the regular exchange or on a temporary list for one year. Thirty-four papers were accepted for publication in the *Proceedings* during the year, as well as seven monographs for the *Transactions* and one book for the *Memoirs* ; two new volumes of the latter were issued in 1947. A list of publications during the year is appended to this report.

The report of the Committee on Research details the general principles adopted by the Committee in regard to grants and lists of the eighty-nine grants, totalling 80,103 dollars, made from the Penrose Fund during the year, with an analysis of the distribution by subjects and a summary of grants made from July 31, 1933, to December 31, 1947, totalling 846,605 dollars. A further nine grants, amounting to 8,300 dollars, were made from the E. R. Johnson Fund, and twenty-two grants, amounting to 46,610 dollars, from the Reserve Fund for Post-War Expenditures. Among the reports from recipients of grants included in this yearbook are those from E. Hille on studies in the theory of semi-groups; W. A. Hiltner on photo-electric observations of selected Wolf-Rayet stars, the polarization of the continuous radiation from early-type stars and selected eclipsing variable stars; and from F. B. Wood on photo-electric observations of eclipsing binaries. F. F. Cleveland reports on his studies on molecular spectra and molecular structure of olefins, acetylenic compounds, diastereoisomers, hexachloroethane, hexabromoethane and other compounds, C. P. Harnwell on the construction of a new type of beta-ray spectrograph to investigate the beta-ray spectra of radio-elements emitting electrons and positrons, and H. H. Nielson on high-dispersion measurements on the infra-red spectra of the polyatomic molecules of hydrogen sulphide, acetylene, difluoromethane, dimethylacetylene, arsine and deuteroarsine. Work is described by E. Berliner on the competitive bromination of alkylbenzenes for the purpose of ascertaining a possible conjugation of alkyl groups with the benzene ring, by J. L. and E. M. Irvin on the apparent acid dissociation constants, quinoline antimalarials such as 'Pamaquine' and other 4-amino- and 4-hydroxyquinolines, and by J. F. Mead on the action of lead tetra-acetate on amino-alcohols and amino-glycols.

Studies in chemical embryology are reported by J. L. A. Brachet, on the quantitative spectrographic analysis of salt metabolism in developing *Fundulus* eggs and senescent *Drosophila* by O. C. Glaser, and on isolated embryonic amphibian cells with special reference to cellular structure, motility, aggregation and differentiation, and embryonic cell inclusions, particularly of yolk, lipochondria and microsomes by J. F. K. Holtfreter. A serological investigation of speciation and evolution, using the Libby photron-reflectometer, has been made by P. A. Moody, and experimental studies on the development of structure and function in the central nervous system of *Fundulus* embryos by J. M. Oppenheimer indicate that metrazol has a selective action on the cell-layers nearest the central canal. C. W. Clancy's investigation of the development of eye colour in *Drosophila melanogaster* suggests that the wild type allele of the vermilion gene is not only concerned with the reactions leading to the formation of the brown pigment component but also in some unknown way with the formation of the red pigment. J. F. Crow reports on the different susceptibility to ether of several closely related *Drosophila* species, H. Geiringer on the theoretical genetics of multivalent organisms, H. P. Hansen on post-glacial forest migrations and climate in Western Canada, and Ching Tsao Wei on the seed-borne diseases of soya beans. C. R. Procter has made an ecological study of a group of ferns, *Dryopteris cristata* and its relatives, in the eastern United States, and E. Girden a phylogenetic comparison of experimental drug dissociation. The electrical responses of the human retina to stimulation by light of various wave-lengths has been studied by L. A. Riggs, the application of the concepts of servo-theory to biological systems by C. L. Kreezer; and the specificity and sensitivity of a further fifty colorimetric tests for eighteen amino-acids by A. P. Kline.

In the field of social sciences, studies of wholesale commodity prices in Philadelphia during the Revolutionary War and of industrial relations in Norway are reported; and, in that of the humanities, of the prehistoric archæology of the Tangier area of Morocco, preliminary excavations at Cottonwood Cave and Pueblo, Colorado, the distribution of petroglyphs in the United States and the archæology of Marajo Island, Brazil.

WEST AFRICAN SEA-FISHERIES

MR. G. A. STEVEN'S report of his work*, as the sole fisheries development officer, under acute difficulties of war-time conditions, in Sierra Leone, a Colony where the sea-fisheries were almost entirely undeveloped, has now been published. It should prove a most valuable guide to Mr. Steven's successors, and leaves one profoundly hoping that they will find their path made smoother for them.

There is little doubt that the sea-fisheries in these undeveloped regions could be made to yield a vastly greater contribution to the sadly inadequate proportion of protein in the local diet. The small-scale trawling experiments with the *Maid Honor* (Skipper R. E. Brown) showed a yield of 86 lb. per hour from a 64-ft. headline trawl, which is sufficiently encouraging. In pre-war years a large British trawler with (say) 110-ft. headline gear, and vastly more expensive to run, could pay her way on double that yield. Since the report was written, we have been verbally informed that *Maid Honor*, still working in the same locality, is paying her way handsomely.

Fish are there in trawlable quantity, building of vessels up to the size of small motor-trawlers seems to be possible in the Colony and—probably Mr. Steven's most valuable achievement—a local team of net-makers was speedily trained to make good trawls and trammels. Machinery, of course, must be imported, but the only weak spot in the local contribution towards an incipient industry would seem to be need for further training of African seagoing trawlermen in repairing nets at sea.

One big question concerning the ground-fish remains unanswered: in the absence of fundamental knowledge of the ecology of those seas, we have no idea how much fishing the stocks can stand. Hence should any considerable industry develop, it must be controlled by guess-work, until some marine biological survey is completed. Mr. Steven justly points out that such surveys are beyond the resources of the smaller individual Colonies, for a central laboratory of some size and an ocean-going research vessel would be essential. Probably the subsequent working-up of the material would be best carried out in Great Britain, for a long experience of marine biological work overseas has left the present writer painfully aware of the almost complete absence of library facilities outside Europe (and the United States), apart from a very few of the larger cities in the greater British dominions.

Until these essential long-term researches are well advanced (which must take years of patient endeavour), there is no practical alternative to Mr. Steven's view that development officers must just go ahead developing as well as they can, and controlling as seems locally expedient; but the danger of bad or inadequate controls, when the cart is thus put before the horse, is very considerable. Mr. Steven admits this; but having worked in an area that seems to be unusually rich (from what little one knows of the fish populations of warm seas) he does not emphasize the danger of over-fishing tropical stocks, on the sudden introduction of efficient European methods, so strongly as the reviewer would have done. Probably this was because it was only too obvious at the time of Mr. Steven's tour that there could be no suggestion of over-fishing with the inadequate equipment at the disposal of the Colony; but a recent example of the type of trouble that must be guarded against has been the very rapid development of an over-fishing problem in the Australian shark fishery.

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* Report on the Sea Fisheries of Sierra Leone. By G. A. Steven (Freetown, 1945; London: Crown Agents for the Colonies, 1947.)

Mr. Steven's descriptions of existing native fishing practice are most interesting, and must be of great value to those about to undertake similar tasks in the Colonies. The Clupeoids, so far as is known, withstand intensive exploitation better than groundfish, and here development of the *bonga* fishery could probably proceed a very long way without danger to the stocks.

The great difficulties of preservation, processing and storage of fish in a climate which is very humid as well as hot should be more clearly visualized by all concerned in such matters (as, for example, those responsible for fixing the price of ice). The demonstration that dehydration may give better value than canning for local purposes amounts to a challenge to the technicians to devise economic means for the large-scale dehydration of fish under the most adverse climatic conditions.

The biologist will follow the report more easily after reading the very brief account of the principal food-fishes of the area, giving scientific as well as local names, in one of the previous Government publications by Hornell[1], to whose pioneer work Mr. Steven refers in his introduction. That so long an interval elapsed between Hornell's report and Mr. Steven's appointment to follow it up is most regrettable.

T. J. HART

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[1] Sierra Leone Studies, 14 (1929).

CHEMICAL INDUSTRIES IN SCOTLAND

THE report of a committee appointed in May 1945 by the Scottish Council on Industry (20 George Street, Edinburgh. Pp. 39. 2*s.*) to inquire into the present conditions and post-war prospects of the chemical industries of Scotland and to recommend action to the Scottish Council is based on a survey made in 1945–46, and its publication has been considerably delayed. The section dealing with research has been rewritten; but the main recommendations and findings of the Committee remain unchanged in spite of the delay. The Committee made no attempt to define a chemical industry but limited the report to those industries covered under the various sections of *British Chemical Abstracts B*, excluding, however, those sections such as iron and steel, metallurgical industries and fuel, which were being studied elsewhere. Figures quoted in the appendix show that so far as explosives are concerned the proportion of operatives employed in Scotland is well above that calculated on a United Kingdom population basis, while in the chemical industry in general the proportion is well below this figure. The Committee, however, has throughout taken the view that Scotland cannot be treated as a separate entity when industrial development is under consideration. It has endeavoured to take a broad view and believes that any expansion of chemical industry in Scotland would have beneficial repercussions on the national economy of the whole of Britain. It also urges that a survey of an industry which so markedly depends on research involves consideration of the research facilities available in Scotland at present.

A survey of research facilities constitutes an important section of the report. This survey leads the Committee to believe that there is scope for a much more intensive application of research to problems of particular importance to Scotland, and that much of this research is of a kind which might properly be undertaken by a Government laboratory or by a research association. The principal recommendation of the report is, in fact, the formation of a chemical research committee, with representatives from industry, academic institutions and existing research associations, to formulate the problems of chemical research and development which require investigation to meet Scottish needs, to survey the facilities available for their investigation and to make recommendations for extending those facilities where required. Next, the Committee concludes that many firms have been, and still are, suffering from a shortage of labour and sometimes of technological skill. The diversity of the operations required of the workman in any manufacturing chemical process demands a high quality of labour, and on this point a conference is recommended between representatives of the Ministry of Labour and of the chemical manufacturers. Furthermore, chemical manufacturers on the whole do not yet appreciate the advantages to be derived from more adequate scientific control of chemical operations; and the Committee also recommends that their attention should be directed to the large number of graduates in pure and applied science who qualify at the Scottish universities and technical colleges every year, only ten per cent of whom at present find employment in Scotland.

Extension of the work of the Geological Survey so as to accelerate the rate of progress is recommended, and this should be given wider publicity. Indigenous raw materials such as limestone, quartz, felspar and baryta should be critically examined by the suggested chemical research committee and industrialists with the view of their utilization in new chemical development, and steps should be taken to bring the possibilities of chemical manufacturing development under the North of Scotland hydro-electric schemes before the industry. The refining and cracking of crude mineral oil in Scotland should be extended considerably and coupled with a more exhaustive utilization of coal tar as a source of chemicals. Further exploration of the potentialities of such processes as the Robinson–Brindley or the Fischer–Tropsch for organic synthesis is also recommended. Stress is laid on the importance of a substantial reduction in the cost of coal and of easing the situation in regard to Government control of raw materials and housing. Conditions for expansion of export trade are regarded as good, but conference with shipping interests is recommended on measures to avoid the burden on manufacturers caused by the tendency to transfer Scottish manufactured material to southern ports for shipment abroad.

In regard to particular industries, the Committee hopes that the newly formed Coal Tar Research Association will find a place within its organisation for a section operating in Scotland where, owing to differences in coal and methods of carbonization, special problems have to be tackled; and also that the enormous post-war demand for all types of glass will be met in part by a general expansion of the Scottish industry. Scotland should also have a considerable share in the expansion of the dyestuffs industry; but the future of the papermaking industry in Scotland is bound up with the renewed importation of esparto grass and wood pulp. The development in Scotland of viscose, other types of rayon, or entirely new fibres from vegetable protein or alginic acid, must depend entirely upon economic factors, but special attention is directed to glass fibre. There appears to be room for a steady expansion of the rubber industry in Scotland generally, in addition to developing the export market, and it is strongly urged that actual manufacture of synthetic resins should be established in Scotland. The extraction of natural drugs could well be expanded in view of the great opportunities for export, and synthetic vitamins should find a place in the well-established fine chemical industry.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, July 5—Friday, July 9

IRISH CHEMICAL ASSOCIATION (in the Department of Chemistry, University College, Dublin), at 10 a.m.—Summer School in Chemistry.

Tuesday, July 6

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—16th Annual General Meeting; Dr. Emil Ott: "The Relation of Physical Characteristics and Chemical Structure of Cellulose Derivatives".

Wednesday, July 7

BRITISH SOCIETY FOR RESEARCH ON AGEING (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 11 a.m.—Conference.*

Thursday, July 8

SOCIETY FOR ENDOCRINOLOGY (in the Clinical Lecture Theatre, Middlesex Hospital Medical School, London, W.1), at 5 p.m.—Prof. Edwin B. Astwood: "Recent Advances in the Physiology of the Thyroid Gland".*

Thursday, July 8—Saturday, July 10

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the Physics Department, The University, Oxford Road, Manchester). —Conference on "Semiconductors and their Applications".

Thursday, July 8

At 2 p.m.—"The Physics of Semiconductors".

Friday, July 9

At 9.30 a.m.—"Industrial Developments"; at 2 p.m.—"Applications".

Saturday, July 10

At 9.30 a.m.—Informal Discussions, Demonstrations and Exhibits.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENTIFIC OFFICER IN THE CHEMICAL RESEARCH DIVISION of the Ministry of Agriculture—The Assistant Secretary (Establishment), Ministry of Finance, Stormont, Belfast (July 9).

ASSISTANT KEEPER (Class II)—The Director, The London Museum, St. James's, London, S.W.1 (July 9).

ENTOMOLOGIST to work on the biology and control of the Pea Aphis, and an ENTOMOLOGIST to assist with investigations on the biology and control of the Pea Moth and to work on the development of methods of pest control—The Secretary, School of Agriculture, Cambridge (July 10).

SENIOR OBSERVER and a JUNIOR OBSERVER—The Director, The Observatories, Cambridge (July 10).

ASSISTANT PLANT PHYSIOLOGIST, ASSISTANT POMOLOGISTS (2), and an ORGANIC CHEMIST for fruit products investigations, at the Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (July 10).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Leeds 2 (July 10).

LABORATORY ASSISTANT (Grade II) IN THE DEPARTMENT OF PHYSICS —The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 10).

SENIOR LECTURERS or LECTURERS (2) IN THE DEPARTMENT OF ENGINEERING—The Registrar, The University, Manchester 13 (July 10).

PUBLIC ANALYST—The Town Clerk, Town Hall, Bolton, endorsed 'Public Analyst' (July 10).

LECTURER IN THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (July 12).

LECTURER IN ARCHÆOLOGY—The Secretary, Queen's University, Belfast (July 13).

ASSISTANT IN GEOGRAPHY—The Secretary of University Court, The University, Glasgow (July 15).

SENIOR LECTURER or LECTURER IN THEORETICAL PHYSICS—The Registrar, The University, Manchester 13 (July 17).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Ref. No. 1768) to undertake research into the chemical composition of Australian pasture plants, a RESEARCH OFFICER—Ecology (Ref. No. 1769)—to undertake research on pasture ecology, and a RESEARCH OFFICER —Agrostology (Ref. No. 1770)—to conduct research into the establishment and management of sown pastures, Division of Plant Industry, Canberra—The Secretary, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (July 24).

CHIEF CHEMIST, and a RESEARCH OFFICER for enzyme chemistry, physical chemistry, X-Ray crystallography, and infra-red spectroscopy—The Secretary, Wool Industries Research Association, Torridon, Leeds 6 (July 24).

SENIOR ANALYST, an ANALYST, and an ANALYST (Biochemist), in the City Analyst's Department—The Town Clerk, Municipal Buildings, Dale Street, Liverpool, with the appropriate endorsement (July 26).

MECHANICAL ENGINEERS (3, Principal Scientific Officer grade) in the Royal Naval Scientific Service, for (*a*) design and development of torpedoes, (*b*) work on small control mechanisms, and (*c*) work requiring a sound knowledge, both practical and theoretical, of steam generating plant and prime movers—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2186 (July 31).

CHAIR OF ARCHITECTURE AT NATAL UNIVERSITY COLLEGE—The Secretary, Universities Bureau of the British Empire, 8 Park Street London, W.1 (July 31).

HEAD OF THE METALLURGY DIVISION at the Atomic Energy Research Establishment—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2184 (July 31)

CHAIR OF CHEMISTRY—The Secretary, The University, Aberdeen (July 31).

CHAIR OF PHYSICS in the University of Adelaide—The Registrar The University, Adelaide, South Australia (August 15).

MECHANICAL ENGINEERS, PHYSICISTS or METALLURGISTS for research on mechanical working problems generally, including rolling, drawing and forging, and MECHANICAL ENGINEERS to assist in research on mechanical working problems generally, in the Metal Flow Research Laboratory—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Metal Flow'.

LABORATORY ASSISTANT or TECHNICIAN with experience in some field of biological laboratory work, and a SPECIAL HISTOLOGICAL TECHNICIAN for a new research programme on radioactive tracer elements—The Professor of Zoology, The University, Bristol.

GOVERNMENT CHEMIST in the Medical Department of the Gold Coast—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

TECHNICAL RESEARCH ASSISTANT by the Professor of Physiology—The Secretary, King's College of Household and Social Science Campden Hill Road, London, W.8.

SCIENTIFIC OFFICERS and EXPERIMENTAL OFFICERS in Ministry o Supply Establishments concerned with the whole field of scientific research for the Services, for Civil Aviation and for a variety o industrial purposes, in the fields of: Chemistry (Ref. F.355/48) Biochemistry, Physiology, Pharmacology (Ref. G.184/48), Aerodynamics (Ref. A.160/48), Aircraft Structural Theory (Ref. C.301/48) Gas Turbines (Ref. C.299/48), Physics (Ref. A.159/48), Radar (Ref A.161/48), Aircraft Instrumentation (Ref. C.300/48), Metallurgy (Ref. F.356/48), Mathematical Applications (Ref. A.158/48)—Technical and Scientific Register (K), York House, Kingsway, London, W.C.2.

CHEMIST with research experience preferably, though not necessarily in field of protein fibres—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.

SENIOR TECHNOLOGIST—The Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1

BIOCHEMIST (non-medical)—The Secretary-Superintendent, County Hospital, Lincoln.

ASSISTANT TECHNICIAN IN THE ZOOLOGY DEPARTMENT—The Registrar, University College, Southampton.

LECTURER IN LIVESTOCK HUSBANDRY—The Principal, Harpe Adams Agricultural College, Newport, Shropshire.

SENIOR LECTURER, and a LECTURER, IN PHYSICS, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

STATISTICIANS in the newly created Statistical Department of the Government of Nigeria—The Director of Recruitment, Colonial Service 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Physical Society. Report on Colour Terminology. By a Committe of the Colour Group. Pp. iv+56. (London: Physical Society, 1948 7*s*. net. [13

A Description of Ordnance Survey Small Scale Maps. Pp. v+21+1 plates. (Chessington: Ordnance Survey Office, 1947.) 1*s*. 6*d*. [13

A Description of Ordnance Survey Large Scale Maps. Pp. v+23+ plates. (Chessington: Ordnance Survey Office, 1947.) 1*s*. 6*d*. [13

F.P.A. Journal. Quarterly. Vol. 1, No. 1, April. Pp. 28. (London Fire Protection Association, 1948.) n.p. [18

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LIMITATIONS OF PLANNING

OF the many repercussions in Britain of the fuel crisis of February 1947, the shock administered to the general belief in economic planning was among the most far-reaching. Those who then began to doubt whether the best way of ordering economic affairs was to place the responsibility for all crucial decisions in the hands of the State have since been joined by many others as a sequel to the balance of payments crisis of August. Behind the resentment originally aroused by the abolition of the basic petrol ration and the direction of labour lies uneasiness as to whether the method of cure is not bringing evils worse than the disease, and endangering precious and fundamental elements of our heritage of freedom.

This is no mere party issue, and while it may still be generally admitted that we must have more State intervention and direction in our economic life than we had before the War, there is probably less disposition to regard economic planning as a magic talisman by which our difficulties may be charmed away. The recent resignation of Sir Charles Reid from the National Coal Board arouses profound misgivings as to whether under the existing conditions the technical man will be allowed to make his all-important contribution to the improvement of technical efficiency and production. Those who believed that, given time, good technique might solve the worst of Britain's coal problems, are forced to admit that mining engineers, at the moment, are not in a position to make their full contribution to the rehabilitation of the industry.

If this is true in the coal industry, nationalization of which was accepted by almost everyone as essential and appropriate, doubts cannot but grow whether the programme of nationalization will make any positive contribution to the improvement of industrial efficiency and productivity, either in the narrower technical or in the wider social and economic context. While the recommendations of the Reid Report are not implemented, the scientific worker and the technologist at least can scarcely be convinced that nationalization as such is the answer to our economic problem, if indeed they do not see in national ownership a fresh obstacle to the technical reorganisation which may be needed in more than one industry. Those doubts will be further strengthened by the opinions voiced by Sir John Henry Woods, 'permanent secretary' to the Board of Trade, in a lecture before the Institute of Public Administration last December. Indeed, that lecture, now published in the *Journal of Public Administration* (26, 85; 1948), contains unmistakable evidence that nationalization of industry in Britain at the pace set by the present Government has seriously overstrained the administrative resources of the country, as indeed both Mr. Shinwell and the Lord President of the Council have admitted.

Despite, therefore, current discussions on the possibilities of securing a better utilization of the country's resources of scientific man-power through planning based on operational research, there is probably a much wider disposition than at any time since the end of the War to recognize that central planning has limits. That much was argued by Sir Oliver Franks in the very lectures to the London School of Economics and Political Science last year which Sir Hubert Henderson criticized in his Rede Lecture in May 1947. The question to-day is rather where is the frontier to be drawn between planning and freedom, given the techniques now at our disposal, the administrative possibilities and difficulties, and the social aspirations which lie behind so much of the programme of reconstruction to which the present Government no less than its predecessor is committed.

Prof. John Jewkes' recent book, "Ordeal by Planning"*, shows plainly that discussion is what is first required. Readable, fluent and clear in its diagnosis, it says much that was worth saying and will be read with approval by many who are becoming conscious that they are losing something they cherish and in danger of losing more. But its analysis is purely destructive, and Prof. Jewkes has thrown away an opportunity all the greater because the persuasiveness and clarity of his style should secure a firm hold on the reader's sympathy and understanding. He defends himself, it is true, on the plea, that it is necessary to clear a field of weeds before sowing a new crop; but sometimes his destructive analysis is more like pulling up the wheat with the tares, and handing over both to the destructor. Nevertheless, it is well that the relation should be established between the fall in the standard of living in Britain, the progressive restrictions on individual liberties, the ever-widening destruction of respect for law, the steady sapping of our instinct for tolerance and compromise, the sharpening of class distinctions and our growing incapacity to play a rightful part in world affairs; though it is going too far to attribute these interrelated changes to something that has happened in the last two years. The danger of liberties being filched away, of the residue of our liberal traditions disintegrating and a planned economy issuing in totalitarianism are plainly stated, but it does not follow, as Prof. Jewkes implies, that we must choose between further planning and a return to the free price mechanism.

It is, however, when he comes to discuss planning as a scientific method, planning and freedom and planning and prosperity, that Prof. Jewkes has most to say that is of direct interest to the scientific worker. Under the first heading his remarks bear closely on the organisation and activities of the nationalized industries and are given point by Sir Charles Reid's resignation and by the inability of members of Parliament to raise a question in the House of Commons regarding a recent widespread failure in power supply. The purely logical and intellectual difficulties of running a planned economy have not yet been solved, though it is pessimistic to assume as yet that they cannot be solved. Prof. Jewkes maintains, however, that central economic planning cannot be scientific. In the first place, he says, such a plan can only have a scientific purpose if it is designed to give the consumers what they want and when they want it, and to provide freedom for the consumer to decide whether he wishes to spend his money now or in the future. In the second place, the centrally planned economy is unscientific in that those who take the final decisions must always avoid the confession of failure.

It may be true that in practice the central planner does tend to avoid admitting failure, but nevertheless Prof. Jewkes' 'must' can well be challenged; similarly the fact that central planners have often disregarded the consumers is no valid reason for asserting that they must necessarily fail to provide the consumer with the freedom on which Prof. Jewkes quite correctly insists. Here as elsewhere Prof. Jewkes indicates the essential criteria for freedom; but, pointing to present failures to meet those criteria, concludes rather too readily that they can never be met. It is well that those weaknesses should be stressed. Britain clearly is ill able to afford the waste of man-power and materials that are inherent in some of the manifestations of planning we are at present witnessing. It is not merely the growth of the administrative staff or bureaucracy. The danger of retarded technical progress, and the deterioration of the atmosphere in which fundamental research is prosecuted to which Prof. Jewkes refers cannot be ignored, and should be seriously considered.

We have to remember that in the last analysis the answer to the problem depends upon which type of economic organisation will provide the greatest incentive to effort. Prof. Jewkes points out that whether planning can evoke sufficiently powerful incentives to enable it to match the economic results of a free economy depends upon many physical, psychological and even spiritual factors bound up with the reasons why men work at all. These factors are complex and difficult to assess; but Prof. Jewkes suggests that there are two groups of workers whose output is likely to be affected adversely in the planned economy of a socialist State. The first, and larger, is that which presses for socialism in the expectation that it will lead to an easier life and bigger returns for less effort. The second and more important group is that responsible for the highest intellectual effort, such as fundamental scientific research.

Prof. Jewkes believes that fundamental research must wither in a planned economy, both because it cannot proceed in such an environment and because those who are capable of it will be disgruntled by what appears to them the foolish policy of the State in failing to provide the only environment in which they can work. He cites in support of this view the wholesale resignation of the experts on jet propulsion when the Government took over this research; and while he is here on debatable ground, the importance of incentives in this context cannot be gainsaid. It must be admitted that the whole question requires very careful examination, for there is no doubt that under present conditions the real work of the world —the patient fostering of the efficient organisation of a factory, the cultivation of craftsmanship, the extending of scientific knowledge, the teaching of the young, the healing of the sick—does tend to fall in public esteem. Moreover, there is continuous erosion or destruction of the sense of responsibility, and this may be quite as serious in its results as the decrease in the differentials in reward in a planned as compared with a free economy.

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* Ordeal by Planning. By Prof. John Jewkes. Pp. xi + 248. (London: Macmillan and Co., Ltd., 1948.) 12s. 6d. net.

Prof. Jewkes argues that the planned and centrally directed economy must inevitably undermine the economic freedoms, such as the choice of occupation, the disposal of incomes and the acquisition and tenure of property. These freedoms, while they can never be absolute, cannot be separated from the freedom of expression in all its forms or the freedom to choose and change the members of the governing body of the community, and their whittling away destroys the independent thought and criticism through which alone freedom can be preserved. However strongly we may feel that Prof. Jewkes is too pessimistic here, the danger is real; and it is well that we should be asked to consider more carefully how it is that planning, which sets out to control things, ends by controlling men.

Prof. Jewkes' argument is strongest at this point, where it directs attention to the dangers to man's moral and spiritual welfare which appear to be inherent in economic planning. Wherever the frontier is drawn between freedom and planning, the organisation we establish to serve the needs of society with the most effective techniques and administrative resources of to-day must take full account of them; we must never forget that the individual is more important than the organisation or plan designed to serve his needs.

This warning of the danger of over-organisation and of central planning is emphasized from another point of view by the lecture by Sir John Woods on the administrative problems of the Board of Trade; Sir John is frankly concerned as to whether the central machine of Government can stand for long a continuance of the pressure, and his lecture underlines all that was urged by the Select Committee on Estimates in its Fifth Report for the Session 1946–47, and by Prof. W. A. Robson in his article on "Machinery of Government, 1939–1947" in the *Political Quarterly* early this year and again in his inaugural lecture at the London School of Economics and Political Science, on the urgent necessity of reconsidering the whole pattern of the Government machine in the light of modern conditions. In particular, Sir John asks whether the work of the Board of Trade as it now stands is a business that can be administered at all; and the whole trend of his lecture suggests that the answer is that it cannot.

The trouble is generally congestion at the top, because in spite of the expansion of government departments the structure remains essentially one that was built up for much lighter and more leisurely tasks. The Board of Trade provides an excellent illustration of the position, but it also illustrates very forcibly one of the points Prof. Jewkes makes. In 1938 the Board of Trade had a staff of 2,400, of whom 60 were administrative officers: there are now 400 administrative officers and a total staff of 15,000. The main divisions of its work are in charge of fifteen 'under-secretaries', above whom are two 'second secretaries' and the 'permanent secretary', through whom theoretically all important questions pass to the president of the Board of Trade.

When the department was small, this system was a practical means of seeing that its policy as a whole was coherent; now it is what Sir John calls a 'super-bottleneck', and in practice it is not possible for everything to go to the president through the permanent secretary. Nevertheless, it is essential to keep in step the policies of some four hundred people, and in spite of all the elaborate methods already adopted to inform each section of what the others are doing, the range of activities is so wide that Sir John admits that it is still possible for somebody to go ahead with a policy only to find that it conflicts with some other line of policy being pursued elsewhere. The administrative confusion and public criticism which result involve further waste of time on remedial measures, and lead to an even greater danger: so much time is spent in being sure of keeping in step that advance is scarcely possible. In Sir John's words, "things that ought to happen do not happen while we are making sure that nobody will be upset if they do happen".

In this great department, the essential function of research or fact finding as a basis for the determination of long-range policy as distinct from day-to-day activities is not being discharged. It should also be remembered that even if we could find the able men outside the Civil Service to serve on a committee to investigate such matters, Civil servants would still have to collect the information. Whatever Prof. Jewkes may urge, and although the Government could avoid making fresh demands on the Civil Service and perhaps reduce some of the present demands, most of the work has come to stay.

Such observations emphasize the importance of such new ventures as the British Institute of Management and the Administrative Staff College, as well as the National Institute of Economic and Social Research, and the increased provision for research in social science at the universities recommended by the Clapham Committee. The training and exchange of staff, and research into problems of administration and government, will both be required before we can either evolve the most effective forms of organisation to serve our needs to-day in industry and in government, or say with certainty where the frontier between planning and freedom lies. The conclusion to be drawn from Prof. Jewkes' book, with its demonstration of the dangers and abuse of planning, is not that planning is impracticable, but rather, as Sir John's lecture indicates, that we have embarked on large schemes of planning and organisation before determining the nature of the organisation required, the precise purposes it has to serve and the limitations imposed by existing techniques and administrative ability, whether individual or collective.

This fresh warning of the dangers of planning and reminder that for the moment we have outstripped our administrative resources and capacity for organisation is really a challenge to creative thought and to fresh efforts to discover the ways of co-operation in which the vast material resources which technology has put at our command may be used for the benefit of the whole community. Whatever mistakes may have been made in planning—and they have been frequent and grievous—mankind cannot go back and abdicate the conscious control of his environment. The preservation of the rich cultural and spiritual heritage of mankind, on which Prof. Jewkes rightly lays such stress, depends on fresh advance in the patient study of human relations and institutions, and the evolution on the basis of past experience of new means to serve the more complex demands of modern society. The price of freedom is indeed eternal vigilance; but a part of that price must be the continuing, courageous and imaginative study of human organisation, inspired by a greater respect for human personality and the moral values of Western civilization.

THE MATHEMATICAL PRINCIPLES OF PHYSICS

Principia Physica

Von Hans Georg Küssner. Pp. 256. (Göttingen: Vandenhoeck and Ruprecht, 1946.) n.p.

IN this book the author presents a new conception of the general principles of physics by trying to construct an axiomatic system in which no descriptions of facts are used which are not "logically definable". Maintaining that the notion of the continuum does not fulfil this condition, he demands that metric geometry be excluded from physics altogether, and that the space-time system be put on a purely arithmetical basis. In other words, the universe is considered to be a discontinuous manifold or point lattice. Quaternion algebra is found to provide the most adequate mathematical description for such a system and to account automatically for the four-dimensionality of space-time and its splitting up into three space-like and one time-like dimensions. In contrast to the usual concept of a dynamic universe to be described by events, the new concept is that of a static universe to be described by its structure, which reflects itself in the group properties of the algebra used for this description. Accordingly, the fundamental laws of physics cannot have the form of differential equations but have to be expressed in the form of integral equations, that is, free of metric, the integrals used being essentially Stieltjes integrals, the definition of which also holds for a discrete set of variables.

These integrals extend over the whole space-time, which is in keeping with the fact that in classical physics both time directions are completely equivalent and that there is no actual difference between past and future. On the other hand, the classical concept of causality, namely, that the future as well as the past of a physical system ought to be completely predictable from a knowledge of its present state, is not compatible with this structural idea, as no exact statement at all can be made about the structure outside a certain finite region of the world lattice from a mere knowledge of the structure within. Thus only approximate extrapolations can be made, which is essentially the same as saying that in general only statistical statements about the future (or the past) of a physical system are possible. Quantum mechanics, which is of an intrinsically statistical nature, is therefore regarded by the author as only an approximation towards the real structural laws. The general theory of relativity is also rejected because it is essentially based on metric geometry.

The world (lattice) points can be classified in different ways. A class of points constituting a line of sufficient length is identified with an 'atom'. Thus the atoms have no geometrical structure and have the character of 'point charges', the charges being of two different types, electric and 'gravic', and of different magnitude. All atoms can be classified into classes of equal charge, and by the application of group theoretical arguments it is shown that only a finite number of such classes exist. Each atom is in integral interaction with every other atom. The laws of this interaction, which are the equivalent of the classical field laws of electromagnetism and gravitation, are supposed to be of the type of Maxwell's equations which, it is shown, can be formulated as integral equations of the above-mentioned character. These equations also comprise interactions between electric and gravic charges which, the author claims, are the explanation for the electric and magnetic fields of the stars. Experiments for the verification of these relations are proposed.

The principles mentioned so far cover the domain of physical laws in medium dimensions. In order to obtain the laws of macrophysics and microphysics other principles have to be added. In the first case a structural principle relating to the structure of the universe as a whole is formulated, which the author calls the "principle of equal surroundings". This, it is claimed, leads to an understanding of the expansion of the universe and a number of other cosmological phenomena, and it also disposes of the notion of an inertial mass, reducing it to the interaction with the total material content of the universe. The non-commutative quaternion algebra, on the other hand, lends itself to the introduction of quantum conditions in the form of commutation rules. In addition to Planck's constant for the electromagnetic interaction of atoms another constant for the 'gravic' interaction is introduced. This leads to a theory of a new kind of atomic disintegration which is believed to be the origin of the primary cosmic radiation, the extra-terrestrial nature of which the author denies.

The fundamental equations of the new theory contain altogether fifteen universal constants. It is well known that only three such quantities can be dimensionally independent. Hence twelve independent relations between these quantities can be established which contain only dimensionless arithmetical constants. These are identified with the twelve arithmetical group invariants of the particular kind of algebra used. This is put to the test by a comparison between the theoretical and the most reliable experimental values of the universal constants, which indeed shows most striking agreement within the limits of accuracy. Moreover, according to the above-mentioned ideas about the nature of the atoms it should, in the view of the author, be possible also to calculate, by similar methods, the masses and spins of all possible atoms in all states of excitation. The solution of this problem is also attempted but only a limited success is claimed.

Although the author repeatedly emphasizes that all new theoretical ideas must be subjected to the most rigorous tests by experiment, it is nevertheless evident that he is essentially of the opinion that complete understanding of the material world can be achieved by purely epistemological methods. This accounts for the frequent appearance of phrases like 'endgültige Erkenntnis' (final cognition). The many extremely close agreements between theory and experiment are presented as stringent evidence for the truth of the theory; but the same claims are made by other theories (like Eddington's) which are based on completely different epistemological principles. In the opinion of the reviewer none of these theories could have been developed without a previous knowledge of the experimental facts and the numerical results of the experiments. Indeed, a great number of recent discoveries about fundamental particles, etc., are definitely not 'predicted' by the theory simply because the author did not know them while developing his ideas. Thus in spite of its extremely interesting aspects the new theory can only be regarded as one of many attempts to restore order and harmony in he rather chaotic state of ideas about the material universe which has its parallel in the state of affairs concerning spiritual values. Every brave effort to achieve unification in both realms of thought is welcome, and therefore the detailed study of the ideas which are briefly outlined in this review can be warmly recommended.

R. FÜRTH

ESSAYS ON ECONOMIC RECOVERY

Britain's Industrial Survival

By Ian Bowen. Pp. 204. (London: Faber and Faber, Ltd., 1947.) 12*s.* 6*d.* net.

Co-operative Communities at Work

By Henrik F. Infield. (International Library of ociology and Social Reconstruction.) Pp. x + 182. (London: Kegan Paul and Co., Ltd., 1947.) 15*s.* net.

The World as an Economic Entity

By Business and Brotherhood and Res et Caritas. Pp. viii + 218. (Nicosia, Cyprus: Guebenlian Press, 1946.) 7*s.* 6*d.*

WITHIN a decade the concept 'economics' has gone out of vogue and 'political economy' has gain taken its place. This is perhaps not so surprising at a time when attention is turned from analysis to application. Mr. Bowen is definitely a political economist; and the use of this self-styled title is evidently a warning not to expect any systematic analysis. His examination of the necessary conditions for Britain's economic recovery unhesitatingly introduces biological and political factors. Indeed, any realistic approach to applied economic problems could scarcely fail to do so. But after having read the book through, the reader might well wonder what the formulation of "the two main world economic problems"—a declining population and unemployment—has to do with the future industrial organisation of Britain, dealt with in the concluding chapter. There is no attempt to analyse fully or assess the relevant problems facing Britain and to reach, through such an analysis, certain conclusions.

The book makes pleasant reading but gives little return for study. Yet despite its two hundred pages contains quite a wealth of economic information, presented in a rather kaleidoscopic form. There is a good section on distribution and imperfect competition and the devices used to restrain retail competition. There is also an interesting chapter on "Advertising in the Modern Economy", followed by a discussion of monopoly in manufacturing, the application of power to industry, industrial efficiency, the formation of capital, population, and overseas capital formation. Indeed, scarcely any of the chapters are without interest; but they would be improved were they treated as separate papers rather than as steps in a logical argument.

In many respects Mr. Bowen falls between two stools. The study is too factual and too detailed for the ordinary reader and not sufficiently analytical for the student. For example, in the section on the rigidity of retail margins, which is an excellent collection of informative data, it is a pity that it did not include any examination of war-time controls and the method of stabilizing prices which has not only perpetuated the fixed margin concept (and possibly petrified it, too) but also strengthened the position of retail associations. There are many other such examples, where the reader feels the study could have been pushed deeper. But this criticism at least shows that Mr. Bowen's writing provokes thought and discussion.

There are some illuminating statistics gleaned from various sources, but again one feels—possibly quite unjustifiably—that many of the correlations are perhaps just statistical freaks. Nevertheless Mr. Bowen's discussion of the organisation of the national boards makes amends. His comments are sound and his emphasis on joint consultative machinery in industry is correct, although one cannot help thinking that under his proposed organisation the influence of the State would penetrate into all spheres of the individual.

Mr. Infield's book is a study of co-operative communities in various parts of the world. This is another system of organisation for the post-war world; but it is the antithesis of nationalization. The communities are collections of individuals who are willing and able to work together as units to develop agricultural production and to promote higher standards of rural life. The purpose of the survey was to help organise co-operative communities as a vanguard of rural resettlement.

The two fundamental motives for all co-operative settlements have been religion and social reform, and the study covers a selection of communities falling into each group. There is a very illuminating analysis of the Hutterites, the New Llano Colony and the Sunrise Community, which also throws light on those communities in the past which have not survived. Examples of more recent ventures which have been included are the co-operative farms established by the U.S. Farm Security Administration (1937–43), the Mexican Ejido, the Russian Kolkboz and the Palestinian Kvutza.

The survey has been carried out in a masterly manner, and the appraisal of each type of community allows a comparison to be drawn. It discusses their economic policies, their political machinery and the results achieved. One conclusion which is immediately apparent in this study is that the absence of the co-operative spirit in any community brings a threat of failure, no matter whether those communities were founded by individuals or governments.

Mr. Infield is adverse to any rigid plan for post-war resettlement on co-operative lines, owing to the great variation in the physical conditions of each settlement and the character of the population. There is the need for a vital motive to knit the group closely together. Rational motives tend to lead to dissension.

In this context the survey discusses the requirements of membership, the administration and management and the degree of co-operation to be achieved. As a study it is both interesting and instructive; but the simple and easy style of the writer should commend this book even to the ordinary reader.

The third book under notice is a poor attempt to propound a fundamental truth—the need for Christian ideals (brotherly relationship, the author calls it)—in an economy run on business-like lines and activated by the profit motive. Some of the comments are certainly of value, but they are completely lost in the book, which is both badly written and badly printed. The reader would, indeed, have to feel very penitential to take the trouble to go through all 218 pages and winnow the chaff from the wheat.

SCIENCE AND PHILOSOPHY

Science and the Meanings of Truth

Studies Introductory to asking What is meant to-day by Physical Explanation of Nature, by Mechanisms of Cause and Effect, and by a Claim that Scientific Knowledge is True. By Dr. Martin Johnson. Pp. 179. (London: Faber and Faber, Ltd., 1946.) 12*s.* 6*d.* net.

As may be gathered from its sub-title, the central theme of this book is an examination of the meanings which have been or may be given to the word 'truth' in relation to recent developments in physics.

"Until the era of some recent researches in atomics and relativity, the advances of science were satisfactorily carried forward by alternation of simple hypothesis and experimental test; the quantities mentioned in the former were not unlike those measured in the latter, the nature of hypothesis being restricted to a certain kind which had served adequately from the Renaissance. In particular, the success of early modern astronomy, in replacing geometrical description of planetary motion as imaginary combinations of circles, by actual elliptic orbits linked causally with a theory of gravitation, had set a type of hypothesis in which a cause was assigned for activating a mechanical model or mental picture. In later uses of this kind of picture, the criterion of truth to be tested by experiment was whether the supposed and imperceptible substances underlying perceivable phenomena act in accord with the Newtonian laws found adequate for the behaviour of visible and tangible objects. Striking success followed the exploitation of this criterion of truth in the theory of gases and of heat, and the electromagnetic theory of light, and some of the simpler theory of metals."

But with recent researches in physics, this idea of cause in the sense of "forces causing changes in motion" broke down, because it became impossible to construct mechanical models. Such models have, in fact, been recognized as concepts, and scientific knowledge regarded as a system of formal relations instead of a correspondence with any external world imagined in a model.

After reviewing briefly the meanings of truth implied in the writings of Heisenberg, Dirac, Eddington, Milne, Whitehead and Russell, Dr. Johnson puts forward a view of his own. For him science rests on the postulate that Nature is intelligible, and the essential fact underlying this is fc him that scientific knowledge is communicabl That is, first, after measurements have been mad propositions are formulated in such a way that th results are repeatable and therefore verifiable secondly, such statements are further judged b 'coherence' in the sense of correlating the widel different physical situations within each of whic communicability has already guaranteed a degree truth. For example, the conic sections which replace the medieval circles in describing planetary motio could also describe the orbits of comets and were valuable though transient help in the suppose orbits of electrons within the atom. This criterion truth is thus a practical one—"coherence betwee communicable patterns of measurement". We n longer ask whether the 'wave-electron' or the 'particl electron' are true or false "in the sense of corr sponding to any permanent object with the mod properties of anyone's mental picture or concept" each theory is simultaneously 'true' as "each communicable over its own range of physical situ tions".

The second part of this book is concerned wit more general philosophical problems arising out the meanings given to truth in science and i particular with the relation of the physicist's min to the experience which comes to him from withou The discussion is confined to the types problems arising rather than with an attempt solve them.

This book is not easy to read, and the style involved and not always happy. It does, howeve cover many interesting topics and not its least val is that it is written by a practising physicist thinki his way through the implications of his subject.

A. C. Crombie

A GUIDE TO THE ASTROLABE

Traité de l'astrolabe

Par Henri Michel. (Ouvrage publié avec le concou de la Fondation Universitaire de Belgique.) P viii + 202 + 24 plates. (Paris: Gauthier-Villa 1947.) 1,200 francs.

There are not a few treatises, old and new, th concern themselves with that ancient a beautiful instrument, the astrolabe; but few, any, are of use to the student or collector possessi an astrolabe who wishes to know how old it is, hc it is used, and what are the principles that under its construction. The work under review mo admirably fulfils these functions, and its account the multifarious types of astrolabe is the cleare and most reliable of those known to the reviewer.

The book is divided into two parts. The former these deals briefly with the history of the astrola and goes on to a description and explanation of t various types, eastern and western. The auth discounts the generally accepted ascription of t invention to Hipparchus, largely on the ground th it was not known to Ptolemy, whose *astrolab organon* was something quite different from t instrument to which the name of astrolabe has be traditionally attached. He finds the first referen to this, the planispheric astrolabe, in the sixt century treatise of Philoponus, who tells us that h master Ammonius (c. A.D. 500) had written on t subject. M. Michel's view is clearly in accord wi he facts as known to us, though many students of ncient science will feel that an instrument so admirably devised and designed is unlikely to have emanated from the almost extinct fires of Greek culture. Very admirable is the author's clear account, in non-technical language, of the basic principle of the astrolabe, namely, the superposition of a movable map of the celestial sphere upon a map of the terrestrial as viewed from the locality of the observer. His explanation of the stereographic projection on which the instrument depends will be clear even to those whose geometrical equipment is of the slenderest. The book next considers the parts of the astrolabe, and enables the reader to discover the purpose of the networks of circles and arcs which are engraved on very part of these instruments; this is particularly valuable for the understanding of the oriental types. M. Michel devotes more than one section to the practical use of the astrolabe, to which some more preentious treatises give so little attention that the reader wonders whether their authors considered the instrument as a thing of use or only as a collector's iece: the reviewer, indeed, when first confronted with a collection of astrolabes, was forced to resort to Geoffrey Chaucer's little treatise on the ubject, which explains the essentials with admirable clarity.

Astrolabes, to-day, are the prized possessions of museums and connoisseurs, and their owners are reatly interested in a matter which seemed less mportant to their makers, namely, the date of their construction. In the second part of the book under otice, M. Michel has assembled the methods by which such dates can be estimated. To find a date on the instrument is eminently satisfactory, yet it is ot uncommon to find that this has been added and indicates the time at which the instrument was epaired or remodelled. The maker's name may be inscribed, and the book gives a very useful and full list of makers with their dates and brief notices of their work. But the collector's chief problem is the dating of the astrolabe which bears no inscription. Considerations of style and design are useful, and the series of full-page plates of astrolabes, twenty-four in number, at the end of the book is a valuable guide to those who have not been able to see a large ollection of these instruments. But the most useful feature is a discussion of the dating of the astrolabe from the astronomical data implied in its markings. Thus many astrolabes are engraved with a zodiacal calendar, and the date of the first point of Aries indicates the number of days by which the Julian calendar differed from the astronomical, and therefore the approximate date. The author makes the aluable point that the difference will depend on which of the four years of the leap-year cycle the instrument was constructed and that an uncertainty f about a century may thus result. Other methods, uch as those involving the alteration of the positions of the stars through the precession of the equinoxes, are more reliable, and the application of them should settle many hitherto doubtful cases.

The book concludes with a section on the use of the astrolabe for the elementary teaching of astronomy, in which connexion the late Prof. Jenkin's Oxford astrolabe, designed for such a purpose, might have received a mention.

All who have to do with the astrolabe will be truly grateful to M. Henri Michel for providing them with a valuable and much-needed instrument of research.

F. SHERWOOD TAYLOR

PUBLIC HEALTH TO-DAY

Recent Advances in Public Health

By Dr. J. L. Burn. Pp. viii+409. (London: J. and A. Churchill, Ltd., 1947.) 25*s*.

THIS book is well printed and illustrated, clearly written and, while full of factual data, is easy to read.

In a volume of this size much of necessity is omitted. We should have liked, for example, in Chapter 22 on venereal disease schemes to have had an account to show how modern methods of treatment by the sulphonamides and penicillin have changed the whole outlook on venereal diseases and advanced the prospect of their ultimate eradication. In the preface the author disarms criticism of this kind by pointing out that recent advances in public health have been on so wide a front, so quick in pace, so significant in nature, that he can only restrict himself to the task of summarizing selected features of recent progress, and has had to leave many advances of fundamental importance unnoticed.

Even with this self-imposed limitation, the field covered is very wide. The subject-matter is considered in three main parts: public health and the individual; public health and the community; and public health and the environment.

In the first part, admirable and succinct accounts are given of the Public Health Nursing Service in Britain; the care of mother and child; nursery care; the school health services, with desirable emphasis on the provision of school meals; health education; mental and dental health services; and social services, with special reference to the important work of the almoner. A chapter follows on the handicapped child; and here due weight is assigned to the work of J. Alison Glover, who for some twenty years, in the reports of the Chief Medical Officer of the Ministry of Education and elsewhere, has adduced cogent evidence to show that in the majority of cases tonsillectomy is an unnecessary operation. Yet still one quarter of a million tonsillectomies are said by Maxwell to be performed annually in Great Britain.

The advantage of dealing with the family in the interests of public health is set out, and an informative chapter on welfare of the aged follows. This is a topical problem of increasing importance and magnitude. Dr. Burn shows what can be done here and in other countries to deal with it. In the second part, chapters of special interest are: Chapter 19, diphtheria immunization, which the Ministry of Health with the co-operation of local authorities has done so much to promote for the past twenty years; Chapter 21, tuberculosis, with an able appreciation of the Papworth Colony and an account of mass radiography; Chapter 23, detailing the modern work on scabies; and Chapter 24, which describes the use of D.D.T. in the conquest of typhus fever, etc. The third part dealing with environment is the shortest in the book, but treats of such varied subjects as smokeless air, milk, road safety, cremation and garden cities. The references in each subject, together with suggested books and papers for further reading, are copious and useful.

The Medical Officer of Health of Salford has done good service to the cause he serves by writing this book, which will appeal to all those who wish to keep abreast of a progressive science.

ARTHUR S. MACNALTY

NATURE LOVER AND FISHERMAN

Travelling Naturalist

By Anthony Buxton. Pp. 224 + 31 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 10*s.* 6*d.* net.

A NEW book by Anthony Buxton is something very special for those who love Nature. He is a shrewd and careful observer, and he writes in charming, simple English prose. In this, his latest book, there is literally not one dull sentence from the beginning to the end. He permits himself a sly dig at naturalists who use long and learned words: he certainly steers clear of them himself.

The book takes us from Norfolk and Essex, Hampshire and Yorkshire, to Scotland, where he fishes the Loch of the Shieling of Angus with skill and profit. We are then taken over the sea on his magic carpet to foreign lands, and with him watch the izzard basking in the autumn sun on the high rocky ridges of the Pyrenees and, still farther afield, watch the snow partridge swing over the snowy slopes of the Caucasus at a height of 10,000 ft. above the sea. With him, we fish rivers in Norway and share his skill in hooking giant sea trout on the lightest of light tackle, and are scarce able to keep pace with him as he flies along the rocky bank of some swift-flowing, green-tinted torrent, or hurls himself, waders and all, into the icy water, to float downstream like one of his flies in order to avoid the arch of a bridge toward which a great sea trout at the end of his line is hurrying him. One of the most attractive things in an attractive book is the author's obvious joy in living. His affection and understanding for the wild creatures which he describes so well are obvious, and he deplores the effects of the prolonged Arctic spell of 1947 on wild life. His home county of Norfolk suffered as severely as any district, and the population of bearded tits has been almost wiped out. He mentions the toll taken of redwings, and this reminds me that for the first time I saw not a single redwing last winter or spring in the Isle of Skye, where numbers are usually to be seen during April on their migration to Iceland.

The story (page 62) of izzard jumping over a man's back recalls the story of a small herd of red deer in the Cuillin of Skye which were descending a steep pass when two climbers came in sight of them. The deer came straight on, and the climbers threw themselves flat on the rock, each member of the herd jumping over them on its headlong downhill rush. Anthony Buxton found that the dotterel was a tame bird, and mentions that he might perhaps have stroked it had he so desired (p. 153). It is true that some dotterel are without fear of human beings. I think the most remarkable experience I ever had was when a dotterel on the nest rose from its eggs, ran over to where I was sitting a few feet away, caught a crane fly on my clothes, then looked at me in a knowing way before hurrying back to the precious eggs. His story (p. 187) of marsh harrier chicks killing and eating their younger brothers and sisters reminds me of the prolonged and bitter attacks made by one golden eaglet on the other in the eyrie, and of another eyrie which I visited where one eaglet lay dead and the other, a particularly truculent bird, although still in the downy stage, attempted to attack the human intruder.

The author (p. 195) writes needed words of protest about the bird photographer who is too much in a hurry with his hide, or who enters his hide without taking a companion with him, in order to see him in and, at the end of his watch, to see him out. Birds with very few exceptions cannot count, and when two people go to a hide and one leaves it the bird does not realize that the other has been left behind. As he says, the interest of the birds should come first, that of the photographer second. I foresee many editions of this book, which is an oasis of sanity in the desert of a mad world.

SETON GORDON

ORGANIC SUBSTANCES USED IN INORGANIC ANALYSIS

Organic Analytical Reagents

By Prof. Frank J. Welcher. Vol. 1. Pp. xv + 442. 44*s.* net. Vol. 2. Pp. xi + 530. 40*s.* net. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.)

THESE two volumes form part of a work which when complete should be a most useful compilation. The author's aim has been to collect information from the literature describing the uses of all organic substances in inorganic analysis. The term "analytical reagent" in the title is thus taken to include all incidental uses of organic compounds, if only, for example, as solvents in an extraction, a precipitation or a colour test. On the other hand, the operations listed are, in fact, all for the detection or determination of inorganic atoms and radicals (with the exception of tests for acetates, cyanides and cyanates) and applications to the detection or determination of organic compounds are not considered, although the title gives no indication of this.

Introductory chapters in the first volume give a useful résumé of the theory of valency with specia reference to co-ordination and chelate compounds and a discussion of the effect of structure on solubility The main part of the work is then arranged according to a rational classification of the organic compounds listed, all the various applications being included under each. Laboratory methods for preparing the reagents are given and the analytical procedures are described with sufficient working details. No attempt is made at a critical selection of the methods given the author's aim being to include everything so that the reader may be free, either to ignore, or to attempt the improvement of, any imperfect methods described References to the literature are given in every instance, though these cannot always be exhaustive

From the point of view of the practical analyst using these volumes to find an analytical method for a particular substance an arrangement unde analytical headings might have been more convenient. That actually adopted does, however permit of a general discussion of the uses of any group of substances or widely used reagent, and the practical usefulness of the book must depend on th indexing. Each volume is provided with two indexes one of organic reagents and one of analytical uses. In the latter, under each analytical problem the various organic compounds are listed alphabetically with references to the body of the work. It may b presumed that collective indexes of all the volume will be provided when the work is complete.

These volumes are excellently printed and produced and analysts will find in them a mine of usefu information and of references to the literature.

G. M. BENNETT

Země Krásná (The Beautiful Earth)

By J. K. Říha. Pp. 376. (Třebechovice, Czechoslovakia: A. Dedourek, 1948.) 540 crowns.

THE sub-title of this remarkable book states that it is "about Nature, civilisation and planning". The author is not only an architect and an engineer, but he also possesses a deep knowledge of the biological sciences and he has attempted to apply this knowledge in town and country planning. Moreover, Mr. Říha has searched old records to find out whether man had in the past attempted to co-operate with Nature in developing civilization.

It appears that in modern times, or at least in the last hundred and fifty years, the production of plant foodstuffs has increased fourfold in Bohemia. Potatoes and cereals have completely changed mankind's living conditions and made possible the extraordinary progress that is usually attributed to technology, though the author emphasizes the part played by biology in this development. He refers to an area in south Bohemia, north of Třeboň, that was converted from useless marshland to useful productivity as early as the twelfth and thirteenth centuries. Ponds and canals (one thirty-five miles long) were made, and the drained land cultivated and used to rear cattle and horses. In the eighteenth century, English influence led to the laying out of tasteful parks both here and elsewhere in Central Europe. This brings the author to his contention that modern civilization is not antagonistic to Nature and indeed succeeds best when planning is directed towards harmonizing the two. The work of the country architect should take account of climate, soil and biological laws so that a community fits naturally into its surroundings.

Other features of this nicely bound folio book, well printed on art paper, are the many fine photographs by the author and his scientific friends, and the 6,000 word summaries in Russian, French and English. J. G. F. D.

Faune de France

47: Hyménoptères tenthredoïdes. Par Lucien Berland. (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. 496. (Paris: Paul Lechevalier, 1947.) 1500 francs.

THIS volume, the most recent in the Faune de France series, is well up to the standard of its predecessors. M. Lucien Berland is the author of the volumes on the Vespoidea and has placed hymenopterists further in his debt in having written the present monograph. Under the term Tenthredoïdes he includes not only the sawflies but also all other members of the Symphyta or Phytophaga, as they are variously known. As in other volumes in the series, illustrations are a special feature—whole insects figuring very largely and often accompanied by sketches of structural details, while larvæ are illustrated where necessary. Under each species will be found its chief synonyms, followed by a description of its external characters, the main facts regarding its habits, and its distribution in France and also in other countries. Diagnostic keys to both genera and species are particularly clear and easy to follow. Taking the book as a whole, it will also prove helpful to students of the British members of the Symphyta. At the end there is a tabular synopsis of larval characters in the different families and a list of species wherein parthenogenesis, in one form or another, is known to occur. This is followed by an enumeration of those species known to be injurious to cultivated plants and, finally, a catalogue of host plants and the species feeding upon them. This latter, it may be added, will be found particularly useful by many workers.

Birds on the Wing

By John Barlee. Pp. 128. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1947.) 12*s*. 6*d*. net.

Birds of Malaysia

By Jean Delacour. (Pacific World Series.) Pp. xvi+382. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 25*s*. net.

The Birds of Brewery Creek

By the Rt. Hon. Malcolm Macdonald. Pp. x+334+23 plates. (London, Toronto and New York: Oxford University Press, 1947.) 21*s*. net.

BIRD books come and continue to come, being for the most part very excellent, and the three here considered are well up to standard. In "Birds on the Wing", we are shown a number of fine snapshots accompanied by excellent notes from the camera and notebook of one of our younger naturalists. "Birds of Malaysia" is of different type, for in it Captain Delacour gives us a handbook to the birds of the interesting islands of Java, Sumatra and Borneo, the Malaya Peninsula, etc., with their wealth of bird life. Here are found such ornithological gems as the giant argus and Bulwer's wattled pheasants, the great hornbills, many sunbirds and so on. This volume with its excellent line drawings is a most helpful guide to them all. The third book, "The Birds of Brewery Creek", is of yet another type, though as good in its different way. In it Mr. Macdonald, High Commissioner for the United Kingdom to Canada, tells of his observations on birds in Brewery Creek, near Ottawa, and a very joyous record it is. The illustrations are from photographs and some of them are in colour, an especially excellent one being that of a snowy owl. FRANCES PITT

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1947. Edited by Ivison S. Macadam, assisted by Hugh Latimer. Pp. xii+568. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 42*s*. net.

FOR the first time in its hundred and eighty-nine years of publication, this volume has been compiled with the aid of an advisory board. The selection of the board has been entrusted to five organisations concerned with the subjects covered by the annual review. These are the English Association, the Arts Council of Great Britain, the British Association, the Royal Institute of International Affairs and the Royal Historical Society. These bodies have chosen the contributors. The "Year in Science", running to more than twenty pages, gives a wide and readable survey of the year's work and is an improvement on the articles of previous years. There is little change, however, in the general arrangement. The greater part of the volume is a review of the history of the United Kingdom, the British Commonwealth and foreign countries. Then follows a chronicle of events and reviews of literature, art, science, finance, industry, trade and law. A number of public documents include the Anglo-French Treaty, and those terms of the Yalta, Teheran and Potsdam agreements which remained secret until 1947. The volume is full, comprehensive and impartial and remains, as always, an indispensable survey of human affairs.

THE RONALD ROSS JUBILEE

ANNIVERSARIES and celebrations of medical discoveries have little except historical interest unless they have some direct bearing on present problems. In the case of malaria they have. Fifty years ago, medical men and sanitarians were given a new tool in the form of knowledge of the means of transmission of malaria from man to man. This was heralded as the immediate forerunner of a recession of malaria throughout the world. Forty years experience left these hopes unfulfilled, the new knowledge being applied on a relatively small scale and mainly to highly specialized communities such as towns, labour forces and armies, which are, of course, unrepresentative of the mass of rural tropical peoples. The last ten years work, which is now being brought together and appreciated, shows that there is no longer any reason why the original aim should not be rapidly achieved if the importance, and the limitations, of recent discoveries are fully realized by medical men, administrators, and others concerned in the health of the tropics. A restatement of past history, an emphasis on the lessons to be learnt from it, and a summary of present knowledge based on an appropriate occasion such as the fiftieth anniversary of Ronald Ross's discovery is therefore considerably more than a sentimental occasion. The Ross Institute of Tropical Hygiene, which is amalgamated with the London School of Hygiene and Tropical Medicine, has attempted this survey and assessment in the form of an exhibition open to the public throughout the past week.

Much controversy has surrounded the subject of Ross's discovery, which was finally completed on July 9, 1898. Briefly, the facts are that Laveran[1] first described the parasites of malaria in 1880, his discovery being much elaborated by Italian workers such as Marchiafava and Bignami[2]. In 1894 Patrick Manson, who had previously described a part of the cycle of development of *Wuchereria bancrofti* in a mosquito[3], suggested that this insect might in some way be an intermediary in the carriage of the malaria parasite[4], though he did not foresee the cycle as we know it. Meanwhile Ronald Ross, who had been in India since 1881 and had shown a passion for the preventive aspect of medicine, set out to discover the basic facts of malaria with the object of producing a method for its control. The present speed of dissemination of knowledge makes it difficult to accustom ourselves to the idea that even an earnest and serious worker such as he remained ignorant of Laveran's discovery, and worked on pointless side-issues, until 1894. In that year he met Manson, who demonstrated the parasite to him, set him to its study in the laboratory and in the new translation of Marchiafava and Bignami's book, and fired him with interest in his own mosquito theory. From that time these two men worked as patron and protégé, Ross carrying out all the experimental work to inquire into the theory formulated by Manson, from whom he received constant advice and encouragement.

During 1894–97 Ross worked mainly in Secunderabad, Hyderabad, on human cases of infection with *Plasmodium falciparum* and several species of mosquitoes. On August 20, 1897, he demonstrated the development of gametocytes of *P. falciparum* up to the stage of four-day-old oocysts in the gut wall of a 'dapple-winged mosquito', almost certainly *Anopheles stephensi*. This was recognized as complete proof that development of the parasite did occur in the mosquito, thereby incriminating that insect as a carrier and establishing Manson's theory, and was published in December of that year[5]. It stopped short at showing that man infected the mosquito without showing how the mosquito infected man, and again it is difficult for us to realize that this was by no means obvious.

At this stage, Ross's work was interrupted by his transfer to a remote non-malarious station. In February 1898 he was able to resume it in Calcutta, but without human material. He turned to avian material and *Culex* mosquitoes, and between February and July 1898 showed successively the ripening of the oocyst, the liberation of sporozoites into the body cavity, their invasion of the salivary glands, and the transmission of infection from an infected bird, through *Culex fatigans* to previously uninfected birds. Some parts of the story were published while the work was in progress, and the full one was communicated by Manson to a meeting of the British Medical Association on July 28, 1898, published by him shortly after[6,7,8], and after a further interval by Ross[9].

During the following six months, some Italian workers, Bastianelli, Bignami and Grassi[10], repeated Ross's observations using *P. falciparum* infections of *A. maculipennis*, and as the result of faults on one side or another an unnecessary and bitter controversy on priority ensued.

Ross left India where his discovery had been coldly received, joined the new Liverpool School of Tropical Medicine, immediately went to Sierra Leone and there in 1899 himself confirmed the full cycle of *P. falciparum* in *A. gambiæ* and *A. funestus*[11]. Manson, as the first item of work of the new London School of Tropical Medicine, confirmed the story by the celebrated Ostia experiment[12]. He and his fellow-workers lived safely in mosquito-proofed huts in the malarious Roman Campagna and brought back to England mosquitoes which infected volunteers who had never left the country.

The value of the discovery and the status of Ross were finally established by the evidence of Lord Lister[13]. Its practical value was soon demonstrated by pioneer work in Malaya[14], Ismailia[15] and Havana; but the record of its application up to 1939 was disappointing. Techniques were elaborated, mosquito larvicides such as Paris green were discovered, the possibility and value of adult mosquito destruction proved[16,17], new drugs such as 'Atebrin' produced[18] and much new knowledge of the epidemiology and entomology of malaria gained; but all this had little effect on the subject which interested Ross, namely, the prevention of malaria throughout the whole tropics including rural areas.

The period 1939–46 has seen the acquisition of much new knowledge, notably of insecticides, techniques of organisation, drugs and a further elaboration of the history of the malaria parasite[19]. For the first time this was brought together at the recent International Congresses on Malaria and Tropical Medicine in Washington, the proceedings of which are not yet in print, and considered by the Malaria Committee of the World Health Organisation[20]. The major interest of these meetings lay in the revelation that malaria control throughout whole countries, urban and rural areas alike, is not only possible but also has actually been put into practice. In Venezuela, British Guiana, Chile, the United States, Sardinia, Italy, Greece and Cyprus, malaria has either practically or entirely ended, as it has also in a rural area of Bombay Province holding some two million people, and in the extensive Kharga and Dhakla oases of Egypt. There have been marked reductions in other places, including the Union of South Africa, and invading foreign mosquitoes have been evicted from Brazil[21] and Egypt.

Two entirely separate principles have been concerned in this. The first is the total eradication of anopheline species (or anopheline genus in Cyprus), made possible by organisational techniques not dependent on new insecticides and ensuring perfection of local work; this has so far been used in areas with some natural protection against re-invasion in Brazil, Egypt, Cyprus and Sardinia. The other is the country-wide application of D.D.T. residual indoor sprays to all houses and anopheline shelters, producing control of anophelines at a level below that necessary for malaria transmission but not of the perfection needed for eradication; it is this process which is largely responsible for the recession of malaria in the United States, Venezuela, British Guiana, Chile, Italy, Greece, the Union of South Africa, and parts of Bombay Province.

The exponents of the two methods are in friendly rivalry; their methods too young as yet for accurate comparison, but both are practicable on a large scale. The tropical and subtropical world stands divided into two sections, one of which has, and one of which has not, attempted to apply either of these principles. It is regrettable to find tropical Africa in the latter group, though as yet unresolved doubt has been thrown on the value of D.D.T. in that country[22]. The Malaria Committee of the World Health Organisation has, however, agreed to support a large eradication scheme in the heart of that continent, and if D.D.T. should be valueless there 'Gammexane' (the gamma isomer of benzene hexachloride) could almost certainly take its place.

The story of these stages and of present trends was told in the Ross Institute Exhibition. If it succeeds in stimulating the British application of these new methods, the Jubilee will have been of real value.

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THE POST OFFICE RESEARCH STATION

THE earliest experimental work in connexion with the telephone and telegraph services of the General Post Office is recorded to have taken place in 1878. It was, however, not until 1904 that one or two members of the Engineering Department were relieved of their administrative duties to enable them to pursue investigations of a purely experimental nature in a room set aside for the purpose in the Central Telegraph Office. In 1909, the 'Research Section' was recognized as a separate entity, and additional laboratories in a nearby building were allotted to it. Natural expansion of the section, curbed during the First World War, was accelerated when hostilities ceased, and a site of eight acres was acquired for a research station at Dollis Hill in north-west London and about seven miles distant from the Central Telegraph Office. The work was transferred to this site in 1921, when the accommodation took the form of ex-army huts; the present permanent buildings were formally opened in 1933. The activities of the Research Station expanded steadily during the inter-war period, and during the Second World War they were diverted to deal almost entirely with objectives having immediate military application. Arrears of normal development of research for the Post Office's services now require an accelerated expansion, which is being effected as rapidly as present circumstances permit.

There are at present about twenty buildings at the Research Station, used as laboratories, workshops and offices by the Research and the Radio Development Branches of the Engineering Department of the Post Office. The present staff totals about 860, of whom about 470 are directly engaged on experimental or theoretical work (including some 275 who are engineers or scientific workers with full professional qualifications or have nearly attained them). About two hundred are employed in the workshops and drawing office. The experimental work of the Department is not confined to the Research Station; there are small laboratories in other parts of the country, and some experimental work has to be done in the field.

The activities of this Research Station are mainly directed towards improved and economical working of Post Office services, especially the telecommunication services, because for these there is wide scope and need for the application of the development of physical science. Apart from some radio equipment, almost all the necessary plant for these services is obtained by purchase from manufacturing companies. For the development and introduction of new types of apparatus into service, the Post Office maintains close liaison with the principal British manufacturers' of telecommunication equipment, and a regular procedure exists for exchanging information concerning, and co-ordinating the development of, much of the equipment that is procured. There is also liaison and, when necessary, co-ordination with other Government research establishments and, on the international plane, with other telecommunication administrations. Broadly speaking, therefore, the main function of the Research Station at Dollis Hill is to contribute to advances in telegraphy, telephony and radio and to give guidance on their applications to Post Office services. Some of the investigations, important though limited in scope, arise from the day-to-day operation of the services and are concerned with existing plant; others are of a long-term character and represent, perhaps, seeds of the telecommunication plant of the future.

Many of the developments (to which the Research Station has contributed) produce results which are by no means immediately obvious to the users of the telecommunication services. The continued, and sometimes rapid, growth of the telephone network in Great Britain could not have been achieved, or only at much greater expense, without entirely new techniques in telephone transmission, such as the use of one pair of conductors to provide speech channels for many simultaneous conversations. Economies resulting from the introduction of more efficient types of equipment cannot be made to give immediate benefit to the users, in terms of lower charges, because, for the very large and dispersed plant which comprises the telephone network, any large-scale replacements must necessarily be spread over a very long period. When costs of labour and materials are tending to rise, the effect of such economies is more likely to appear as a lower increase in the charges for the service than would otherwise be necessary. On the other hand, some developments, for example, those which open up new services or facilities for the user, are more obvious; a case in point is the 'speaking clock'. This was the result more than eleven years ago of research into an electric drive starting from a 'free' pendulum and other research on sound-recording on glass disks.

Modern technique for telephone transmission over long land-line routes is to concentrate a number of telephone conversations on to a single pair of conductors, the conversations being separated on the route by occupying different bands of the frequency spectrum. Thus, the traffic capacity of a route is determined by the total band-width of frequencies it can carry rather than by the number of conductors it contains. With wide-band amplifiers (or 'repeaters') spaced at intervals of about six miles on a modern coaxial (or concentric) type of cable, two coaxial tubes can carry more than six hundred separate conversations simultaneously. This technique of wide-band transmission is being still further developed for the transmission of television to programme centres at different parts of Britain. Short lengths of wires in ordinary telephone cabling can be 'equalized' for carrying television signals locally, but for long-distance line transmission of television, the newer types of cable are essential.

By means of frequency separation, several telegraph transmissions can be sent simultaneously over a single telephone circuit independently of whether the telephone circuit is on a radio link, a coaxial cable, or by normal transmission over a pair of wires.

The Post Office Research Station has played a leading part in the development of semi-automatic means of switching long-distance telephone circuits. These enable the trunk operator at the calling end to actuate switches by dialling over the long-distance line and avoid the delay which arises when she is dependent on the assistance of other operators at the remote exchanges. The methods of dialling which are used in local areas could not be extended to the long-distance lines, and a system had to be worked out in which all the signals could be transmitted by currents in the speech frequency range without mutual interference between speech and signals. This system is now working on more than three thousand British long-distance circuits.

For telephoning overseas, either submarine cable (for the shorter distances) or radio links have to be used. In the case of the cable, a substantial advance has been made towards increasing the band-width of frequencies (and hence the number of simultaneous conversations) transmitted by inserting a submerged repeater. The repeater has to be capable of continuous operation under water without any maintenance for several years, with power for its valves supplied along the cable. The repeater which the Research Station constructed in 1943 for the Holyhead – Isle of Man cable was the first submerged repeater to be inserted in a working telephone cable anywhere in the world. The scheme is being developed to enable several repeaters to operate along a submarine cable, with facilities for testing and supplying power to each one from the shore ends.

Long-distance, short-wave radio links have been greatly improved since their inception by the use of single-sideband radio transmitters and receivers. On the trans-Atlantic link, reception from the United States has been made much better by the employment of special receivers and an aerial system, two miles long, installed at the radio station at Cooling (Kent). This equipment separates the mutually interfering waves by which the signals arrive after successive reflexions from ionized layers in the upper atmosphere, and so reduces the effects of distortion and noise. The study of other means for dealing with these effects has been facilitated by a laboratory device for simulating them under controllable conditions. Since 1934, radio links on much shorter wave-lengths have been used for extending the telephone network to islands around the coast of Britain; equipment operating on the frequency-modulation system was first installed on one of these links in 1942.

The Post Office not only operates radio telephone and telegraph services to all parts of the world, including ships at sea; it is also the Department responsible for control and regulation of radio communication. This responsibility involves the need for very exact measurements of any frequency which may be used. The applications of piezo-electric quartz crystal vibrators has been studied since 1925 for frequency control of radio transmitters and for frequency measurement, and the Research Station possesses one of the most comprehensive frequency standard installations in the world. It has provided quartz clocks, the most accurate timekeepers now known, to the Royal Observatory, Greenwich. Other piezo-electric materials are being studied for various applications, notably as components in the electrical circuits used for frequency selection and separation.

Telephone instruments are electro-acoustic devices, so there is need for acoustical as well as electrical measurements; the techniques for acoustical measurement have been developed much more recently than their electrical counterparts. The Research Station has contributed to these developments and it maintains a standard and equipment for the measurement of sound pressures at any desired point, in the open or in a confined space, so that objective measurements of the performance of telephone instruments of any type can be made in conditions appropriate to their use. It also has to set and maintain a standard of 'telephone transmission', which is based on subjective tests and is therefore of a less tangible nature, combining physics with physiology. Recording of sound is studied for special applications by the Post Office; two techniques have received particular attention, namely, sound tracks on glass disks for frequent repetitions of short announcements, and lacquer-coated metal disks for high-quality gramophone recording, usable (for short life) by direct play-back.

New developments and applications of electronic devices are of vital importance to telecommunications. Facilities for the manufacture of experimental types of thermionic valves enable, for example, knowledge to be built up concerning the causes of their eventual failure and may be helpful towards the provision of the very long-life valves required for submerged repeaters. Such facilities also open the way for development of a few special valves for special uses. Techniques of application, such as are used in electronic computers, are studied; in fact, an elementary form of electronic computer has been made for dealing with some specific problems of plant provision and arrangement at automatic exchanges.

The main exception to the concentration of effort at the Research Station on telecommunication problems is the work that is being done to explore the practicability of introducing more mechanical processes in the handling of mail. Machines incorporating photo-electric devices can be devised to work at high speed for stacking letters, all with the stamps in correct position to be fed into stamp-cancelling machines, and also for enabling sorters to direct letters into a much larger number of sorting compartments than can be reached by hand. Considerable experimental and development work is necessary before any machines of this kind can be proved to be practicable.

LAND AND POVERTY IN THE MIDDLE EAST

DURING the Second World War, the Middle East Supply Centre—the history and achievements of which should be made public before memory fades—acted in various directions as a regional authority over an area embracing about fourteen territories, and extending from Persia to Tripolitania, and from Cyprus to Ethiopia. One of its important short-term objectives was to encourage increased food-production in the Middle East territories, to offset the unavoidable restrictions due to war conditions. This immediate objective threw into sharp relief the need for a comprehensive regional survey of the basic underlying problems of the Middle East—in particular, land utilization, peasant economy and social organisation—and this task, among others, was given to an Anglo-American Scientific Advisory Mission, the reports of which have now been published by the Stationery Office*. War conditions threw the Middle East territories into close association, and emphasized the fact that they had many common basic obstacles to overcome before any post-war social and economic development was possible.

There were high hopes that some form of regional organisation would succeed the Middle East Supply Centre, to serve these non-political aims. But political inexperience and short-sighted nationalism were too strong. Chatham House has, not for the first time, attempted to fill the gap by publishing a series of studies on social and economic problems in the Middle East. The pamphlet* under review is the first of the series; it deals with Egypt and the Fertile Crescent—Palestine, Transjordan, Syria, Lebanon and Iraq. Dr. Warriner describes the vicious circle enclosing the peasant cultivator in these regions; but the description is equally true for other Middle East countries, and for India. It is essentially an absentee landlord system, with a form of land tenure under which the tenant suffers the maximum disadvantages. Government of the country is largely in the hands of the landlords, most of whom believe their immediate interests would be threatened by any measures designed to improve the tenants' lot. The tenant is wrapped in a fatalism, which is founded on his poverty and helplessness, and reinforced by the technical difficulties of agriculture—especially of peasant farming—in tropical and sub-tropical climates and soils. The social and environmental circumstances that brought about in England the change from the open three-field system to the four-course rotation on enclosed farms do not exist in the Middle East.

Dr. Warriner examines in detail the alternative possibilities. Although most of the suitable land and a good deal of the marginal areas are already settled to capacity or beyond, there are under-populated spaces in the Jezira region of Syria; in Iraq, with better regulation of water supplies, there could be absorbed some five million people, and she points out, as one item in the immensities of the Middle East problem, that this is an authoritative figure for the surplus rural population in Egypt alone.

On the question of quick technical improvements in agricultural methods, Dr. Warriner rightly concludes that these are strictly limited, first, by our present lack of knowledge of tropical agricultural science (a point that cannot be overstressed), and secondly, by the limitations of the existing system of peasant agriculture. Further, such improvements could only be short-range palliatives, for, in the present stage of social emergence of the peasant, any increase in output per acre is more than offset by an increase in the population. At present there appear to be two possibilities only for increasing the output: the development of irrigation under State ownership and control; and, in the drier areas, mechanized dry farming on a village co-operative basis. Both involve a basic change in land tenure customs, and the second especially calls for less, not more, workers per acre.

Dr. Warriner discusses my first proposal for a tripartite organisation that would circumvent the grave obstacles of land ownership and inheritance laws. The proposal is as follows. The Government takes over, on a long lease, land from its present owners, and sub-leases the whole area to a body of the public utility corporation type. This body reconditions the land, divides it into economic units and lets them to tenant farmers for whom it performs certain desirable services—such as bulk-marketing of any cash crops—and from whom it requires certain standards of farming as a condition of the lease. In concluding that this model would not be generally applicable, because it depends on the existence of a special market for which the corporation can finance sales and organise production in relation to the market, Dr. Warriner has rather missed the point of the proposal. It is true that in

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[*] The Agricultural Development of the Middle East. By Dr. B. A. Keen. 5*s*. net.
Middle East Science. By Dr. E. B. Worthington. 7*s*. 6*d*. net.
Rural Education and Welfare in the Middle East. By H. B. Allen.
Animal Industry in the Middle East. By Dr. N. C. Wright (in preparation).
(London: H.M. Stationery Office, 1946.)

[*] Land and Poverty in the Middle East. By Doreen Warriner. (Middle East Economic and Social Studies.) Pp. vii+149. (London and New York: Royal Institute of International Affairs, 1948.) 7*s*. 6*d*. net.

certain of the examples given by me this aspect is prominent and that it even initiated some of them. But it is not the essential requirement, which is, of course, the circumventing of the land ownership laws: without some such device, an agrarian revolution, expropriation and the rest, are sooner or later inevitable. There is no reason why the proposal should not apply to subsistence crop production; the general financial level would be lower and the operations of the corporation more modest, approximating to what would be done by a co-operative buying and selling society, composed of the tenants themselves. Organisations of this type were working well among the Bulgarian peasant proprietors before the War, and their success was not dependent on the fact that the peasant owned his farm.

At the same time it is clear that lack of capital in the Middle East is an obstacle to rapid development, for it also causes peasant indebtedness to the landlord-moneylender class. Dr. Warriner examines two sources of supply: the war-time sterling credit balances and oil royalties. Both are wasting assets, and both are likely in the present conditions to enrich the few. A speculative possibility briefly mentioned by Dr. Warriner is to form, perhaps under the United-Nations, an international agency to promote investment and long-term economic development. This is, in fact, the public utility corporation referred to above, on a somewhat more ambitious scale.

The pamphlet sets a high standard for the succeeding ones. It is lucidly written and the author's personal knowledge of the area has enabled her to set out the essentials of a very complicated situation.

B. A. KEEN

THE MEDICAL NOBEL INSTITUTES, STOCKHOLM

THE Caroline Institute in Stockholm, in all but name the medical university of the Swedish capital, appointed a committee in 1945 for the planning and building of new laboratories for the three departments of the Medical Nobel Institute. The Department of Biochemistry was founded in 1937 under the direction of Prof. Hugo Theorell; in 1940, Prof. Ragnar Granit was appointed to a research chair in neurophysiology, established with the aid of a gift from the Wallenberg Foundation in Stockholm, and also supported by the Rockefeller Foundation; this became a Nobel Institute in 1945. At the same time, a third department of the Nobel Institute was created, in cell research, under the direction of Prof. Torbjörn Caspersson.

During the academic year 1947–48, the three departments have been moving into their new and spacious buildings in the 'medical city' which is being created by the Caroline Institute in north-west Stockholm on an old estate known as Norrbacka. The administrative centre, the library and some of the laboratories have already moved out to the new site. The Departments of Physiology and Pharmacology are expected to move out in the autumn.

The Medical Nobel Institute was formally opened in May by the Crown Prince of Sweden and dedicated to the Nobel Foundation by Prof. Bergstrand, president of the Caroline Institute. In addition to Swedish representatives from universities and academies, Scandinavian, British and American guests were present. Great Britain was represented by Prof. E. D. Adrian, foreign secretary of the Royal Society. A dinner presided over by Dr. Ekeberg, president of the Nobel Foundation, concluded the ceremony.

In his speech, Prof. Bergstrand, president of the Caroline Institute, emphasized that the Caroline Institute needed full-time research laboratories engaged in work along the front lines of modern science, for its own sake as well as to enable it to fulfil the important task entrusted to it by the will of Alfred Nobel. The beautiful and well-equipped new laboratories, he went on to say, expressed the confidence of the Caroline Institute in the three directors appointed to lead them. Financially, the three laboratories were a joint effort: the buildings and part of the equipment came from the Nobel Fund, which also supported one of the chairs and part of its running expenses; the Government of Sweden supported the other two chairs and contributed to their annual budget; the Wallenberg and Rockefeller Foundations contributed generously to most items of the budget. Prof. Bergstrand concluded his speech by expressing the gratitude of the Caroline Institute to the donors, and, finally, extended a hearty welcome to the guests. Congratulatory addresses were presented by Prof. E. D. Adrian, Prof. W. D. Bronk, foreign secretary of the U.S. National Academy of Sciences, Prof. Linderström-Lang, director of the Carlsberg Institute, Copenhagen, Prof. A. I. Virtanen, director of the Valio Research Laboratory in Biochemistry, Helsinki, and Prof. Mohr, rector of the University of Oslo.

COLOUR TERMINOLOGY

THE Committee on Colour Terminology appointed in 1941 by the Colour Group of the Physical Society had originally two objectives: (*a*) to record definitions of terms current in the various groups of people concerned with colour; and (*b*) to examine the possibility of co-ordinating the terms commonly used. Later, in the light of the Committee's discussions, a third objective was added: (*c*) to recommend a consistent terminology. This was a significant step, as the subject of colour has very wide ramifications and there was every reason to expect very great difficulty in even approaching consistency. The report now published* shows that, provided a few key changes are made, the terms used by different technical groups can be embodied in a single scheme which avoids gross ambiguities while keeping the specialized terms of particular interests substantially intact. The nomenclature of colours themselves, as distinct from the terms used in describing and specifying them, was expressly excluded from the Committee's consideration.

In drawing up the basic list of current terms with their definitions or mode of use—a list which occupies about two-thirds of the 56 pages of the report—the Committee's net was thrown very wide. The fields covered were colour physics (general, photometric, subjective and colorimetric terms), colour vision, colour-atlas systems (Munsell and Ostwald), technologies involving colour (dyeing, paint and pigment, printing, photographic, glass and decorating industries), the painting art and the colour terms of everyday speech. The definitions are fully descriptive, and sufficient explanation of the underlying principles is given to make clear how certain expressions have come into use. In colour physics, once the distinction has been established between subjective terms describing the sensations produced and the corresponding objective terms specifying the stimulus, the definitions themselves present no serious difficulty. The case is different with technological terms. For example, in the paint and pigment industry, the term 'chalky' has a meaning which in the Committee's definition runs "An excess of white (in a match supposed to be close)". But, as is pointed out, in practice, 'chalky' frequently implies that by the addition of wrong pigments or otherwise, a pigment mixture has been made whiter than the sample and that the difference is irremediable.

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* Physical Society. Report on Colour Terminology. By a Committee of the Colour Group. Pp. iv+56. (London: Physical Society, 1948.) 7*s*. net.

The colour terms used by contemporary artists are handled very gingerly by the Committee—the proper course for an exclusively technical body—and for these and for the terms of ordinary speech no recommended usage is put forward.

The interrelations of the terms of different groups are displayed in tabular form, and in the case of the dyeing and paint and pigment industries, the different meanings of comparative terms such as 'stronger', 'dirtier', 'brighter', etc., are indicated by vector lines in colour triangles of the Ostwald type with black, white and a particular colour at the vertices.

As a first step to co-ordination the Committee drew up a self-consistent list of essential terms that could be used by all colour workers without risk of confusion. The final recommendations are based on this self-consistent list and cover nearly a hundred terms. The main changes required of different groups are as follows. In colour physics, the term 'brightness' is to be replaced by 'luminosity' when the subjective aspect is in question, and by 'luminance' when brightness as an objective or stimulus quantity is intended. The term 'shade', which at present has several different meanings in the dyeing, paint and pigment and printing industries, is to denote "darker colour of same hue and saturation". The same groups are asked to reserve 'tone' for "any small variation from another colour". 'Duller' (paint and pigment industry) is not to be used to mean "containing more black" but as "less colourful" or "less saturated", while 'deeper' is to mean "containing less white".

In a concluding section the recommended terms are compared with those proposed in the recent Colorimetry Report of the Optical Society of America. Among the comparatively few points of disagreement may be noted the American retention of the term 'brightness' for the subjective meaning of the word, while the corresponding term recommended by the British committee—'luminosity'—is used in the American report for the "ratio of the luminous flux to radiant energy flux". The latter quantity is called 'visual sensitivity' in the British scheme. It is probable that the terms 'luminosity' and 'visual sensitivity' will prove the most controversial in the Committee's recommended list.

Discussions on terminology often appear to non-participants as rather unproductive. But whether or not the changes recommended in this report are adopted, there can be no question that the careful exposition of present usage which it contains will be of the greatest value to workers on colour problems.

W. S. Stiles

NEWS and VIEWS

Geology at the University of Liverpool: Dr. R. M. Shackleton

Dr. Robert Millner Shackleton, who has been appointed to the George Herdman chair of geology at Liverpool, vacant by the resignation of Prof. F. Coles Phillips, returns to the University from which he graduated in 1930 and at which he was awarded the degree of Ph.D. in 1933 for researches into the complex structure of Moel Hebog, Caernarvonshire. On leaving Liverpool, Dr. Shackleton went to the Imperial College of Science and Technology, London, with a Beit Fellowship, and joined the staff of the Geology Department of the College in 1934, becoming senior lecturer in charge of petrology in 1946.

Dr. Shackleton's field-experience has been extraordinarily extensive and varied. He has travelled widely in South and Central Africa and in Russia and Siberia. In 1935–36 he made a reconnaissance survey of Viti Levu in the Fijis, where he discovered that the plutonic rocks, previously thought to be an old basement, are of Tertiary age. During 1940–45, he served on the Geological Survey of Kenya, his chief work dealing with economic problems connected with the Migori gold-belt, the phosphate possibilities of North Kavirondo and the water supply of the Aberdare Range and Mount Kenya areas. In 1946 he returned to Kenya and made a one-man expedition to the Rift Valley, where the sequence of the artefact-bearing beds of the Pleistocene was determined and the structure of a section of the Rift Valley elucidated. Last year he took part in the Royal Society Expedition to Rusinga Island in Lake Victoria, Kenya, from which important results concerning the succession and structure of the Miocene beds in which hominoid remains occur are expected. It is to be hoped that Dr. Shackleton will find time to prepare for publication a part at least of these important results of his field-studies.

Dr. Shackleton has been a member—and largely director—of a research team from the Geology Department, Imperial College, that has been working for a number of years on a project to compare the two sides of the North Atlantic and to test the continental drift theory and in particular to determine the magnitude of any drift that may have occurred. As soon as the grasp of the structure and stratigraphy on the eastern side of the Atlantic is sufficiently firm, it is intended to proceed to the examination of Eastern Newfoundland and the coast of Labrador. His new sphere at Liverpool will provide Dr. Shackleton with increased opportunities for the continuation and completion of this attractive study.

Physiology at the Queen's University, Belfast: Dr. A. D. M. Greenfield

The Queen's University of Belfast announces the appointment of Dr. A. D. M. Greenfield to the Dunville chair of physiology in succession to Prof. H. Barcroft, now at St. Thomas's Hospital Medical

School (see *Nature*, 160, 704; 1947). Dr. Greenfield was a scholar of St. Mary's Hospital, and obtained first class honours in physiology in the B.Sc. examination of the University of London. After holding posts at St. Mary's in both medicine and pathology, he was appointed to the Department of Physiology, under the direction of Prof. A. St. G. Huggett. A year ago he became senior lecturer in experimental physiology. Dr. Greenfield at first worked with Dr. Killick (now Professor) on acclimatization to chronic carbon monoxide poisoning. More recently, he has shown great ingenuity in devising methods for the study of the circulation both in man and animals. During the War, these were used on behalf of the R.A.F. to study the effect of variations of *g* on the blood pressure. Since then Greenfield has worked with Huggett on fœtal physiology and found a method for determining the rate of the blood flow in the umbilical cord. At a recent meeting of the Physiological Society he showed how the movements of a large bubble could be photographed and used to indicate the rate of the blood flow in a part of the body, as, for example, the hand. Dr. Greenfield's special knowledge of the physiology of the circulation will be of great value in Belfast, where work in this field has been in progress for some years.

Anatomy at the University of Glasgow: Prof. G. M'C. Wyburn

George M'Creath Wyburn has been appointed regius professor of anatomy in the University of Glasgow in succession to Prof. W. J. Hamilton, who has been appointed to the chair of anatomy at Charing Cross Hospital Medical School, London. Dr. Wyburn is a pupil of the late T. H. Bryce, and graduated at Glasgow in 1925: after holding appointments in various hospitals, he returned to Glasgow as demonstrator in 1929. He became senior lecturer in anatomy in 1936, and was acting head of the Department during 1944–45. His researches include work on embryology, with special reference to bone formation, on the endocrinological aspects of reproduction, and on tissue-grafting (of skin, cartilage and cornea in particular). He was awarded the Struthers Gold Medal and Prize in 1939 for embryological research, and again in 1947 (with Dr. Paul Bacsich) for work done during the War on the repair of peripheral nerve injuries.

Mathematics at Queen Mary College, London: Dr. G. C. McVittie, O.B.E.

The appointment of Dr. G. C. McVittie to the new chair of mathematics at Queen Mary College, University of London, is of considerable interest, not only because he will be the first professor of mathematics at this College, but also because his appointment will go a long way towards strengthening the present somewhat meagre representation of applied mathematicians among the appointed teachers of the University. In pre-war days, Dr. McVittie was well known for his researches into relativistic theories and in particular for his trenchant criticisms of some aspects of certain forms of the cosmological theory. During the Second World War, Dr. McVittie was seconded for special service with the Meteorological Office. Here he was engaged in a number of important problems. As a result of his successful activities both as a man of science and as an administrator he was recently awarded the O.B.E. Since his return to academic life, Dr. McVittie has developed a new interest in the theoretical basis of meteorology and has been made a member of the Meteorological Research Committee. He has also become, with Prof. Ferraro, one of the editors of the new *Quarterly Journal of Applied Mathematics and Mechanics*, the first number of which has recently appeared, and which seems destined to have an important influence on the future development of applied mathematics in Great Britain. Dr. McVittie has also been very actively interested for many years in problems of theoretical astronomy and has been one of the editors of *The Observatory*.

Mathematical Statistics at the University of Sao Paulo: Mr. W. L. Stevens

Mr. W. L. Stevens has been appointed professor of mathematical statistics in the University of Sao Paulo, Brazil. Mr. Stevens worked under Prof. R. A. Fisher, at the Galton Laboratory, University College, London, during 1935–41. He then joined the staff of the Statistical Department, Rothamsted Experimental Station, for a few months on urgent war work prior to leaving for Portugal to take up a lectureship in statistics at Coimbra at the request of the British Council and the Foreign Office. In 1944 he returned to Britain and took a post as statistician with Imperial Chemical Industries, Ltd., Billingham. In 1947 he joined the staff of the Admiralty Statistical Department under Mr. H. L. Seal. He has been chiefly concerned with the development of statistical methods in the fields of biological and agricultural experimentation, and has also made contributions to the methods applicable to quality control of industrial products.

New Atomic Pile at Harwell

Rather less than a year has passed since the Atomic Energy Research Establishment at Harwell put into operation 'Gleep', the first atomic pile to be built in Great Britain. Now a second and more powerful pile has been completed and put into operation. Its rated output is 6,000 kW., and it has been designed primarily as an experimental tool, to provide as many facilities as possible without unduly complicating the engineering of the structure. In addition, when operating at rated output, the pile should be able to produce, by transmutation of inactive elements, all the artificial radioactive isotopes required in Britain by medical and other research workers. Like 'Gleep', the new pile is a graphite-moderated air-cooled pile. The uranium rods are enclosed in aluminium cases which lie in channels in the graphite. Cooling air is drawn through the channels by several large electrically driven exhausters. The whole pile is surrounded by a concrete shield several feet thick, to protect workers from radiations, and the cooling air is discharged up a chimney stack 200 ft. high. There are about forty holes in the shield, giving access to the strong fluxes of neutrons in the interior of the pile. These neutron fluxes, many times more intense than can be obtained in any other way, are required for many experiments in nuclear science, both in fundamental and in applied research. Thus, for example, the applied research programme will include an investigation of the effect of irradiation by neutrons on the properties of materials, to provide information about materials used in the construction of piles. The experimental holes are also the means by which inactive elements are placed in the pile for transmutation into radioactive isotopes. Surrounding the pile structure are the control rooms and laboratories used by the scientific and operating staff. The operation of the pile is controlled by two sets of neutron-absorbing rods; the first set of rods is adjusted to keep the pile operating at a constant-power level, and the second set is available to shut the pile down in any emergency. The basic calculations for the Harwell pile were begun in 1945 by a team working under Sir John Cockcroft in the laboratories of the National Research Council of Canada, and were continued when the team moved to the newly formed Atomic Energy Research Establishment at Harwell. It was the first task of the Department of Atomic Energy at Risley, under the direction of Mr. C. Hinton, to undertake the design of the pile, based on the information provided by the Harwell team. This work began in April 1946. The actual construction of the pile was made the responsibility of the Ministry of Works, assisted by their contractors, Messrs. Chivers.

Earthquakes in Japan

At about 8 p.m. local time on June 28, four severe earthquakes affected the sea and land areas around the town of Fukui, on the west coast of Honshu Island, Japan. The epicentres of the shocks appear to have been near lat. 36·1° N., long. 136° E., though news from the Japanese observatories has not yet been received. An area within a radius of about 30 miles from Fukui was destructively affected. The population of Fukui (about 85,000) was largely engaged in the textile industry (mostly silk), as more than one quarter of the looms of Japan were in the town. There were some ferro-concrete buildings in the town, but most of the buildings were made of wood and these were soon set alight by the fires scattered by the shocks. The fires were difficult to check owing to earthquake damage to the water supply, and it is estimated that nearly 40,000 buildings were damaged beyond repair. A cinema collapsed, burying alive a large number of people, and many casualties were caused by falling debris at the railway station. Six other towns and thirty-nine villages in the neighbourhood were severely affected, including Marouka, Mikuni, Matsuoka, Daishoji and Kanaza. Communications were severely affected and an important railway bridge was destroyed, making relief work difficult. Huge waves lashed the coast. Altogether, some 3,200 people are believed to have lost their lives, and there are thousands of others injured. Aftershocks continued for some days.

In the whole of the densely peopled islands of Japan, there are about five hundred earthquake shocks of varying intensity every year, and although probably the greatest of the world's earthquakes have not happened there, yet there have been tremendous Japanese disasters from time to time. Examples include the Mino-Owari earthquake just after 6 a.m. local time on October 28, 1891, and the shock which almost destroyed Tokyo and Yokohama on September 1, 1923. The present shock is estimated to have been about three quarters of the strength of the latter. Between the smaller shocks of July 16–17, 1941, in the Nagano Prefecture and the shock of May 9, 1947, in Hida, there has been little news, and for part of the time some of the Japanese observatories closed down. Mr. Ernest Tillotson states that news of this period is, however, beginning to arrive: thus between December 18, 1943, and December 1945, to the accompaniment of hundreds of seismic disturbances, a 1,200-ft. high mountain called the 'New Showa Mountain' arose with volcanic eruptions on the fringe of Lake Toya, Hokkaido, similar to the Paricutin Mountain in Mexico. Further news of these tremendous earth movements is awaited.

Scientific Advisory Council to the Minister of Fuel and Power

The Minister of Fuel and Power has appointed the following to be members of the Scientific Advisory Council which will advise him on the scientific aspect of his statutory duties: Sir Alfred Egerton (chairman), Eng. Vice-Admiral Sir Harold Brown, Dr. H. Roxbee Cox, Sir Charles Ellis, Prof. F. H. Garner, Sir Charles Goodeve, Dr. E. S. Grumell, Mr. J. Hacking, Dr. H. Hollings, Prof. D. M. Newitt, Sir Harry Ricardo and Prof. S. Zuckerman. The terms of reference of the Council will be: (1) to advise the Minister of Fuel and Power on the scientific aspect of problems which he may remit to them in connexion with his statutory duty of securing the effective and co-ordinated development of coal, petroleum and other sources of fuel and power in Great Britain, and of promoting economy and efficiency in the supply, distribution, use and consumption of fuel and power, whether produced in Great Britain or not; (2) to advise the Minister of new scientific knowledge or developments which in the opinion of the Council should be taken into account in the performance of his statutory duties; (3) to keep the whole field of fuel and power under continuous review with the object of identifying problems needing scientific investigation and advising the Minister of those problems.

Ordnance Survey Maps of Britain

The initiation of an entirely new ordnance map series on a scale of 1 : 25,000, or about 2½ inches to the mile, was one of the chief recommendations of a departmental committee set up in 1935. It was felt that the gap between the 1-inch and 6-inch was too wide for many users. In the areas already covered there are signs that the new scale is growing in popularity. Some five hundred sheets, or about one fifth of the projected total, are now published, and it is hoped that the remainder will be ready in about three years time. The new map is based on the old six-inch map, to which has been added certain revisions made for war purposes. In this sense only is it provisional: the final edition will incorporate 50-in. re-surveys of built-up areas, now in hand in many towns, and an overhaul of 25-in. plans in rural areas. The sheet edges lie along the 10 kilometre grid lines of the national grid, and each sheet is known by the 10 km. grid reference of its south-west corner. The new map is sold in three styles, the fully coloured, the outline and the administrative areas. In the first, contours and main roads are in brown, water in blue, black for outlines of roads, buildings and railways, and solid black for public buildings. The outline edition is in grey monochrome without contours and is printed on specially heavy paper suitable for drawing offices. The administrative areas edition has all such boundaries shown by a red overprint on the outline edition; apparently it is being considered whether or not to continue the production of this edition. The following areas are now in the course of being covered by the 1 : 25,000 map: Greater London, Edinburgh, Glasgow, Dundee and Aberdeen; Plymouth and Dartmoor; Purbeck, New Forest, Southampton and Portsmouth, and most of the south coast; South Wales and Bristol; Gloucester, Oxford, Reading and Luton; East

Anglia and the Broads; Birmingham and district; Tyneside and Lancashire, Yorkshire and Cheshire. These maps, with the 6-in. to the mile, are known as 'medium scale'. Full descriptions of other Ordnance Survey maps, with illustrations and indexes, are given in two pamphlets, one dealing with small-scale maps and the other large-scale maps, issued by the Director General, Ordnance Survey Office, Chessington, Surrey (1*s.* 6*d.* each).

Research in Telecommunications

THE past decade has demonstrated the great importance of efficient and rapid communication as an essential part of modern civilization. Although in certain directions spectacular advances have been made in the development of telecommunications, which includes both radio and land-line signalling, there is more need now than hitherto for pursuing that fundamental research which underlies all the many applications of these techniques. In order to meet this need, the Department of Scientific and Industrial Research formed in 1946 an *ad hoc* Telecommunications Research Committee under the chairmanship of Sir Stanley Angwin, for the purpose of defining the basic problems in the whole field of telecommunications that would require investigation in the next few years. The Committee, which consisted of representatives of the radio industry, of those Government departments directly concerned with this subject, and of the British Broadcasting Corporation, drew up a report which has recently been published by the Department of Scientific and Industrial Research ("The Fundamental Research Problems of Telecommunications", London, H.M. Stationery Office, 1948. 1*s.* 6*d.* net).

This publication contains both the full reports and abstracts of the nine 'working parties' set up by the Committee to deal with the various phases of the subject. These working parties surveyed existing knowledge in their various fields to determine what deficiencies in that knowledge required attention; and they have indicated in considerable detail the specific items of research which appear to require investigation. It is believed that the formulation of these problems will prove a very useful step forward in the development of telecommunications research in Great Britain, and it is to be emphasized that university research laboratories, as well as those of government and industry, will find in the document many items suitable for their attention. With the issue of this report, the Committee has completed the task assigned to it: but the Department of Scientific and Industrial Research has already constituted a Standing Conference on Telecommunications Research, the function of which is to survey periodically the progress being made in this subject, and to provide a means for consultation between the Department's Radio Research Board and industry on these and other such matters of common interest.

Air Routes

THE advent and growing use of air transport has done a great deal to alter geographical values. Speed has reduced the importance of distance and thus recast many political, economic and social relationships. In a small pamphlet recently published ("Air Transport and Geography." London: Royal Geographical Society, 1947. 1*s.*), Mr. W. G. V. Balchin refers to many of the aspects of geography that touch on the course and uses of air routes. After referring to the vexed problem of air maps and their projections, he inserts a world map on an oblique zenithal equidistant projection centred on London and its antipodal point; on this the chief civil routes are shown. These maps show that 94 per cent of the world's population, and nearly all the world's manufacturing industry, fall in one of these hemispheres, and the central hub is in western Europe with London or Paris the actual centre. The distribution of population, especially of large urban growths, determines the course of the chief air routes. There are some forty-four world areas each of more than a million inhabitants, of which the largest are in Europe and the Atlantic side of North America and fewest in Africa and in Asia, outside China and Japan. The greatest number are on a great circle track through London and Melbourne. Major flying routes do not cross the Pacific, and contrary to often expressed belief, do not pass through north polar regions. Mr. Balchin goes on to consider other factors influencing the course of air routes.

Strawberries and Watercress as Commercial Crops

BULLETIN 95, "Strawberries" (London: H.M. Stationery Office. 2*s.* net), was originally published by the Ministry of Agriculture in 1937, but since that time so much new knowledge about the crop has become available that a new edition became necessary. This has now been accomplished with gratifying completeness, by co-operation between the scientific staffs of Long Ashton and East Malling Research Stations. All aspects of culture are discussed; but such items of practice as relate to the propagation and maintenance of healthy stocks receive special mention. One section deals with newer methods of out-of-season production, and an appendix describes the recognition of varieties. The section on diseases and pests is adequate; but prompts the gentle criticism that it is scarcely complete enough to deal with some troubles which are common in the northern part of Britain. Twenty-seven good half-tone figures add greatly to the value of the bulletin.

Watercress cultivation is a fascinating speciality. Bulletin 136 (London: H.M. Stationery Office. 1*s.* net) is written by Mr. Charles H. Sansom, and gives details of all aspects of this crop. Continuous growth is given by water at about 50° F., and it is often best to obtain this by boring through chalk to a depth of 300 ft. This special crop brings special pests, for the freshwater shrimp (*Gammarus* sp.) and caddis fly larvæ cause some damage, as well as the mustard beetle. Eight plates and diagrams show details of establishment and management of the beds.

Mushroom Diseases

BULLETIN No. 10 of the Mushroom Growers' Association (Yaxley, Peterborough. 2*s.* 6*d.* net) contains a brief note by F. C. Atkins and C. J. La Touche on *Pseudobalsamia microspora*, an ascomycete which may compete with the mushroom on commercial beds. It is almost certainly introduced with the surface soil and so can possibly be eliminated with care. Boards and the house-structure should be sterilized and flies kept down, as they spread the trouble. The same bulletin contains reprints of Dr. W. M. Ware's paper on "*Clitopilus cretatus* as an Invader of Mushroom Beds" (*Gard. Chron.*, May 18, 1935), and Dr. W. F. Bewley's work on mushroom casing soil (Cheshunt Exp. Sta. Ann. Rep., 1946). A separate leaflet lists useful volumes on mushroom culture in the Association's library.

Philosophy of Science

At a meeting held at University College, London, on June 1, a Philosophy of Science Group was formally constituted and affiliated with the British Society for the History of Science. The Group adopted the following statement of aims: "The purpose of the Group is to study the logic and method of science as well as of the various special sciences, including the social sciences. The main emphasis is upon an approach through the various special sciences to the philosophy of science." The Group intends to hold meetings for the reading and discussion of papers and to publish an account of its activities in a supplement to the *Bulletin of the British Society for the History of Science*, which will be circulated to members. The Group has elected the following Committee: Prof. H. Dingle (chairman), Dr. K. R. Popper, Mr. F. I. G. Rawlins, Dr. G. J. Whitrow and Dr. A. C. Crombie (honorary secretary), Department of History and Philosophy of Science, University College, Gower Street, London, W.C.1. It is hoped to hold the first ordinary meeting in the autumn of this year.

Conference on Noise and Sound Transmission

The Acoustics Group of the Physical Society, in association with the Royal Institute of British Architects, is holding a three-day International Conference on Noise and Sound Transmission during July 14–16. This is the first major international discussion of the subject for many years, and papers will be read by European and American investigators in addition to the contributions from Great Britain. Among those reading papers are L. L. Beranek (United States); T. Vogel, R. Lehmann, P. Chavasse, F. Canac (France); W. Fürrer (Switzerland); W. K. Westmijze, C. W. Kosten, J. van den Eijk (Holland); F. Ingerslev, V. L. Jordan, P. V. Bruel (Denmark); E. Meyer, A. Schoch, L. Cremer (Germany); N. Fleming, R. S. Dadson, H. L. Kirke, W. A. Allen and A. J. King (Great Britain). The papers will cover the subjects of sound insulation in buildings, aircraft and ships; impact sound; resilient suspension systems; proposals for standardization of measurement, and the measurement of noise. Those who desire to have copies of summaries of papers in advance of the meetings should send requests to the Joint Honorary Secretaries of the Acoustics Group at 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

International Congress of Industrial Medicine

The ninth International Congress of Industrial Medicine will be held in London, at the Caxton Hall, during September 13–17. The last congress was held in Frankfurt in 1938. The congress will meet in six sections devoted respectively to social aspects, environment, nursing, clinical studies, practice and legal and miscellaneous topics. Among the subjects announced for discussion are incentives, work and skill, dust hazards, pneumokoniosis, physical, biological and psychological effects of environment, effects of working with the newer chemicals and metals, hazards of radiant energy, etc. Further particulars can be obtained from the secretary of the Congress, Room 501, Garden Court Wing, B.M.A. House, Tavistock Square, London, W.C.1.

Congress on Biological Chemistry

The Société de Chimie Biologique will hold its eighth congress in Paris during October 6–8. This will be the first international congress on the subject in France for ten years, the previous meeting having been held at Liège in 1946. Subjects for special consideration at the Paris congress are: proteins and hormones (reports by Profs. Theorell and Fromageot); biological organic chemistry and plant biochemistry (reports by Profs. Stoll and Janot); vitamins and hormones (reports by Profs. E. C. Dodds and Horeau). Sessions will also be reserved for communications outside these subjects, and provision will be made for experimental demonstrations. Further particulars can be obtained from the secretary-general of the congress, M. Jean Courtois, 4 Avenue de l'Observatoire, Paris, VI^e.

Science and Industrial Practice in the Iron and Steel Industry

The British Iron and Steel Research Association is arranging two conferences to be held next autumn at Ashorne Hill, nr. Leamington. The first, in which the Institute of Physics is also interested, will be held on September 8 and 9, and is to discuss non-destructive testing of castings. Three sessions will be arranged to discuss papers on X- and gamma-ray methods and on X-ray equipment, radioactive materials and radiography abroad; magnetic and ultrasonic methods; recent work by the Non-Destructive Testing Sub-Committee of the Association on the comparison of X-ray, gamma-ray and ultrasonic methods, and a paper on acceptance standards. It is intended that the papers shall deal essentially with the practical aspects of the subject and be of interest to executives not conversant with the methods, but who might be considering their use. The second conference is planned for October 21 and 22, and is to discuss foundry core bonding agents. The object is to bring to the notice of founders the wealth of information that has been obtained in recent years on the new materials that may be used for the bonding of foundry cores. The use of such materials, in many cases with an appreciable reduction in cost, would enable the linseed oil used hitherto to be diverted to alleviate the shortage of edible fats. There will again be three sessions: natural resources of the materials, recent work by the Association on the practical and fundamental aspects of bonding, and the properties of new materials such as plastics and petroleum products; experience of founders with such materials; and the impact of these materials on matters such as core-blowing, and dielectric and infra-red heating.

International Scientific Film Congress

The second congress of the International Scientific Film Association will be held in London during October 4–11. It is being convened by the Scientific Film Association of Great Britain, with the help of the British Film Institute. Three days will be devoted to business meetings of the Association, and three days to a festival of scientific films, when it is hoped to show many contributions from all the participating countries to members of the general public. The congress will close with a general assembly of the delegates on October 11. The Association was constituted last year in Paris by delegates from twenty-two countries who had accepted the joint invitation to the inaugural congress from the Scientific Film Associations of Great Britain and France. The primary aim of the Association is: "To raise the standard and to promote the use of the scientific film and related material throughout the world in order to achieve the widest possible understanding and appreciation of scientific method and outlook, especially in relation to social progress". Further details may be obtained from the Scientific Film Association, 34 Soho Square, London, W.1.

Annual Reviews of Psychology and of Physical Chemistry

AN "Annual Review of Psychology" is to be published under the auspices of Annual Reviews, Inc., Stanford, California, the first volume to appear early in 1950. Prof. Calvin P. Stone and Donald W. Taylor, of Stanford University, will serve as editor and associate editor, respectively. The editorial committee will consist of the following: John E. Anderson, Institute of Child Welfare, University of Minnesota; John G. Darley, University of Minnesota; Clarence H. Graham, Columbia University; Carl I. Hovland, Yale University; James G. Miller, University of Chicago. The subject-matter of each volume will consist of critical appraisals of research proceeding in the major divisions of the field. Subjects of greatest activity will be reviewed annually, while those of lesser activity, together with any topics which encompass small divisions of the field, will be reviewed biennially.

Organisation of an "Annual Review of Physical Chemistry" of a similar type, operating under the same editorial policies and characterized by a corresponding recurring list of topics, is also announced by Annual Reviews, Inc. This will be edited by Prof. G. K. Rollefson, of the University of California, Berkeley, and will be directed in the selection of topics and authors by an editorial committee consisting of Henry Eyring, University of Utah; George Glockler, State University of Iowa; W. F. Libby, University of Chicago; J. W. Williams, University of Wisconsin; and E. Bright Wilson, jun., Harvard University. The first volume will also appear in 1950. Annual Reviews, Inc., is a non-profit corporation which was first constituted in 1932 to publish the "Annual Review of Biochemistry". Since then it has initiated the "Annual Review of Physiology" (jointly with the American Physiological Society) and the "Annual Review of Microbiology".

Zoological Society of India

THE following have been elected members of the Executive Council of the Zoological Society of India: *President*, Dr. S. L. Hora; *Vice-President*, Prof. D. R. Bhattacharya; *Secretary*, Dr. M. L. Roonwal; *Editor*, Prof. K. N. Bahl; *Treasurer*, Dr. B. S. Chauhan; *Members*, Dr. K. Panikkar, Prof. M. A. Moghe, Dr. B. N. Chopra, Dr. Bhattacharya, Dr. G. D. Bhalerao, Dr. D. V. Bal, Dr. T. J. Job. It is intended to bring out the first volume of the *Journal of the Zoological Society of India* this year. Papers intended for publication, which should be original contributions or critical reviews of current researches not published elsewhere, should be sent either to the Editor (at the Zoology Department, Lucknow University, Lucknow) or to the Secretary (at the Zoological Survey of India, Banaras Cantt., U.P.).

University of Glasgow

THE University Grants Committee is supporting the development of electrochemistry in the University of Glasgow; and Dr. J. C. James, at present at Battersea Polytechnic, London, has been appointed lecturer in chemistry under this project. Similar support is to be given to zoological taxonomy. Other recent appointments in the University of Glasgow are: Mrs. Rhoda M. Ainley, assistant in anatomy; J. Highet, lecturer in sociology; A. W. Sloan, lecturer in physiology; Bruno Toushek, a Nuffield fellow in physics; Mrs. Jean A. Wapshaw, part-time assistant in biochemistry; and A. Williams, lecturer in geology (with a year's leave of absence while holding a Commonwealth fellowship).

Work has been begun on the final portion of the new Chemistry Department at Glasgow, and on the building which is to house the 300-MeV. synchrotron. A 30-MeV. instrument is already in operation in the Department of Natural Philosophy.

Announcements

PROF. T. DALLING, director of the Veterinary Laboratory of the Ministry of Agriculture and Fisheries at New Haw, Weybridge, has been appointed chief veterinary officer to the Ministry from August 21 on the retirement of Sir Daniel Cabot, who has reached the age of sixty. Sir Daniel Cabot's services will be retained part-time in a temporary capacity in connexion with certain international veterinary organisations.

MR. ALFRED EASTHAM, chief officer of the Official Seed Testing Station since 1923, retired on June 30 and the Council of the National Institute of Agricultural Botany has appointed Mr. C. C. Brett to this post. Mr. Brett has been senior assistant to the chief officer since 1922, and during the past eighteen months has been seconded as executive officer of the Seed Production Committee.

THE following have been appointed to readerships in the University of Edinburgh: Mr. E. G. Dymond (natural philosophy), Dr. W. L. Edge (mathematics), Dr. Alexander Nelson (botany) and Dr. E. G. V. Percival (chemistry).

THE autumn meeting of the Deutsche Physikalische Gesellschaft in der Britischen Zone will take place at Clausthal-Zellerfeld/Harz during September 9–12.

THE fourth Commonwealth Mycological Conference will be held at the Imperial College of Science and Technology, South Kensington, during July 19–24. Plant pathologists from all parts of the British Empire will be present, and the topics to be discussed include the control of virus diseases, with special reference to swollen shoot of cacao, measures to be taken to avoid the transmission of seed-borne parasites through the seed, the certification of healthy planting material of certain vegetatively produced crops, new developments in fungicides, including their application from the air, and forest pathology.

AT the annual general meeting of the Institute of Welding on June 30, the following were elected honorary officers for 1948–49: *President*, Dr. J. H. Paterson; *Vice-President*, O. V. S. Bulleid; *Honorary Treasurer*, W. E. Harriss.

THE Governing Body of the Imperial College of Science and Technology has decided that the schemes for the international exchange of students during summer vacations, initiated by its Vacation Work Committee in 1946, shall be broadened in 1949 to include university students from other colleges in Great Britain. The exchange is operated through the recently established International Association for the Exchange of Students for Technical Experience, which at present includes Belgium, Czechoslovakia, Denmark, Finland, France, Netherlands, Norway, Sweden and Switzerland.

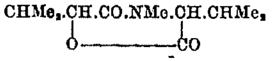
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Antibiotics Produced by Fungi, and a New Phenomenon in Optical Resolution

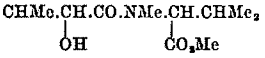
It was reported earlier[1] that a strain of *Fusarium lateritium* produced an antibiotic, lateritiin-I, which was representative of a group of related compounds in presenting several remarkable chemical features. These features were elaborated in a communication to the Eleventh International Congress of Pure and Applied Chemistry held in London in July 1947, in which it was stated that lateritiin-I gave rise on hydrolysis to $D(-)$-α-hydroxy*iso*valeric acid and $L(+)$-N-methylvaline (II). The different configurations of these products were an indication, taking their configurational stabilities into account, that these units had an individual existence in the original antibiotic. This conclusion was supported by the isolation from lateritiin-I, after mild alkaline hydrolysis, of a lactone from which a crystalline methyl ester was prepared, the properties of these compounds being compatible with the structures (III) and (IV) respectively.

$CHMe_2.CH(OH.)CO_2H$ (I) $CHMe_2.CH(NHMe)CO_2H$ (II)



(III)

$$\begin{array}{l}CHMe_2.CH.CO.NMe.CH.CHMe_2\\ \quad\;\; | \qquad\qquad\qquad\;\; |\\ \quad\;\; O\text{———————}CO\end{array}$$



(IV)

$$\begin{array}{l}CHMe.CH.CO.NMe.CH.CHMe_2\\ \qquad\;\; | \qquad\qquad\quad |\\ \qquad OH \qquad\quad\; CO_2Me\end{array}$$

Meanwhile Gaumann, Roth, Plattner, Ettlinger and Nager[2] had, unknown to us, reported the production by a strain of *F. orthoceras* of enniatin, which appeared to be closely related to, if not identical with, lateritiin-I. After exchanging samples of the two materials, it is agreed by Prof. Plattner and by us that a mixture of them is undepressed in melting point and that they must be regarded as identical. However, in a paper which has only recently reached us[3], it is concluded that the simple nitrogenous acid hydrolytic fragment of enniatin is probably identical with the higher homologue of (II), namely, N-methylleucine.

It seems, therefore, desirable to report that the structure of the fission product under discussion has been completely established by oxidation and by synthesis. Oxidation afforded *iso*butyraldehyde, which was identified as its 2 : 4-dinitrophenylhydrazone and 2 : 4-dinitrophenylsemicarbazone. Interaction of methylamine and lævo-α-bromo*iso*valeric acid afforded $L(+)$-N-methylvaline, identical in all respects with the material of natural origin; this was also obtained by the methylation of $L(+)$-valine in the usual way. Any remaining structural doubt has been removed by the synthesis of the lactone (III) and the derived ester (IV) in the following way. *lævo*-α-Brom*iso*valeryl chloride and DL-N-methylvaline were condensed together and the product was refluxed with pyridine and water, when the hydroxy-acid condensation product was formed. This was extracted and heated for several hours on the steam bath under reduced pressure, when the lactone (III) was obtained as a viscous oil similar to the natural material. This had the rotation $[\alpha]_D = +52°$ (ethanol); but on passing it through an acid-washed column in ethereal solution, about half the material was lost and the remainder had the rotation $[\alpha]_D = +79°$ (ethanol). The natural lactone has the rotation $[\alpha]_D = +82°$ (ethanol). On mild alkaline hydrolysis the synthetic material reverted to the hydroxy-acid, which on treatment with diazomethane gave the methyl ester (IV) identical in melting point with the ester of natural origin, with which it gave no depression on admixture; it was identical in all other respects with the material obtained by degradation, both showing the same optical activity, $[\alpha]_D = -128°$ (chloroform). Finally, the synthetic material yielded $L(+)$-N-methylvaline on hydrolysis.

The above reactions virtually constitute a facile resolution of N-methylvaline; apparently the lactone derived from D-α-hydroxy*iso*valeryl-D-N-methylvaline is more strongly absorbed on the alumina than that derived from D-α-hydroxy*iso*valeryl-N-methylvaline and undergoes hydrolysis. The lactone and derived hydroxy-acid pairs are, of course, not mirror images and no new theoretical principle is involved, nor is this an asymmetric synthesis in the conventional sense. The process is, however, unexpectedly simple; it might have considerable utility if it were general, and it clearly offers interesting speculation on the genesis of optically active amino-acids from existing optically active compounds.

Using the same procedure and starting with DL-α-brom*iso*valeryl chloride and DL-N-methylvaline, a crystalline optically inactive lactone was obtained, which was also formed by mixing equal amounts of the natural lactone with that derived from L-α-hydroxy*iso*valeryl-D-N-methylvaline.

A number of lactones similar to (III) have been made and are being studied, and full details of the present and related work will be published elsewhere.

Note added in proof.—Since the above was written a further communication (Plattner, Pl. A., and Nager, U., *Helv. chim. Acta*, 31, 665; 1948) has come to our notice in which 'enniatin A' and 'enniatin B' were described. Of these 'enniatin A', which appeared to be identical with lateritiin-I, afforded N-methylleucine, while N-methylvaline arose from 'enniatin B'. The above authors suggested that lateritiin-I was highly contaminated with 'enniatin B'. It must be emphasized, however, that we find no evidence to support this contention, the various degradation products affording no sign of heterogeneity.

A. H. Cook
S. F. Cox
T. H. Farmer

Imperial College of Science and Technology,
London, S.W.7. March 24.

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[1] Cook, A. H., Cox, S. F., Farmer, T. H., and Lacey, M. S., *Nature*, 160, 31 (1947).

[2] Gaumann, E., Roth, S., Plattner, Pl. A., Ettlinger, L., and Nager, U., *Experientia*, 3, 202 (1947).

[3] Plattner, Pl. A., and Nager, U., *Experientia*, 3, 325 (1947).

The Antibiotic Agent from *Marasmius ramealis*

It has earlier been shown that species of the genus *Marasmius* produce substances inhibiting the growth of *Staphylococcus aureus*[1]. Our investigations now show that *Marasmius ramealis* Fr. exercises an antibiotic effect upon various pathogenic bacteria *in vitro*.

The *Marasmius* strain used was isolated and investigated for nutritional requirements by Lindeberg[2]. The fungus was grown upon different media, the most suitable one being a modification of the Czapek-Dox substrate. Erlenmeyer flasks containing 25 ml. of the nutrient solution were inoculated and incubated at 25° C., and the culture liquid tested for antibacterial activity at different intervals against: (1) bacteria named in the accompanying table (State Bacteriological Laboratory) and (2) human tubercle bacilli (Institute of Physiological Botany).

The inhibitory action against the former bacteria was tested on solid media using a modification of the cylinder plate method due to Schmidt and Moyer[3], and in dilution series in broth. The solid medium was buffered with phosphates to neutralize the bacteriostatic effect caused by an acid solution. The bacterial concentration in the surface layer was 10^{-4} or 10^{-5} of a 20-hr. broth culture, giving a confluent growth. The plates with porcelain covers were kept at room temperature two hours before incubation at 37° C. overnight. The zones of total inhibition were read to the nearest 0·5 mm. The action on different bacteria is shown in the table.

Dilution tests were performed in broth with inocula of about 10,000 organisms per ml. The last tube showing no visible growth was determined after 20 hours incubation at 37° C. (see table). It was evident from secondary platings of the tubes that the antibacterial action was a bacteriostatic one.

	Inhibition zone (mm.)	Max. dilution for inhibition
Staphylococcus aureus, *H*	23·0	1/32
Staphylococcus aureus, 209 *P*	22·0	1/16
Streptococcus hæmolyticus, S.B.L.	0	
Diplococcus pneumoniæ, S.B.L.	28·0	
Klebsiella pneumoniæ, Friedländer *C.G.* 8	27·0	1/8
Salmonella typhi, *I.S.* 57	13·0	1/4
Salmonella paratyphi B, *I.S.* 3	10·0	1/2
Escherichia coli, *C.G.* 16	0	
Aerobacter aerogenes, *C.G.* 4	15·0	1/2
Shigella sonnei, S.B.L. 5	9·0	1/2
Proteus vulgaris, S.B.L. 2	19·0	1/2
Fæcalis alcaligenes, S.B.L.	14·5	1/8
Pseudomonas æruginosa, S.B.L.	0	
Bacillus subtilis, 219 *P*	42·0	1/256
Bacillus anthracis, S.B.L. 1	30·0	1/16
Corynebacterium diphtheriæ mitis, S.B.L.	0	
Hemophilus pertussis, S.B.L.	0	

For the tubercle bacilli, the serial dilution method was used. The *Mycobacterium* cultures employed were two strains of *M. tuberculosis* var. *hominis*: the *H* 37 *Rv* strain (obtained through Dr. Lagergren, of the State Bacteriological Laboratory, Stockholm) and the 1354 strain (isolated by Dr. Zetterberg, Institute of Hygiene and Bacteriology, University of Uppsala). The inhibitory effect upon *H* 37 *Rv* was studied only in Dubos' medium[4]; with the 1354 strain, the dilutions were made in different media: veal broth, Long's and Dubos' solutions. After the addition of the active filtrate to the substrate, the *p*H of the liquid was adjusted to about 7 with sodium hydroxide. The flasks with Dubos' medium were inoculated with a suspension of the bacteria, the other substrates with small floating pieces of the pellicle. Control flasks containing dilutions of the basal fungus nutrient solution were also seeded. The flasks were incubated at 37° C.

Dilutions of 1/3, 1/5 and 1/11 in Erlenmeyer flasks were used for routine tests. The flasks were examined at intervals of three days; but no visible growth could be detected in any medium after two months of incubation. In the controls the bacteria grew vigorously. Dilution experiments were also carried out in glass tubes, the growth being measured photometrically. After about three weeks a slight growth was found in the 1/50 dilution. In the tubes with the 1/30 dilution bacterial reproduction was completely inhibited (two months of observation). The two *Mycobacterium* strains tested behaved in a similar manner.

The antibacterial material has been separated from the culture medium in two different fractions, both showing an inhibitory effect against the two *Mycobacterium* strains. On distillation of the culture filtrate *in vacuo* (bath temperature 15° C.), a colourless, aqueous distillate of *p*H 6·5, showing activity, was collected in the receiver. The distillation was continued, while maintaining the volume in the distillation flask constant by adding water, until the distillate showed no activity. The aqueous distillate, containing the active principle, was extracted with small portions of ether or chloroform and the solvent removed under reduced pressure, leaving an oily residue, soluble in ether, petroleum ether and chloroform, and fairly soluble in water. All the active material could not, however, be removed by distillation; the rest was extracted with ether from the culture medium left after distillation, the *p*H being adjusted to 1·5–2·5. The ether was removed under reduced pressure leaving an orange-yellow residue, not volatile but readily soluble in water, ether, chloroform and ethyl alcohol.

The *volatile* substance can also be isolated from the antibacterial filtrate by extraction with chloroform, which does not remove the *non-volatile* principle, or by adsorption on activated charcoal ('Norit'), followed by elution with chloroform or ether.

Aqueous and ethereal solutions, or a dry preparation of the *volatile* substance, undergo a chemical change on standing at room temperature, yielding an inactive, yellow residue, which is no longer soluble in water or ether. Stored at + 2° C., however, an aqueous solution can keep its activity for at least one month. Potassium permanganate solution and bromine water are decolorized by the substance in question, which also gives a precipitate with a mercuric chloride solution.

These preliminary investigations of the *volatile* substance indicate a certain resemblance to allicin, the antibacterial principle of *Allium sativum*[5,6]. As to the *non-volatile* substance, it can be extracted with ether only from acidified aqueous solutions. If it is kept at room temperature in a dry state or in solution, there is no appreciable change in its inhibitory effect for at least five weeks.

GERD BENDZ
Chemical Institute,
University of Uppsala.

GÖSTA WALLMARK
State Bacteriological Laboratory,
Stockholm.

KARIN ÖBLOM
Institute of Physiological Botany,
University of Uppsala.

March 5.

[1] Melin, E., Wikén, T., and Öblom, K., *Nature*, **159**, 840 (1947).
[2] Lindeberg, G., *Symb. Bot. Upsal.*, **8**, No. 2 (1944).
[3] Schmidt, W. H., and Moyer, A. J., *J. Bact.*, **47**, 199 (1944).
[4] Dubos, R. J., and Davis, B. D., *J. Exp. Med.*, **83**, 409 (1946).
[5] Cavallito, C. J., Buck, J., and Suter, C. M., *J. Amer. Chem. Soc.*, **66**, 1952 (1944).
Small, L. D., Bailey, J. H., and Cavallito, C. J., *J. Amer. Chem. Soc.*, **69**, 1710 (1947).

Utilization of Mineral Constituents of the Egg-shell by the Developing Embryo of the Stick Insect

THE presence of a relatively large quantity of mineral material, mainly calcium carbonate, in the egg-shell (exochorion) of Phasmidæ has been established by Pantel[1] (in eggs of *Donusa prolixa*). Extending his examinations to the egg content, Pantel found that the Malpighian tubules of fully developed embryos contained calcium salts far in excess of the quantity which he was able to demonstrate in the yolk of freshly laid eggs. Pantel interpreted this finding by assuming that most of the calcium in the yolk was organically bound and therefore not responsive to his methods of detection.

The egg-shell of *Bacillus libanicus* Uv. contains, besides calcium carbonate, also calcium oxalate and smaller quantities of aluminium, magnesium and potassium salts. Most of the calcium carbonate is concentrated in a white crystalline layer covering the inner surface of the shell. In freshly laid eggs, this white layer appears dense and opaque, its compactness and structure being the main cause of the rigidity of the egg-shell. It was observed that in the shells of fully developed or hatched-out eggs, the white layer is much reduced in thickness, the whole shell being less opaque and more brittle. A similar appearance could be produced in shells of freshly laid eggs by emptying them and immersing in water acidulated with carbon dioxide.

Considering these differences in thickness of the white layer, and in view of Pantel's observation, there arose the question whether during embryonic development mineral material from the egg-shell might not be passing into the egg-content. The possible occurrence of such a process in insect eggs was originally suggested by Needham[2], in view of the fact that in some avian and reptilian eggs utilization of egg-shell calcium by the developing embryo had been demonstrated[3,4].

To test this possibility, the quantities of ash in shells and in contents of eggs at various stages of development were determined and compared. As eggs laid by different females may vary considerably with regard to their ash content, only eggs of the same parentage were used for comparative measurements.

Material	% of ash in terms of dry weight in	
	Shells	Egg contents
Freshly laid eggs	38·4	0·7
Eggs entering diapause (age, 80 days)	35·4	1·1
Post-diapause eggs (10 days before hatching)	32·7	2·3
Eggs at hatching	30·8	3·5* (Neonate nymphs)
One-year old, undeveloped eggs	38·0	0·6

* The actual rise in ash quantity is somewhat lower, there being a corresponding decrease of about 6·4 per cent in the dry weight of the egg due to the development of the embryo.

The accompanying table summarizes some of the results concerning changes in the relative quantity (in terms of dry weight) of the mineral components in shells and in contents of developing and undeveloped eggs laid by one female. It shows clearly that in the shells of developing eggs the quantity of the mineral components decreases continuously, its percentage in dry shell weight diminishing by about 8 per cent; no such change is observable in shells of eggs which do not undergo development. Further, the quantity of the mineral material in the developing embryo rises markedly, there being no such rise in the undeveloped one-year-old eggs.

Thus it seems safe to conclude that during development of the egg of *B. libanicus*, a transfer occurs of mineral material from the egg-shell to the developing embryo. Although it was not possible to carry out a quantitative identification of the transferred minerals, the morphological observations mentioned above suggest that it is mainly calcium carbonate from the white layer of the shell that is absorbed by the embryo.

A more detailed account will be published elsewhere.

A. MOSCONA

Department of Entomology
and General Zoology,
Hebrew University,
Jerusalem.
March 5.

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Function of Hyaluronidase in Fertilization

Pincus[1] and Pincus and Enzmann[2] observed that the mass of follicle cells surrounding the freshly ovulated rabbit egg could be dispersed by means of sperm suspensions, and they inferred the presence of a proteolytic enzyme. Gilchrist and Pincus[3], describing the events taking place during *in vivo* fertilization in the rat, state that the freeing of adherent follicle cells is "an inevitable accompaniment of sperm penetration . . .". Afterwards, McClean and Rowlands[4] and Feketé and Duran-Reynals[5] produced evidence to show that the enzyme is probably hyaluronidase. They also expressed the view that the denudation of the egg is a necessary preliminary to the penetration of the sperm, and this theory, and the important role thus ascribed to hyaluronidase, have become widely accepted.

It should be noted, however, that Lewis and Wright[6] concluded from their investigations on the mouse egg that sperm penetrate to the vitellus "long before" the dissolution of the surrounding mass of follicle cells. Their evidence consisted chiefly in the finding of sperm in the perivitelline space of the freshly ovulated egg, and the extrusion of the second polar body when the eggs were kept in culture. They were, however, unable to observe pronuclei or sperm within the vitellus in their material. For some reason the evidence presented by Lewis and Wright appears to have been overlooked by the protagonists of the present concept of the function of hyaluronidase in fertilization.

During an investigation of fertilization in the rat, it has been observed that if females are killed when the copulation plug is found, the eggs are recovered in cumulus masses of varying degrees of integrity. Frequently the cumuli are indistinguishable under the microscope from those obtained from unmated rats. Nevertheless, most of the eggs show sperm within the vitellus, and when examined under the phase-contrast microscope, the male and female pronuclei can also be discerned. This means that an appreciable time, perhaps an hour or more, has elapsed since sperm penetration. In other cases, eggs observed in cumuli in varying degrees of disintegration show pronuclei of progressively greater size and more complex structure. It is clear, therefore, that in the rat the disintegration of the cumulus occurs over a period following fertilization.

A similar state of affairs appears to exist in the cat, for Prof. E. C. Amoroso (personal communication) has demonstrated the presence of sperm in the zona pellucida of the cat's egg while the latter was still surrounded by an apparently intact layer of follicle cells.

It is concluded that the penetration of the intact cumulus by the sperm as envisaged by Lewis and Wright does, in fact, occur, and that denudation of the egg, at least in some species, is not a prerequisite of fertilization. Clearly, therefore, the destruction of the cumulus prior to sperm entry is not an essential function of hyaluronidase, though the local presence of the enzyme may conceivably assist the passage of the individual sperm.

Illustrations of fertilized eggs in apparently intact cumuli, together with details of microscope technique, will be included in a full paper being prepared, in collaboration with Mr. J. Smiles, for submission to the *Journal of the Royal Microscopical Society*.

I wish to record my grateful acknowledgments to the Medical Research Council and Dr. C. R. Harington for the hospitality of the National Institute for Medical Research, Hampstead, and to Dr. A. S. Parkes and Prof. E. C. Amoroso for their valuable criticism and advice.

C. R. Austin

National Institute for Medical Research,
Hampstead, N.W.3.
March 22.

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Metabolism of Aminohydroxybenzoic Acids

We have recently been studying the metabolism of some aminohydroxybenzoic acids. In view of the interest in these compounds which has been stimulated by the observations of Lehmann[1], Vallentin[2] and of Dempsey and Logg[3] of the beneficial effects of 4-aminosalicylic acid (*P.A.S.*) on patients with various tuberculous lesions, a preliminary statement of some of our results seems opportune.

We have already identified some aminohydroxybenzoic acids (or amides) as metabolites of aminobenzamides in the rabbit[4]; for example, 3- and 5-hydroxyanthranilic acids from *o*-aminobenzamide, 5-aminosalicylic acid from *m*-aminobenzamide and 4-amino-3-hydroxybenzoic acid from *p*-aminobenzamide. It is our intention to study the metabolism of the ten isomeric aminohydroxybenzoic acids, and so far we have carried out a preliminary examination of four, namely, 3-, 4- and 5-aminosalicylic acids and 3-amino-4-hydroxybenzoic acid. The three aminosalicylic acids appear to be metabolized by the rabbit in similar ways, being excreted partly unchanged and partly as acetamidosalicylic acids, all three of which have been isolated from the urine. No increase in ethereal sulphate excretion was observed. (Salicylic acid itself is not excreted as ethereal sulphate[5].) 3-Amino-4-hydroxybenzoic acid, however, does appear to be conjugated with sulphuric acid to a slight extent (about 4 per cent), as well as being excreted unchanged and as 3-acetamido-4-hydroxybenzoic acid.

Owing to its clinical interest and to the kind co-operation of Mr. D. E. Seymour, of Herts Pharmaceuticals, Ltd., in supplying us with the compound, we are examining 4-aminosalicylic acid in somewhat greater detail. In the rabbit, approximately 50 per cent of a dose of 1–2 gm. is excreted unchanged and 50 per cent as 4-acetamidosalicylic acid (m.p. 238–239°), which has been isolated and characterized. There has, so far, been no evidence of the formation of ethereal sulphate or of glucuronides of either ester or ether type. 4-Acetamidosalicylic acid has also been isolated from human urine after oral administration of 3 gm. sodium 4-aminosalicylate. Considerable amounts were excreted unchanged.

A fuller account of this work will be published elsewhere.

H. G. Bray
Brenda E. Ryman
W. V. Thorpe

Department of Physiology,
Medical School,
University, Birmingham.
March 23.

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Lipoid Content of the Oxyntic Granules of the Rat's Stomach

There have been a few suggestions in the literature that the granules of the oxyntic cells of the stomach might consist in part of a lipoid material. The evidence for this view has, up to date, been circumstantial, having been based on (*a*) the tendency of these granules to show some blackening after fixation in fluids containing osmium tetroxide[1], and (*b*) the assumption that, since they can be readily demonstrated by the Altmann – Regaud technique[2] and can be supravitally coloured by Janus Green *B*[3] they are mitochondria, and therefore contain lipoid.

Recently, more positive evidence for a lipoid component has been forthcoming. Foster[4], using a method by Baker[5], has shown that these granules have, in frozen sections of formol calcium chloride fixed rat's stomach, a strong affinity for Sudan Black (Fig. 1),

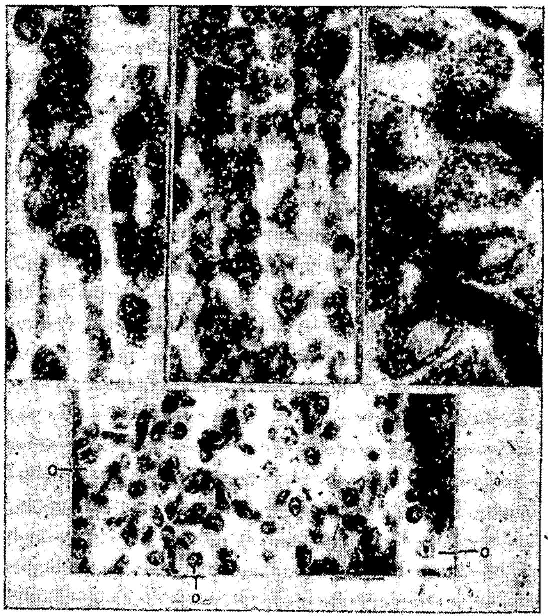
Fig. 1 Fig. 2 Fig. 3

Fig. 4

Figs. 1, 2 and 4. × 375. Fig. 3. × approx. 800. Fig. 4. O, OXYNTIC CELL. NOTE POSITIVE REACTION OF NUCLEI AFTER PYRIDINE EXTRACTION a fact strongly indicative of the presence of lipoid. I have confirmed these observations, and extended them by the use of Baker's acid hæmatin test[6] for lipines.

The oxyntic cells of the rat's stomach are strongly positive to the acid hæmatin test (Figs. 2 and 3) and therefore very probably contain lipine, although some oxyntic cells at the bases of the fundic glands are negative, showing only the unstained refractile granules. There is reason for believing that this is not a fixation artefact, or some similar effect, related to the technique employed, but that it represents a specific functional state of the cells in these positions.

After removal of the lipoids by the pyridine extraction method[6], the acid hæmatin test gave negative results (Fig. 4). It was quite clear, however, that the cells still contained refractile granules, comparable in numbers to those of the non-extracted cells, and it was possible to stain these with Heidenhain's iron hæmatoxylin. It seems reasonable to suppose, at this stage of the investigation, that these extracted granules consist partly of protein. If this is so, the oxyntic granules appear to be of a duplex nature, consisting of a protein core and a lipine (and perhaps non-lipine lipoid) envelope. In this respect they resemble not only mitochondria, but also the lipoid-invested vacuoles of the Golgi complex.

A preliminary study of the behaviour of these granules under certain experimental conditions that stimulate gastric secretion has shown (*a*) that in some cells there is a very marked enlargement of the granules, and an intensification of their positive reaction to acid hæmatin, and (*b*) that in others, perhaps the majority, there is a negative reaction to the acid hæmatin test, suggesting that in these cells the granules have lost their lipine component.

A full account of these and other observations on oxyntic and other chloride-secreting cells, their probable relation to mitochondria and the Golgi complex, and their possible relation to the mechanism of hydrochloric acid secretion, will be given elsewhere.

GORDON MENZIES

St. Mary's Hospital Medical School,
Anatomy Department,
(University of London),
Paddington, London, W.2.

March 22.

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Discriminating 'Athrocytes' in the Reticulo-endothelial System

'ATHROCYTOSIS' can be defined as the property of some types of cell (termed 'athrocytes') of absorbing and storing in granular form extraneous substances, mostly electronegative colloids. Lison[1] showed recently that the Kuppfer cells of the frog and toad liver do not all have this property to the same extent. Some—provisionally termed '*G*' cells—store certain electronegative dyes, namely, those in which the diameter of the particles is greater than 60–80 A. Others ('*F*' cells) accumulate preferentially those of smaller diameter. This behaviour is clearly seen when a frog is injected intraperitoneally with a mixture of two acid dyes the particulate diameters of which are respectively greater and less than 80 A.; for example, a mixture of soluble Prussian blue (228 A., calculated by means of Einstein's formula from the diffusion coefficient measured with a Nistler's diffusion microscope) and ammonium carmine (20·5 A.). In these conditions, the '*G*' Kuppfer cells take up only the blue, the '*F*' cells only the carmine.

Both cell types are 'discriminating athrocytes' according to the definition of Cordier, Gérard and Lison[2]: they select among the athrocytable substances, taking and storing some of them, neglecting the others. In this case, it was shown conclusively that the main factor controlling the selection is the dimension of the particle in solution (other types of discriminating athrocytosis have been described by Lison[3]).

The purpose of this communication is to present evidence of the existence of such discriminating athrocytes in the reticulo-endothelial system of mammals. The technique used in our experiments was the intraperitoneal injection into the rat of suitable mixtures of acid dyes. In contrast with the common practice in the investigations on the reticulo-endothelial system, one single injection was made, and the quantity of the dye injected was relatively small—in most experiments 0·01 gm. of each dye. Preliminary experiments showed that high doses of dyes and repeated injections result in strong reaction of the reticulo-endothelial system, involving mobilization of many cells and fundamental changes in the characteristics of its components. The dyes used were all non-dialysable electronegative dyes; and they can be divided into two groups: 'high-dispersion' dyes, for which the diffusion coefficient is less than $0\cdot050 \times 10^{-5}$ cm.^{2}/sec., corresponding to theoretical particulate dimensions less than 80 A.; and 'low-dispersion' dyes, for which the diffusion coefficient is greater than this value. This classification is merely a question of convenience and is adopted for reasons of clarity only.

The most striking results are obtained with mixtures of one 'high' and one 'low' dispersion dye. After one day, the two components appear to be nearly quantitatively separated and are found stored in granular form in different cells. The high-dispersion dye is accumulated in fine and medium-sized granules in elongated, spindle-shaped cells. These fixed cells are found throughout the connective tissue surrounding or penetrating the organs and must be regarded as 'histiocytes'. The low-dispersion component of the mixture is stored in medium- or large-sized granules in large polymorphous mobile cells with rounded or reniform nuclei. These cells, which are rather scarce in the common connective tissue, but are very numerous in the medullary of the lymphatic nodes and in the omentum, must be identified with 'free macrophages'. The greatest part of the dyes injected is found separately in these two cell types. In addition, a few cells store both components in the form of mixed granules. These cells, macrophagic in aspect, must be considered as transitional elements between histiocytes and macrophages for the following reasons: they occur in the regions where the production of free macrophages is intense, such as the medullary of the lymphatic nodes and the omentum: the granules are formed of various relative proportions of the two dyes, in such a way that all the transitions can be observed.

The high-dispersion dye appears in the histiocytes throughout the whole body, while the athrocytosis of the low-dispersion dye is restricted to the area near the point of injection, that is, in the abdominal and sometimes mediastinal lymphatic nodes, in the omentum, and in the connective tissue in the immediate neighbourhood of the abdominal cavity. It is evident that the resorption and the transportation of the low-dispersion dyes are much slower than those of the high-dispersion ones, resulting in a more restricted area of athrocytosis. It must be emphasized, however, that the storage of the two dyes in different types of cell is not the result of circulatory conditions, preventing the access of one dye to one type of cells, since both types of athrocytes can be seen in the same location closely packed together.

In the liver, also, the two dyes are found in separate cells. The Kuppfer cells selecting the high-dispersion dye are scattered equally in the whole lobule, while the cells which store the low-dispersion dye are restricted to the periphery of the lobule, near the interlobular veins. Thus the two types, '*G*' and '*F*', of the Kuppfer cells previously described in amphibians occur also in mammals, but their location is different.

When the two components of the mixture used in the previous experiments are injected separately their location is the same as if they were injected simultaneously.

When mixtures of two high-dispersion dyes are injected, the two components are not separated, but are stored in the same cells, mainly in the form of mixed granules; these findings are in accordance with the observations of von Möllendorff. When mixtures of two low-dispersion dyes are injected, the two components are found both in the same macrophages, sometimes in the form of mixed granules, more often in the form of separate granules; cells with only one component are not found.

The present experiments afford evidence that the athrocytes in the reticulo-endothelial system of mammals act selectively towards different substances, and that the main factor controlling the selection is the dimensions of the particle in solution. Therefore, substances of different dispersions are stored in different cell types, the critical value of the dispersion corresponding approximately to a diffusion coefficient of $0{\cdot}050 \times 10^{-5}$ cm.^{2}/sec.

L. LISON
J. SMULDERS

Department of Histology,
Faculty of Medicine,
University, Brussels.
May 12.

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A Further Example of the Anti-*S* Agglutinin

A SECOND example of the human hæmagglutinin, anti-*S*, discovered by Walsh and Montgomery[1] has been identified. This agglutinin was shown by Sanger and Race[2] to be connected with the *MN* blood-group system, and to define either two more allelomorphs, *MS* and *NS*, at this locus, or else a second locus *S*, very closely linked to that for *M* and *N*. For practical purposes there is no difference between these two alternative possibilities.

The present example was found together with an anti-*D* agglutinin in the serum of a patient whose second pregnancy terminated in a stillborn hydropic fœtus at twenty-eight weeks gestation. The serum was first tested with a series of 48 *Rh* negative bloods, of which 22 were found to be agglutinated. It showed no relationship to *ABO*, *P*, Lewis or Lutheran blood groups, though there was suggestive evidence that it was connected with the *MN* groups, for, of the bloods of group *M*, eight were positive and five negative, and of those of group *N*, two were positive and six negative. Differential absorption was successfully achieved with three out of four *Rh* positive bloods chosen at random, the fourth donor removing all agglutinins.

The bloods of 250 unselected non-related people have been tested with the absorbed serum, and the results are given in Table 1 with the two previously published series. Dr. R. R. Race has also tested the bloods of 21 known *S* positive and 15 *S* negative individuals with the new serum, with complete agreement in all cases.

TABLE 1

	M		*N*		*MN*			
	S+	*S*−	*S*+	*S*−	*S*+	*S*−	Total	*S*+%
Walsh and Montgomery[1]	30	9	13	21	40	27	140	59·3%
Sanger and Race[2]	36	14	15	30	57	38	190	56·9%
Oxford series	55	20	12	33	67	63	250	53·5%
	28·28%		21·38%		50·34%		580	56%

A total of 580 bloods have now been tested with the two examples of the anti-*S* antibody, and the distribution of the *MN* groups is in good agreement with that expected in England. Prof. R. A. Fisher has very kindly recalculated the gene frequencies[3] for the combined data (Table 2).

TABLE 2

	S+	*S*−	Total
M	0·25585	0·27863	0·53448
N	0·08113	0·38439	0·46552
Total	0·33698	0·66302	1·00000

From these gene frequencies the expected genotype frequencies can be calculated (Table 3).

TABLE 3

Phenotypes		Genotypes	Expected	Observed	χ^2
M	*S*+	*MSMS* *MSM*	120·6921	121	0·000
	S−	*MM*	44·9958	43	0·088
MN	*S*+	*MSN* *MSNS* *MNS*	164·3819	164	0·000
	S−	*MN*	124·2390	128	0·113
N	*S*+	*NSN* *NSNS*	39·9928	40	0·000
	S−	*NN*	85·6983	84	0·033
			579·9999	580	0·237
					d.f. 2 $p = 0\cdot$

It will be seen that the agreement between the calculated figures and those actually observed is very close indeed, and provides additional evidence of the correctness of the genetical interpretation of Sanger and Race.

The blood groups of the family are as follows:

Mrs. M.G.	Group *A* *R*″ (*cdE*/*cde*) *M* *S*− Lutheran− Lewis−
Mr. G.	Group *O* R_1R_2 (*CDe*/*cDE*) *MN* *S*+ Lutheran− Lewis−
C. G., son	Group *A* *Rh*+ *M* *S*+
Stillborn infant	Group *A* *Rh*+ Direct Coombs' Test +++

The anti-S titre of the serum rose from 1 : 1 three days before delivery to 1 : 16 three weeks after delivery, and by six weeks *post partum* had fallen to 1 : 8. The antibody was active at 37° C. and 20° C., though slightly more intense reactions were obtained at 37° C. The thermal range and the familial incompatibility of S groups suggest that this is an immune agglutinin, though the presence of the anti-D agglutinin (titre 1 : 16) does not allow of any evaluation of the part it may have played in fœtal morbidity. It is unlikely that the agglutinin has been previously encountered in this laboratory, as the donor of the *Rh* negative cells which were first found to be agglutinated by this serum has been one of the standard *Rh* negative controls for antibody investigations since 1943.

I should like to thank Dr. R. R. Race for his interest and advice, and Mr. J. A. Morton and Mr. W. Penfold for technical assistance.

M. M. Pickles

Division of Laboratories,
Radcliffe Infirmary,
Oxford.
April 1.

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Variations in Spermatogenesis of Oligospermic Men

Zondek, Bromberg and Polishuk have suggested[1] that oligospermia in men can be divided into two types, constant and periodic; and that it is only men in the latter group who are likely to produce pregnancies. While agreeing that individuals differ in the range of variation of their sperm counts, we do not think this is either a clear-cut or a useful distinction.

It is, of course, impossible to draw conclusions about the reaction of a patient to treatment for oligospermia unless several specimens have been examined before treatment is given. It is also essential that specimens for comparison should have the length of the period of abstinence since the previous ejaculation controlled in both directions. Zondek *et al.* give only a minimum of length of interval. An interval of two or three weeks may result in sperm counts five times as high as those obtained after three to five days. As the number of motile spermatozoa does not increase with a long interval to anything like the same extent as does the total number of spermatozoa present, and as their viability is frequently impaired, the increase in sperm density cannot be regarded as improving the chances of fertilization. A possible cause of apparent periodic oligospermia is the occasional loss of the first few drops of the ejaculate, the majority of the spermatozoa being in the first fraction[2]. In our experience this is often the cause when men, whose sperm density is usually more than 60 million per c.c., produce specimens with counts less than 20 million.

Case	Sperm densities (M./c.c.)	Corresponding interval since previous ejaculate (days)
I	0·4, 1·0, 0·1, 0·2	3, 3, 3, 3
II	5, 3, 5, 4, 5, 10, 2, 5	3, 4, 3, 7, ?, 13
III	10, 6·5, 6·5	5, 4, 2
IV	8, 2	11, 3
V	6, 5, 17	2, 8
VI	1·5, 0·5	28+, 2
VII	1·5, 1·5, 1·0, 2·0, 0·65	?, 8, 4, ?, 4

It is not necessary to postulate periodic, as opposed to constant, oligospermia to explain pregnancies in wives of oligospermic men. The lower limits of sperm count usually stated as necessary for fertilization are definitely too high. In a series of more than seven hundred sub-fertile marriages, seven women whose husbands constantly had sperm densities less than 20 million per c.c. have conceived. Details are given in the accompanying table. In cases II–V conception took place shortly after the last semen analysis; in case I the last count was done a month after conception occurred. Cases VI and VII are less convincing, as conception did not take place until more than a year after the patients stopped attending the clinic, and the husbands may have improved in the interval. A further seven conceptions occurred in women whose husbands had, in a single seminal analysis, sperm densities less than 20 million per c.c.

Margaret Hadley Jackson
Clare Harvey

University College of the South-West, Exeter,
and the
Exeter Sub-Fertility Clinic.

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Relation Between Fountain Pressure and Heat Current in Helium II

Allen and Reekie[1] directed attention to the fact that the fountain-pressure difference ΔP at the ends of a narrow slit or capillary produced by a temperature difference is, in the absence of mass flow, exactly proportional to the heat current W appearing simultaneously with the fountain pressure.

For very narrow slits (up to 10^{-4} cm.) the heat current is proportional to the temperature difference at all temperatures up to the immediate neighbourhood of the λ-point. For wider slits (greater than 10^{-3} cm.), the linear relation between heat current W and temperature difference ΔT changes gradually over to proportionality between W and the cube root of ΔT. These deviations from linearity are greater for wider slits, and for higher temperatures and greater gradients at any constant slit width.

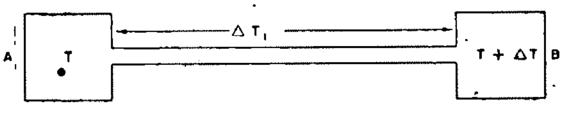
Keesom and Duyckearts[2] and Mellink[3] confirmed that the Allen – Reekie proportionality between fountain pressure ΔP and heat current W is retained no matter what the relation between W and ΔT, including the regions where this dependency approaches the cube root law.

This is difficult to understand so long as the factors responsible for the deviation from linearity between W and ΔT are regarded as operative in the slit itself where the fountain pressure gradient must exist.

A simple explanation can be given in terms similar to the model proposed recently[4] for the anomalous mechano-caloric effects in the super-critical mass flow of helium II through slits.

The experimental arrangement for measuring W and ΔP may be represented schematically as in the accompanying figure.

A narrow slit of from 0·1 to 20 μ, or a capillary filled with emery powder, connects two temperature



baths A and B containing bulk liquid at temperatures T and $T + \Delta T$ respectively.

The anomalous heat effects accompanying mass flow could be explained by the assumption that the temperature difference ΔT between A and B is greater than the temperature difference ΔT_1 between the ends of the slit itself, if the velocity of the particles emerging from the slit (or entering the slit) is greater than the critical velocity of the superfluid flow.

In the present problem there is no net mass flow. But according to L. Tisza and F. London[5], the heat flow in a narrow slit can be considered as a viscous back-flow of normal particles under the fountain-pressure difference. The velocity u of the normal (excited) particles can be estimated from the equation $W = \rho Q u$, where ρ is the density and Q the heat content of helium II. u is actually about equal to the critical velocity for values of W in the region where the first deviations occur from the linear relation between W and ΔT. These deviations from linearity may thus be due to the appearance of temperature differences $\Delta T_b = (\Delta T - \Delta T_1)$ in the bulk liquid near the ends of the slit, caused by the normal particles emerging from the slit at a velocity higher than the critical one.

The fountain pressure can only depend on the temperature difference ΔT_1 between the ends of the slit itself. For narrow slits it obeys the relation given by H. London[6],

$$\Delta P = \rho S \, \Delta T_1, \qquad (1)$$

and generally (see S. R. deGroot[7])

$$\Delta P = k_f \, \Delta T_1, \qquad (2)$$

where k_f falls to lower values than ρS for capillaries of such a width that some excited particles can also pass, and the heat of transportation Q^* is less than TS.

The heat current, on the other hand, depends on the total temperature difference $\Delta T = \Delta T_1 + \Delta T_b$; but the thermal resistance consists of two resistances in series, namely, the resistance in the bulk adjacent to the ends of the slit, and the resistance in the slit. It is assumed that W is proportional exactly to ΔT_1 within the slit in accordance with the model of viscous back-flow, and that all deviations from linearity are due to the resistance in the bulk liquid. From the fact that the heat flow in wide tubes is proportional to $(\Delta T)^{1/3}$, we may assume the same dependency to be valid for the resistance in the bulk liquid.

The condition for continuity of heat flow states that

$$W = k_1 \, \Delta T_1 = k_2 (\Delta T_b)^{1/3}, \qquad (3)$$

with

$$\Delta T = \Delta T_1 + \Delta T_b.$$

Comparing the first part of (3) with (2) yields exactly the Allen – Reekie relation

$$W / \Delta P = k_1 / k_f = \text{constant}. \qquad (4)$$

This result holds no matter what the relative importance of the different series resistances, remaining true even when the heat current follows almost the cube root law. Thus for wider slits the fountain pressure may be very small because $\Delta T_1 \ll \Delta T$, so that $\Delta T \doteqdot \Delta T_b$ and W is almost exactly proportional to $(\Delta T)^{1/3}$; for narrower capillaries the fountain pressure and ΔT_1 both become appreciable, so we get values intermediate between linearity and the cube root law. For the narrowest slits the fountain pressure assumes its maximum value, $\Delta T = \Delta T_1$, $\Delta T_b = 0$, because the particles emerge from the slit at velocities smaller than the critical one and no temperature gradient appears outside the ends of the slit. So W is now exactly proportional to ΔT.

In consequence of this interpretation, the transition probability relation derived by us previously to account for the cube root law[8] can hold only in the bulk liquid, and not in very narrow slits or capillaries. The proximity of the wall apparently inhibits the relaxation effects, a circumstance which is probably related with the fact that the superfluidity of helium II appears near walls and in narrow slits.

LOTHAR MEYER
WILLIAM BAND

Institute for the Study of Metals,
University of Chicago.
May 19.

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High-Frequency Resistance of Superconductors

MEASUREMENTS of the high-frequency resistance of superconducting tin, extending previous work[1] at 1,200 Mc./s., have now been carried out at frequencies around 9,200 Mc./s. (wave-length 3·2 cm.). The experimental technique is in principle the same as at 1,200 Mc./s., with the twin-wire resonator replaced by a half-wave coaxial resonator. The variation of the resistivity, R, with temperature is shown in the accompanying graph, together with the results of the earlier measurements for comparison. For convenience, R is expressed in terms of the resistivity, R_n, of normal tin just above the transition temperature. The experimental points plotted are those taken with one of the five specimens actually measured; the points for the other specimens are in close agreement.

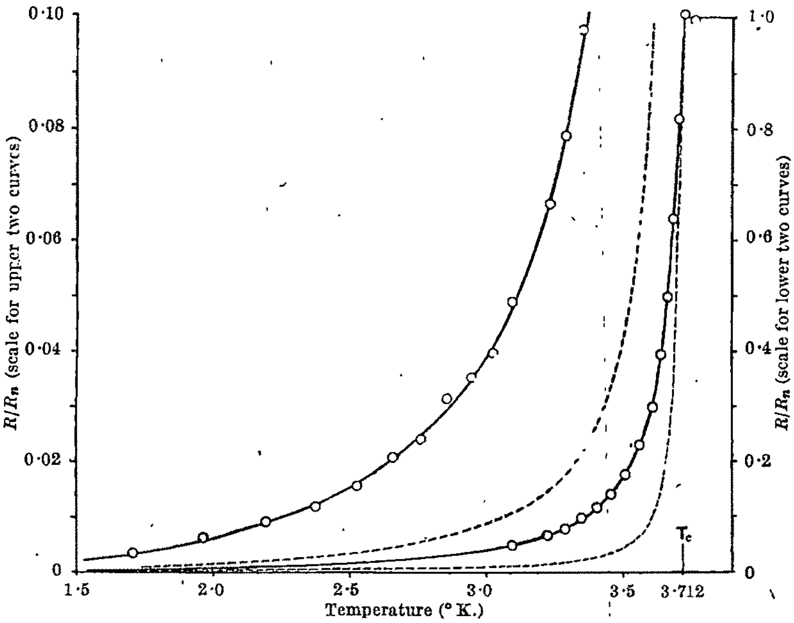
If the usual assumption[2] be made that a superconductor contains both 'superconducting' and 'normal' electrons, which react independently to an applied field, certain predictions about the frequency-variation of r $(= R/R_n)$ may be made by means of general arguments. In the first place, it may be shown that the initial slope dr/dT, just below the transition temperature, T_c, should vary with frequency as $\nu^{-2/3}$. The experimental results are not in agreement with this prediction. For the two frequencies used, the ratio of the slopes is 2·95 instead of the predicted 3·9.

It may further be shown that at temperatures sufficiently far below T_c that $r \ll 1$, the resistivity R at a given temperature should vary as ν^2. A separate experiment has shown that $R_n \propto \nu^{2/3}$, in accordance with the theory of the anomalous skin effect[3], so that it would be expected that $r \propto \nu^{4/3}$ at any temperature well below T_c. It may therefore be predicted without any but general arguments based on the model that, for $r \ll 1$,

$$r = Af(T), \qquad (1)$$

where

$$A \propto \nu^{4/3}. \qquad (2)$$



RESISTIVITY OF SUPERCONDUCTING TIN: FULL LINES, AT 9,200 Mc./s.; BROKEN LINE, AT 1200 Mc./s. THE UPPER CURVES ARE ON TEN TIMES THE SCALE OF THE LOWER CURVES

Now it has been found empirically that for $T < 3·3°$ K. the experimental curves for both frequencies, in agreement with equation (1), are closely fitted by the expression

$$r = A' \cdot \frac{t^4(1 - t^2)}{(1 - t^4)^2},$$

in which t is the reduced temperature T/T_c.

The experimental values of A', however, show a marked departure from the frequency-variation of equation (2). Thus, $A' = 0·0195$ at 1,200 Mc./s., and 0·0865 at 9,200 Mc./s.

The ratio of these two values, 4·43, is very different from the predicted ratio of 15·12. A discrepancy of this magnitude cannot be accounted for by observational errors, and it must be concluded either that some relevant factor has been omitted from the general arguments, or that an incorrect model has been used. Further experiments are in progress to discover the cause of these anomalies, and the measurements are also being extended to mercury, which appears from preliminary results to exhibit similar anomalies, though to a lesser extent.

A full account of this investigation will be published elsewhere.

A. B. PIPPARD

Royal Society Mond Laboratory,
Cambridge.
May 21.

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Oxidation of Uranium Dioxide (UO_2)

IN connexion with earlier investigations on uranium oxides in this Institute, it was observed that uranium dioxide (UO_2) can react with oxygen at so low a temperature as 120° C. To obtain more exact information about this low-temperature oxidation of UO_2, the oxide was heated in purified oxygen at different temperatures from 100° to 265° C. and the reaction products examined by the X-ray powder method[1].

At 150° C., UO_2 takes up oxygen at least to the composition $UO_{2·34}$. This oxidation causes a displacement of the X-ray interference fringes and a broadening of some of them, indicating a change to lower symmetry. As an approximation the lattice of the new structure was considered to be cubic. A specimen with the composition $UO_{2·34}$ was found to have the lattice constant $a = 5·40$ kX. (for UO_2, $a = 5·468$ kX.). It is difficult to decide whether or not the structure of UO_2, the β-phase, changes continuously as the oxygen content increases. If the change is discontinuous, the two structures belong to different phases.

The experimentally found density of UO_2 is 10·80 gm./c.c. and of $UO_{2·34}$ 11·05 gm./c.c. The increase of the density from UO_2 to $UO_{2·34}$ can only be explained by the assumption that oxygen, at least partly, enters into interstitial positions of the UO_2 lattice. Nevertheless, the lattice contracts; this must be due to the fact that the expected increase of lattice dimensions due to interstitial addition of oxygen is overcompensated as some of the uranium ions change their charge from + 4 to + 6 (or + 5).

By raising the temperature to 200°–250° C. the oxygen content exceeds the formula $UO_{2·34}$, and another new phase, the δ-phase, is formed. X-ray photographs indicate that the δ-phase has a narrow range of homogeneity around $UO_{2·40}$. The phase is found to be tetragonal, a specimen with the composition $UO_{2·43}$ having the following lattice constants: $a = 5·37$ kX., $c = 5·54$ kX. and $c/a = 1·03$.

TABLE 1. CALCULATED DENSITIES OF THE δ-PHASE

Phase	Formula	Density in gm./c.c.
AB_2-addition	$UO_{2·43}$	11·46
AB_2-substitution	$U_{0·88}\ O_{2·12}$	10·04
AB_2-subtraction	$U_{0·82}\ O_2$	9·44

Table 1 gives the densities calculated for a preparation with the composition $UO_{2·43}$ if the lattice is derived from that of UO_2 by: (1) addition of oxygen; (2) substitution of uranium with oxygen; or (3) subtraction of uranium. On comparing these densities with the observed one, 10·00 gm./c.c., only assumption (2) provides agreement between observed and calculated values. The lattice of the δ-phase must then be regarded as derived from that of UO_2 by substitution of uranium with oxygen. The formula of the specimen $UO_{2·43}$ must therefore strictly be written $U_{0·88}.O_{2·12}$.

The intensities of the X-ray interference fringes indicate that the uranium atoms form a face-centred lattice (000 ; 0 ; $\frac{1}{2}\frac{1}{2}0\frac{1}{2}$; $\frac{1}{2}0\frac{1}{2}\frac{1}{2}$). In Table 2 intensities are calculated for the uranium atoms in the usual way, including corrections for absorption, but without temperature factor. Observed and calculated intensities are in good accord.

TABLE 2. OBSERVED AND CALCULATED INTENSITIES ON POWDER PHOTOGRAPH OF $UO_{2\cdot 48}$. IRON K RADIATION

$h\,k\,l$	$I_{obs.}$	$I_{calc.}$	$h\,k\,l$	$I_{obs.}$	$I_{calc.}$
111	st.	5·2	313	st.	5·9
002	w.	1·0	331	m.	3·0
200	m.	2·0	204	st.	3·1
202	st.	3·1	402		3·1
220	w.	1·5	420		3·2
113	m.	2·6	224	m.	4·0
311	st.	5·2	422	v.st.	8·7
222	m.	2·6	115	m.	5·4
004	v.w.	0·7	333	st.	6·4
400	v.w.	1·3	511	v.st.	14·0

The existence of a uranium oxide with the composition U_2O_5 has often been assumed, and recently by R. Lydén[2], who prepared it by the action of potassium hydrogen carbonate on U_3O_8. In the tensimetric phase diagram of W. Biltz and H. Müller[3], an oxide U_2O_5 had no observable range of existence. In our investigations, however, a phase near the composition U_2O_5 was found; but the oxide exists only at temperatures below 260–270° C. as a tetragonal deformed substitutional UO_2 phase and has a composition which does not seem to exceed the formula $U_{0\cdot 88}\ O_{2\cdot 12}$.

X-ray photographs of products prepared according to Lydén exhibit a slightly modified U_3O_8-structure. The products were found to have a composition in the region of $UO_{2\cdot 60}$ although approximately a third of the uranium had gone into solution. By reduction of U_3O_8 with hydrogen at 330° C., similar X-ray photographs were obtained, indicating that U_3O_8 has a range of homogeneity between $UO_{2\cdot 67}$ and $UO_{2\cdot 56}$.

P. Jolibois[4] has recently published results on the oxidation of UO_2 which also show the existence of a phase with a composition close to U_3O_7 ($UO_{2\cdot 33}$) but without giving further information on the properties of this phase.

FREDRIK GRØNVOLD
HAAKON HARALDSEN

Department of Inorganic Chemistry,
Chemical Institute,
University of Oslo.
March 5.

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Crystal Structure of Uranium Oxide (U_3O_8)

THE uranium oxide U_3O_8 can be obtained by heating UO_2 as well as UO_3 in air or oxygen to red heat. So far as we know, however, no determination of the structure of this oxide has been published; the difficulty in preparing single crystals of U_3O_8 may be the reason.

While preparing UO_2 crystals, F. W. Hillebrand[1] got some small green-olive-greyish crystals. They seemed to be orthorhombic and were perhaps U_3O_8 crystals. V. M. Goldschmidt and L. Thomassen[2] reported that U_3O_8 did not crystallize regularly.

We did not succeed in preparing U_3O_8 single crystals; but one of the preparations gave X-ray photographs on which reflexions with indices $00l$ only were sharp and well defined, and this has enabled us to put forward a hypothetical crystal structure. All lines on the X-ray photographs can be identified as belonging to an orthorhombic cell with the dimensions: $a = 6\cdot 703$ kX., $b = 3\cdot 969$ kX., and $c = 4\cdot 136$ kX.

The density of U_3O_8 was found pycnometrically to be 8·34 gm./c.c. On comparing this density with those calculated under different possible assumptions as given in Table 1, one finds for U_3O_8 that with three uranium atoms in the elementary cell the density is not in agreement with that observed. The observed density is only compatible with U_3O_8 as an AB_3 subtractive phase (or an AB_2 interstitial phase). The elementary cell then contains two uranium atoms.

TABLE 1. CALCULATED DENSITIES OF U_3O_8

Phase	Formula	Mol.	Density in gm./c.c.
$AxBy$	U_3O_8	1	12·63
AB_3-addition	$U_{1\cdot 12}\ O_3$	2	9·46
AB_3-substitution	$U_{1\cdot 09}\ O_{2\cdot 91}$	2	9·18
AB_3-subtraction AB_2-addition	$UO_{2\cdot 67}$	2	8·42
AB_2-substitution	$U_{0\cdot 82}\ O_{2\cdot 18}$	2	6·88

Here we will not give a general discussion of the space groups which can be considered, but only state that the intensities of the lines on the X-ray photographs indicate the uranium atoms to have the positions a : 000, b : $\frac{1}{2}\frac{1}{2}0$. The arrangement of the atoms may then be referred to the space-groups D_{2h}^{19}, D_{2h}^{13}, D_{2h}^{9}, D_{2h}^{7}, D_{2h}^{5}, D_{2h}^{4}, D_{2}^{6}, C_{2v}^{14}, C_{2v}^{11}, C_{2v}^{8}, C_{2v}^{6}.

The observed intensities were estimated visually. Intensities were calculated in the usual way, including corrections for absorption in the powder rod, but without the temperature factor. The structure factor was calculated for the uranium atoms only. As seen from Table 2, observed and calculated intensities are in good agreement.

TABLE 2. OBSERVED AND CALCULATED INTENSITIES ON POWDER PHOTOGRAPH OF U_3O_8. IRON K RADIATION

$h\,k\,l$	$I_{obs.}$	$I_{calc.}$	$h\,k\,l$	$I_{obs.}$	$I_{calc.}$
001	m.	2·1	402	m.	1·8
110	m.	3·3	130		1·8
200	w.	1·6	420	st.	1·8
111	m.	5·4	113		3·7
201	w.	2·7	203		1·8
002	w.	1·1	510	w.	1·8
020	w.	1·0	131	m.	3·9
310*	m.	2·1	421	w.	3·9
021	w.	1·9	511*	m.	4·0
112	v.st.	3·6	330	w.	2·5
311		3·6	023	w.	2·6
202		1·8	313	m.	5·2
220	w.	1·7	600	v.w.	1·3
400	v.w.	0·9	132	st.	5·6
221	m.	3·4	331		5·6
401	v.w.	1·7	422	m.	6·0
022	w.	1·6	512	m.	6·1
312	m.	3·2	601		3·0
003	v.w.	0·9	223	m.	6·7
222	m.	3·5	403	w.	3·5
			004[1]	m.	2·3

* Coincides with β-reflexions.

Oxygen ions scatter X-rays so slightly that with visually observed intensities we cannot draw conclusions regarding their positions. It is probable, however, that the U_3O_8 structure is related to the ReO_3 structure, but with deformed UO_6^{-4} octahedrons with anion vacancies. If the distribution of these vacancies is statistical, the cell already mentioned can be considered as the elementary cell, or else it would be larger. The ReO_3 structure type is, according to K. Meisel[4], the highly symmetrical form of an AB_3 structure, with which the CrO_3, MoO_3 and the WO_3 structures[5] are also closely related.

FREDRIK GRØNVOLD

Department of Inorganic Chemistry,
Chemical Institute,
University of Oslo.
March 5.

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Structure of Abraded Surfaces

THE importance of surface conditions in the fatigue of metals and alloys has led to an investigation in this Laboratory into the effect of abrasion on the hardness and microstructure of surface and sub-surface layers.

Hardness measurements were made with a 'Tukon' microhardness tester and a load of 25 gm. on metallographically polished 2° taper sections prepared in a manner described by Nelson[1], and more recently by Moore[2], except that the bulk of the metal was used as a backing for the hardness impressions instead of thin wedges. The mechanical magnification obtained was of the order of 20, thus allowing hardness impressions to be spaced at effective distances of 0·5 μ below the surface.

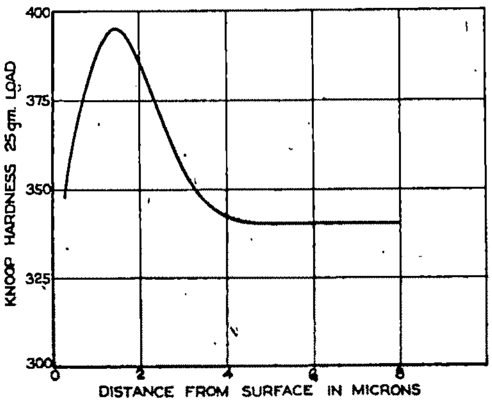

Fig. 1

In the case of chromium-molybdenum steel, heat-treated to a uniform sorbitic structure and to an average bulk hardness of Knoop 340, it was found that abrasion caused an increase in hardness in the surface layers to a depth of 3·5–6 μ according to the degree of abrasion. The maximum hardness obtained was approximately constant at Knoop 400 and occurred at a depth of 1·5 μ in all cases (Fig. 1). However, the most notable feature of the curves of hardness against depth was the fact that the hardness increase diminished progressively from a depth of 1·5 μ to the surface.

Metallographic examination of the taper sections at high magnifications (× 2,500) revealed a layer, corresponding in thickness to the depth of 'softening', in which a modification of the original structure of the steel was evident. Similar structural changes have been observed by Wulff[3] and his associates, in stainless steel, and by Benard, Lacombe, and Chaudron[4], in 'Armco' iron, and have been explained as being due, principally, to the plastic deformation accompanying abrasion. However, the 'softening' effect in the surface layers of steel specimens used in this investigation indicated that plastic deformation cannot be responsible for all the effects observed. The probable cause for this 'softening' was tempering or recrystallization due to the frictional heat of the abrading process, since decarburization of the surface was proved to be absent, and structural alteration during the polishing of the sections was overcome by using a polish-etch technique.

To obtain further information on this point, a series of severely abraded alpha-brass samples (containing 35 per cent zinc) were sectioned after various annealing treatments at temperatures up to 350° C. In the unannealed specimen, the hardness curves were of the same form as previously described, while metallographic examination revealed a layer of fine crystallites at the surface extending to a depth of 1–2 μ (Fig. 2), followed by a deformed layer to a depth of 35 μ. The crystallites were resolved at a magnification of 2,500, the average size being 0·5–1 μ (Fig. 3). No change from the above microstructure was observed in specimens annealed up to 240° C., but annealing at 249° C. caused an increase in the depth of the layer of fine crystallites, indicating that recrystallization of the deformed sub-surface layers had commenced (Fig. 4).

The similarity between the structure obtained by recrystallization of the deformed layers on annealing, and that existing in the extreme surface layer of the unannealed specimen, indicated that the 'softening' observed was due to recrystallization during abrasion. Annealing at still higher temperatures produced considerable grain-growth in the already recrystallized zones and progressive recrystallization into the more lightly deformed regions.

It is concluded from these experiments that, during abrasion, the temperature of the extreme surface layers is raised sufficiently to cause recrystallization. It has further been shown that recrystallization in an alpha-brass, containing 35 per cent zinc, when deformed as in abrasion, occurs at a temperature of 249° C. with the formation of crystallites of approximately 10^{-4} cm.

These results are important in relation to the failure of metals by fatigue. Since fatigue cracks normally start at the surface, the recrystallized and deformed layers produced by surface grinding should be removed before testing, to ensure that endurance curves characteristic of the material are obtained.

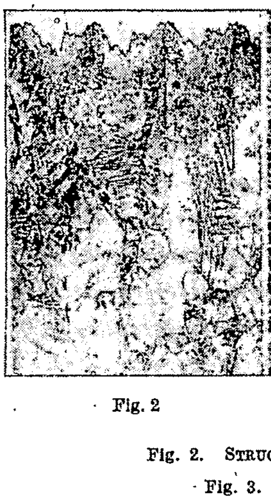

Fig. 2

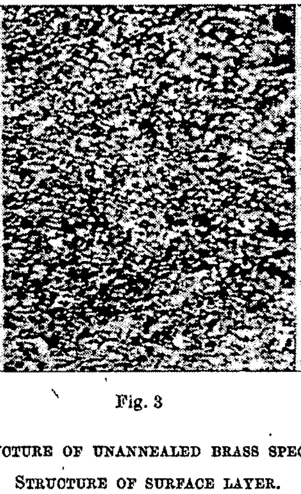

Fig. 3

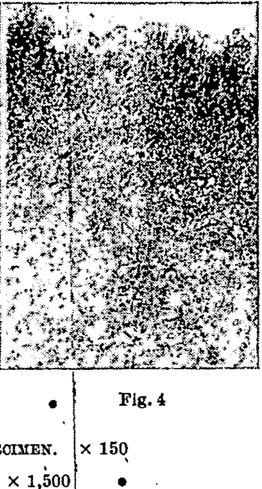

Fig. 4

Fig. 2. STRUCTURE OF UNANNEALED BRASS SPECIMEN. × 150

Fig. 3. STRUCTURE OF SURFACE LAYER. × 1,500

Fig. 4. STRUCTURE OF ANNEALED BRASS SPECIMEN. × 150

The work described above was carried out as part of the programme of the Metallurgy Section, Division of Aeronautics, Council for Scientific and Industrial Research.

J. B. DANCE
D. J. NORRIS

C.S.I.R. Aeronautical Laboratory,
Melbourne.
March 5.

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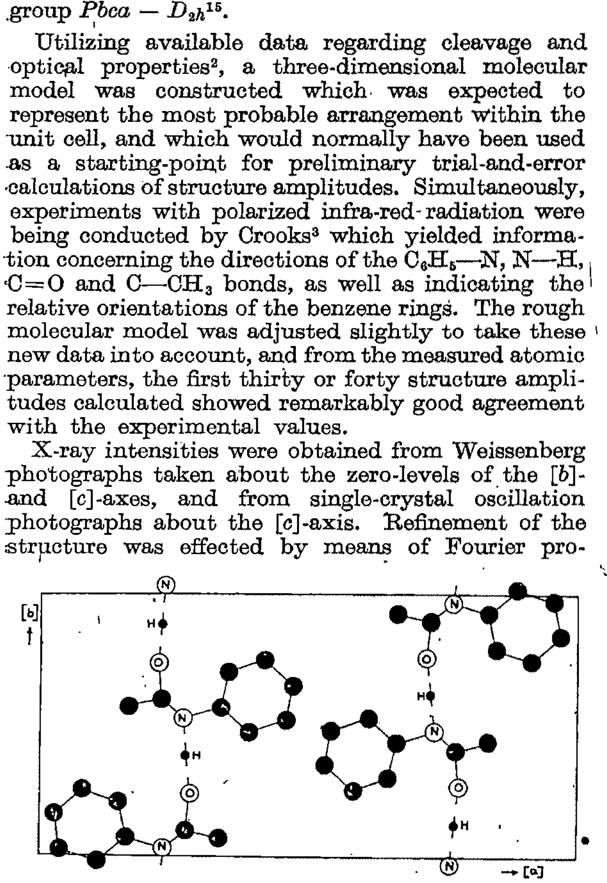
Crystal Structure of Acetanilide: Use of Polarized Infra-Red Radiation

THE crystal structure of acetanilide has been determined[1] by classical X-ray diffraction methods, making use of information derived from polarized infra-red radiation technique as a time-saver in the trial-and-error process. The crystals from water or ethanol vary in form from plates {100} to truncated bipyramids {111}, but growth from the molten state results in acicular crystals, elongated along [*b*] and tabular on (100). The orthorhombic unit cell contains eight molecules and has dimensions:

[*a*] = 19·50, [*b*] = 9·46 and [*c*] = 7·96 A.; space group $Pbca - D_{2h}^{15}$.

Utilizing available data regarding cleavage and optical properties[2], a three-dimensional molecular model was constructed which was expected to represent the most probable arrangement within the unit cell, and which would normally have been used as a starting-point for preliminary trial-and-error calculations of structure amplitudes. Simultaneously, experiments with polarized infra-red radiation were being conducted by Crooks[3] which yielded information concerning the directions of the C_6H_5—N, N—H, C=O and C—CH_3 bonds, as well as indicating the relative orientations of the benzene rings. The rough molecular model was adjusted slightly to take these new data into account, and from the measured atomic parameters, the first thirty or forty structure amplitudes calculated showed remarkably good agreement with the experimental values.

X-ray intensities were obtained from Weissenberg photographs taken about the zero-levels of the [*b*]- and [*c*]-axes, and from single-crystal oscillation photographs about the [*c*]-axis. Refinement of the structure was effected by means of Fourier projections on (010) and (001) and by means of appropriate lines and sections of a three-dimensional synthesis, with the result that the phases of about three hundred structure amplitudes are now known with certainty. The structure is depicted in the accompanying diagram; bond-lengths appear to be within the accepted values; the length of the hydrogen bond distance N—H—O is 2·9 ± 0·1 A. It is hoped that further refinement will be carried out later; but since this is by no means certain, the following list of co-ordinates is here placed on record.



ARRANGEMENT OF MOLECULES IN UNIT CELL BETWEEN $z = 0$ AND $z = 1/2$. THE OTHER FOUR MOLECULES IN THE CELL MAY BE OBTAINED BY REFLECTING THESE FOUR ACROSS THE PLANE $y = 1/4$ AND GLIDING THEM *c*/2

	X	*Y*	*Z*
C_1	0·16	0·07	0·12
C_2	0·11	0·98	0·17
C_3	0·04	0·02	0·14
C_4	0·03	0·16	0·06
C_5	0·08	0·25	0·01
C_6	0·15	0·21	0·04
N	0·23	0·03	0·15
C_7	0·27	0·10	0·25
O	0·28	0·24	0·30
C_8	0·33	0·07	0·29

The use of polarized infra-red radiation promises to be of great assistance in crystal structure determinations, but further trials with more complex substances will be necessary before a full assessment of its value can be made. It is probable that the infrared technique will require further development so that small single crystals may be used. In some work with crystals containing water of crystallization it has been found that strong water-bands tend to obscure that part of the spectrum which would yield most information, but it is expected that more complete polarization would enable this difficulty to be overcome. In a crystal where several similar bonds are distributed in different directions, it may not prove possible to analyse the results adequately without a considerable increase in sensitivity of the infrared apparatus.

C. J. BROWN
D. E. C. CORBRIDGE

Research Laboratories,
Imperial Chemical Industries, Ltd.,
Hexagon House,
Manchester 9.
March 22.

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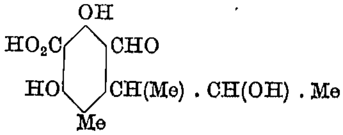
[3] Crooks, D. A., *Nature*, 160, 17 (1947).

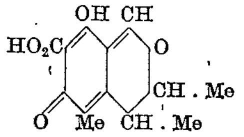
Structure of Citrinin

IN view of the recent communication on this topic by Cram[1] to the editor of the *Journal of the American Chemical Society*, we wish to record that in the course of an extensive investigation on the chemistry of citrinin initiated in these laboratories in 1945, the synthesis of 4-methyl-5-ethylresorcinol[2], m.p. of anhydrous material 94–95°, was effected in 1946, and the orientations of the two isomeric phenols '*A*' and '*B*' $C_{11}H_{16}O_3$ afterwards established. From these results, *inter alia*, together with a study of the degradation products of methylated citrinin and of dihydrocitrinin and its ether, evidence has accumulated which leads to the conclusion that citrinin in all probability is best represented by the expression (II).

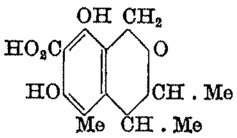
The claims of competing structures, including those of the quinol (*cyclo*hexadienolone) type, have been considered; but so far as our evidence goes it would seem that formula (II), which is an anhydro



I



II



III

form of (I), most satisfactorily explains (*a*) the ready aromatization of the compound in warm acid or alkaline media with the extrusion of formyl (as formic acid) and carboxyl (as carbon dioxide) groups; (*b*) the formation of formic acid and not formaldehyde or glyoxylic acid on the ozonolysis of citrinin and its ester; and (*c*) the formation of a stable dihydro derivative (III) with simultaneous aromatization. The structure (III) ascribed to the latter compound is in agreement with its blue ferric reaction, which is characteristic of γ-resorcylic acids. On the basis of formula (II), the phytochemical formation of citrinin may conceivably proceed by way of the intermediate (I).

It would seem that the claim by Cram[1], that the isolation of authentic 4-methyl-5-ethylresorcinol from citrinin completely eliminates the formula proposed for the latter by Robinson *et al.*[3], can scarcely be sustained at present. The above formula retains the original suggestion of a hemi-quinone type of kernel.

J. P. BROWN
N. J. CARTWRIGHT
A. ROBERTSON
W. B. WHALLEY

Department of Organic Chemistry,
University, Liverpool.

[1] Cram, *J. Amer. Chem. Soc.*, **70**, 440 (1948).

[2] Compare Brown, M.Sc. Thesis, May 1947, University of Liverpool.

[3] Robinson *et al.*, *Phil. Trans. Roy. Soc.*, B, **220**, 297 (1931).

Nitration of Simple Heterocycles

IN a recent letter in *Nature*[1], Schofield and Swain comment, *inter alia*, upon the failure of resonance theory to explain non-nitration of *iso*quinoline in position 7: the following results may be of interest.

In the course of work in these laboratories we have been led to investigate the nitration products of 3 : 4-dihydro*iso*quinoline derivatives and have found, for example, that 1-*p*-nitrophenyl-3 : 4-dihydro*iso*quinoline gives an 80 per cent yield of the 7-nitro derivative, this structure being proved by comparison with the product of cyclization of N-*p*-nitrobenzoyl-2-(4′-nitrophenyl)ethylamine. On the other hand, 1-*p*-nitrophenyl*iso*quinoline yields 85 per cent of 1-*p*-nitrophenyl-5-nitro*iso*quinoline, identified by conversion to 1-*p*-chlorphenyl-5-chlor-*iso*quinoline and comparison with a synthetic sample. Such substitution in the *iso*quinoline ring may be compared with that of quinoline which is nitrated in the 5 and 8 positions, whereas tetrahydroquinoline has been shown to nitrate in position 7 [2], a result compatible with expectation since *o*-toluidine yields 4-nitro-2-aminotoluene[3]. Similarly, *iso*quinoline is nitrated principally in the 5 position with a small proportion of the 8-isomer[4]. Nitration of reduced *iso*quinoline has escaped attention, and investigation of the products of nitration of 3 : 4-dihydro- and 1 : 2 : 3 : 4-tetrahydro*iso*quinoline is now being undertaken, when we expect to isolate the 7-nitro derivatives in accordance with the above result and by comparison with the nitration of *o*-cyantoluene, which yields 4-nitro-2-cyantoluene[5], and of 2-phenylethylamine, which has been shown to give 45 per cent of the para and 18 per cent of the meta isomer[6]. Results will be reported in detail elsewhere.

We wish to thank the directors of May and Baker, Ltd., for permission to publish these results.

DAVID W. MATHIESON
A. MCCOUBREY

Research Laboratories,
May and Baker, Ltd.,
Dagenham, Essex. May 5.

[1] *Nature*, **161**, 690 (1948).

[2] Hoffmann and Königs, *Ber.*, **16**, 736 (1883). v. Braun, Grabowski and Rawicz, *Ber.*, **46**, 3173 (1913).

[3] Noelting and Collin, *Ber.*, 17, 265, 268 (1884).

[4] Andersag, *Chem. Zentr.*, 1, 3595 (1934).

[5] Landsberger, *Ber.*, 31, 2880 (1898).

[6] Ehrlich and Pistschimuka, *Ber.*, 45, 2431 (1912).

Production of Quinolyl and Pyridyl Anions during Decarboxylation

IT has been shown[1,2] that when picolinic and quinaldinic acids are decarboxylated in the presence of aldehydes and ketones, α-pyridyl and α-quinolyl carbinols of the type Py(Qy).CH(OH).*R* are produced in good yields (40–80 per cent). The course of this reaction has been formulated in terms of the intermediate formation of α-pyridyl and α-quinolyl anions, which are formally of cyanide ion type[1,3]. The possibility that the cyanide function might by conjugation be extended to the γ-position has been confirmed recently by Mislow[3], who has obtained γ-pyridyl diphenylcarbinol by the decarboxylation of *iso*nicotinic acid in benzophenone. We now report that we have prepared γ-quinolyl diphenylcarbinol, m.p. 247°, from cinchoninic acid and benzophenone in yields of 7–10 per cent; we are developing the reaction as a possible route to quinine analogues.

We also find that, in the presence of decarboxylating quinaldinic and picolinic acids, it is possible to exchange the alkoxy groups of esters for pyridyl and quinolyl groups and to effect substitution by these groups at cationoid (electrophilic) centres in aromatic molecules; we take this to confirm our view that quinolyl and pyridyl anions are produced during the decarboxylation process.

B. R. BROWN
D. LL. HAMMICK
B. H. THEWLIS

Dyson Perrins Laboratory,
University, Oxford. April 15.

[1] Dyson and Hammick, *J. Chem. Soc.*, 1724 (1937).

[2] Ashworth, Daffern and Hammick, *J. Chem. Soc.*, 809 (1939).

[3] *J. Amer. Chem. Soc.*, 69, 2559 (1947).

Ecology of Sponges

THE statement has often been made that sponges can be found growing almost up to high-tide mark. As a result of close observation over miles of shore in a dozen different localities on the south and west coasts of Britain during the past twelve months, I have no hesitation in saying that only exceptionally are sponges found above mid-tide level. Even then, the most to be seen are a few undersized specimens of *Hymeniacidon perlevis* (= *H. sanguinea* Auctt.) in damp sheltered crevices protected from swirl and direct sunlight; and these are no more than a foot above mid-tide.

The second current statement proved to be false is that sponges are capable of surviving considerable desiccation. Careful observation shows that rarely are they found growing where there is no drip, or where they are not overhung with seaweed. I have found a few specimens of *H. perlevis* exposed to the strong rays of a spring sun. After exposure of two hours or more, between the ebb and flow of the tide, they have appeared dry and the surface shrivelled. The following day they have appeared completely regenerated. By marking such specimens and inspecting them at intervals, the following sequel has been established. They can appear regenerated after several such exposures; but in due course they disintegrate by stages, and after a month, instead of a sponge 50 mm. square, there are found a few small growths each about 5 mm. across. In two to three months time, depending on the amount of sunshine, even these feeble residues are gone.

The third, oft-repeated, fallacy is that sponges have no enemies apart from the nudibranchs that feed on them. I have often found *Patella, Littorina littorea* and *L. obtusata* on sponges, and have found their stomachs to contain spicules. At least two other gastropods are suspect. *L. obtusata* feeds more particularly on *Grantia compressa* and can often be found on it with its mouth closely fixed on the rim of a large hole in the wall of the sponge. There is sufficient circumstantial evidence for the view that these holes, commonly found in the sides of *Grantia*, are entirely the work of *Littorina obtusata*.

The fourth fallacy is that *Halichondria panicea* is the sponge most commonly found on the shore. *Hymeniacidon perlevis* grows higher up the beach and is more abundant; but because it is usually tan, or a dull brick-red, as against the conspicuous green or yellow of *Halichondria*, it is less readily seen. In some places it is a hundred times more plentiful, bulk for bulk, often twenty times, and, at a rough but conservative estimate for all British coasts, not less than ten times as plentiful. This last low average allows for any occasional restricted areas there may be where *Halichondria* is as abundant, or slightly more abundant, than *Hymeniacidon*, and of which I have not had experience.

Finally, there is clear evidence of a zoning of sponges. From mid-tide level there is usually (in my experience, always) a zone of *Hymeniacidon perlevis*. This gives place, at a depth varying with local circumstances, to a mixed *Hymeniacidon perlevis–Halichondria panicea* zone, extending approximately to the shallowest low-water neaps. In this zone, but of sporadic occurrence, may be found *Sycon ciliatum, Leucosolenia coriacea* and *L. complicata*. The next zone contains predominantly *Grantia compressa*, with scattered *Hymeniacidon, Halichondria, Sycon*, and the two species of *Leucosolenia*, rarely anything else. The *Grantia* zone is bounded roughly by the shallowest and deepest low-water neaps. In the last zone, of the low-water springs, we find the richest crop. Here thirty or more species may occur, including those already mentioned for the first three zones.

This zoning, although like all zoning it is not absolutely invariable, is sufficiently consistent to serve as a working guide. To the experienced eye it is a good enough (the word infallible might almost be used) index to the state of the tide.

The fallacious ideas referred to above may individually seem unimportant; but in any study of the ecology of sponges they can, if not corrected, lead badly astray.

MAURICE BURTON

Department of Zoology,
British Museum (Natural History),
London, S.W.7. April 2.

Neurotic Behaviour in Ants

WHILE investigating ant learning with maze apparatus, behaviour was observed in one individual which is similar to that described by Cook[1] and Maier[2] as psychopathic or 'neurotic' behaviour in rats. What are thought to have been early symptoms of similar behaviour were later observed in a virgin female of the same colony of *Formica fusca* Latr.

The particular worker ant concerned was one of several which had already several times successfully completed this maze. On completion of the run, the ants were normally picked up in the experimenter's fingers (an act to which they were habituated and against which they did not struggle) and returned to the observation nest in which they were kept; that is, in effect, to their fellow-workers and a female which was at that time laying eggs.

On this occasion the worker ant had already successfully run the maze almost immediately after being placed in the starting chamber, making few errors and quickly correcting those which it did make. It was then placed back in the nest; but about five minutes later was once more taken from the nest and replaced in the starting chamber. It at once exhibited slight jerking movements of the legs and antennæ, but soon commenced to run the maze, moving very quickly and without error or returning, until halfway through, when it missed one of the solution-turns and followed an error-path until it reached its blank end. At first it made no movement back along the error-path, but with rising physical excitement and an increasing jerking of the limbs and antennæ constantly touched the three glass sides of the maze in the immediate vicinity of the blank end. After about a minute it returned along the error-path until near its commencement, where for a few seconds it remained standing while exhibiting constant and increasing limb and antennæ jerking. It then turned until facing down the error-path, and still jerking moved with a staggering motion backwards (the limb-jerking, which appeared to be completely out of its control, made ordinary movement a matter of difficulty) and almost at once commenced to circle, still backing, in a small area of the intersection of the tracks. The rapidity of the circling increased and the jerking became even more pronounced, and a few seconds later the ant was rescued, since it was, for other reasons, of experimental value. It was quiescent while held firmly in the experimenter's fingers, but was placed under a tap of cold running water for about ten seconds before being returned to the nest. In the nest it still exhibited slight tremors of the legs and antennæ, but soon ran about normally. On the next day the ant ran the maze successfully with some errors, but no sign of its earlier behaviour. On one following occasion, however, it showed pronounced jerking movements of limbs and antennæ after making the same error, and commenced trying to clean itself. It was, however, at once rescued and returned to the nest. This particular individual is one of the most active workers of that particular colony, and also proved to be among the three workers of the colony (which consisted of 23 workers and two females) which were most successful at maze-learning.

A virgin female which was originally taken from the same colony but which had been isolated for nearly two months exhibited similar marked jerking movements of antennæ and legs on being placed in a strange plaster nest (she had previously been in a glass one containing earth). These movements soon stopped, however, when another virgin female was placed in the nest with her about one minute later.

I know of no previous records or accounts of similar behaviour in ants.

DEREK WRAGGE MORLEY
Institute of Animal Genetics,
West Mains Road, Edinburgh.

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[1] Cook, S. W., *Psychosom. Med.*, 1, 293 (1939).

[2] Maier, N. R. F., "Studies of Abnormal Behaviour in the Rat" (New York: Harpers, 1939).

Distribution of Lugworms

ON the muddy sand of the Whitstable flats the casts made by the large population of *Arenicola marina* L. do not appear to be distributed in random manner at all times of the year. During the summer months there are straight lines, a foot or two wide, along which the casts, and very probably the worms, are more numerous than they are on the adjacent parts of the shore. There is no mistaking these lines, which appear clearly in photographs of the shore. They may be a hundred yards long and are apparently arranged in all directions, being neither all parallel with, nor all at right angles to, high or low tide marks.

We have been unable satisfactorily to account for this grouping; but a few preliminary tests suggest that the layer of soil worked by the worms and which overlies the clay substratum is deeper along the lines than on either side of them. We have not yet been able to discover what is the cause of the difference in soil depth.

We should be very interested to hear if this grouping phenomenon has been noticed on other *Arenicola* shores and we should be grateful if anyone who has observed it would write to us, especially if he has any explanation to offer.

G. E. NEWELL
GARTH CHAPMAN
Department of Zoology, Queen Mary College,
Mile End Road, London, E.1.
June 2.

Life-History of *Splachnidium rugosum*

THE peculiar brown alga, *Splachnidium rugosum*, has been a subject for investigation on a number of occasions. Early workers considered that it should be classed with either the Laminariales or the Fucales. In 1920, Skottsberg[1] pointed out that the resemblances to those orders were more apparent than real and that its proper position should be near to the Chordariaceæ. Skottsberg went on to suggest that there should be a sexual generation, as he considered the commonly known plant to be asexual, reproducing by zoospores from sporangia borne in the conceptacles.

I have spent some time investigating the life-history of this alga, and I can now confirm Skottsberg's suggestions. The sporangia, which are unilocular, give rise to numerous swarmers which do not fuse and must therefore be zoospores. These swarmers settle down and germinate to give a dwarf, microscopic, branched, filamentous thallus so characteristic of many members of the Ectocarpales and allied orders. This thallus, which is presumably the gametophyte, has been maintained in culture now for more than a year: so far, however, no gametangia have been produced.

The account will be published later in full elsewhere. I wish to express thanks to Prof. V. J. Chapman for his advice during the course of this investigation.

R. J. HOPKINS
Botany Department, University College,
Auckland, New Zealand.
April 20.

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[1] Skottsberg, C., *Svensk. Bot. Tid.* (1920).

A Method of Distinguishing between Young and Old Colorado Beetles

PREVIOUS records do not appear to give any indication of how to distinguish between young and old Colorado beetles, except during the first few days following the emergence of the young beetle. I have found evidence that it is possible to separate young and old beetles for a period of at least fourteen days after the emergence of the young adult by means of colour changes in the membranous wings. This fact is of considerable practical importance and assistance to entomologists, especially in countries where the beetle has not yet become an endemic pest.

Trouvelot states (private communication, 1946) that it is only possible to distinguish between young and old beetles for several days after emergence, (1) by the fact that the chitinous integuments remain soft for the first two to three days, after which they become hard like those of the mature beetle, and (2) by the fact that the yellow colour of the elytra takes several days to reach that bright hue so characteristic of the mature adult.

In looking for a more satisfactory method whereby young and old beetles could be separated for a longer period of time, I found the colour difference between the membranous wings of the freshly emerged and mature beetles was very marked, and appeared to remain distinguishable, although to a decreasing extent, for approximately fourteen days.

The membranous wings of the fresh emergent are transparent and devoid of colour, while those of the mature beetle are red except for the apex and anal border of the wing. The wings remain colourless for at least four to five days after emergence, and afterwards develop a pink colour which gradually deepens and diffuses over the greater part of the wing surface, especially along either side of the nervures, until the pink colour has given place to a distinct red hue. On an average it takes fourteen to twenty days for the colour intensity to equal that of the mature beetle. This colour change is probably due to the carotene absorbed by the beetle when it commences to feed. Therefore the period taken for the wing to reach the maximum colour intensity will vary within certain limits, according to the temperature and intensity of feeding.

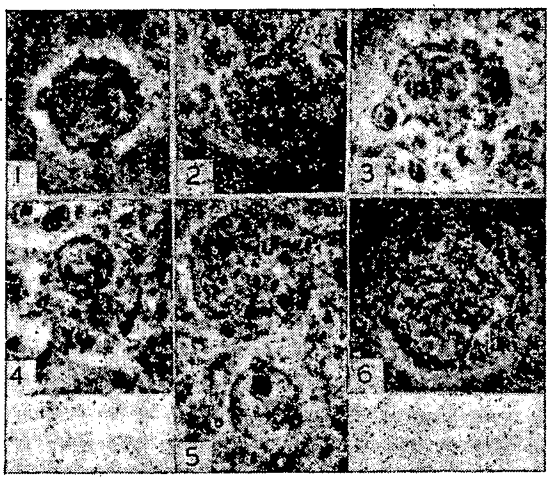
It is hoped to publish fuller details of these findings at some future date.

E. DUNN
(States Entomologist)
States Experimental Station,
Trinity, Jersey.

GOLGI APPARATUS OF LIVING HUMAN TESTICULAR CELLS SEEN WITH PHASE-CONTRAST MICROSCOPY

By A. G. OETTLÉ
Medical School, University of the Witwatersrand, Johannesburg

It was pointed out previously that in the unstained living human spermatid the Golgi apparatus is sometimes discernible with bright-ground illumination, as an area slightly differing in refractive index from the remainder of the cytoplasm[1]. Recently, I have been able to confirm and extend these observations with the phase-contrast microscope. This instrument was of the phase-accelerating or positive type, so that dark and light regions in the image indicated higher and lower refractive indices, as a rule.



FIGS. 1–6 ARE UNRETOUCHED PHOTOMICROGRAMS OF LIVING HUMAN TESTICULAR CELLS TAKEN WITH A COOKE PHASE-CONTRAST SYSTEM, OBJECTIVE N.A. 1·30, MAGNIFICATION × 1,000, KODAK CONTRAST PROCESS ORTHO FILM. TRACINGS OF THESE FIGURES ARE GIVEN ON THE RIGHT AND INDICATE IN ADDITION STRUCTURES REVEALED BY CHANGE OF FOCUS

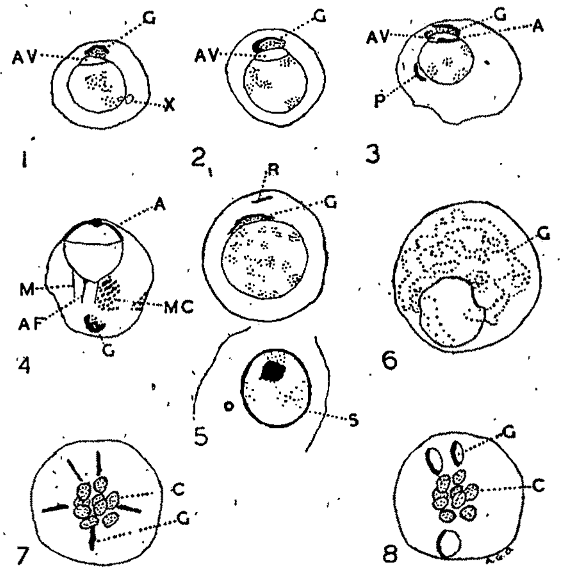
Figs. 1–4. Spermatids. Fig. 5. Primary spermatocyte and Sertoli cell. Fig. 6. Interstitial cell

Fresh testicular tissue was obtained from a European aged twenty-nine, at operation, and three Bantu, two aged twenty-eight and one aged twenty-three, less than half an hour after sudden and violent death. The biopsy specimen was preserved in plasma and also in Ringer–Locke solution, and the post-mortem material in pericardial fluid. Examination of the teased cells began within two or three hours after removal and extended over a period of ten hours.

In the earliest spermatids (Figs. 1 and 2), with phase-contrast microscopy, the acrosomal vacuole appears as a clear hemispherical space, slightly indenting the nuclear membrane. External to this lies a smaller dark hemisphere composed of a darker cortex and a lighter medulla. In some spermatids this cortex forms a continuous rind; in others it is interrupted and seems to consist of separate segments (Fig. 3). In older spermatids, the acrosomal granule and acrosomal cap can be seen within the acrosomal vacuole (Fig. 3). This vacuole gradually diminishes in size and, simultaneously, the dark bilaminar hemisphere comes to lie on its margin. In still later stages (Fig. 4), the acrosomal vacuole can no longer be seen, and the dark body, still composed of cortex and medulla, can be found lying free in the cytoplasm caudal to the nucleus, outside the area enclosed by the manchette.

Near the posterior region of the nucleus of the early spermatids, another dark cytoplasmic body is often evident (Fig. 3). This is probably identical with the postnuclear body. It has roughly the same size as the bilaminar structure already described, but it may be differentiated from it by its situation and the absence of two distinct zones.

It is relatively certain that the dark bilaminar body described in the spermatid is identical with the structure usually regarded as the Golgi apparatus in fixed tissue impregnated with silver or osmium tetroxide[2]. The body seen in living spermatids resembles the Golgi apparatus of impregnated spermatids in size, situation and behaviour, and such morphological differences as may be observed can quite easily be explained by known effects of impregnation[3].



FIGS. 7 AND 8 ARE DRAWINGS OF A SINGLE DIVIDING PRIMARY SPERMATOCYTE. FIG. 8 WAS DRAWN FOUR HOURS AFTER FIG. 7. *A*, acrosome and acrosomal granule; *AF*, axial filament; *AV*, acrosomal vacuole; *C*, chromosomes; *G*, structures presumed to be identical with the Golgi apparatus; *M*, manchette; *MC*, mitochondria; *P*, presumed to be the post-nuclear body; *R*, rodlet; *S*, Sertoli cell; *X*, artefact, an extra-focal image of an extracellular granule

In testicular cells other than spermatids definition of the Golgi apparatus is difficult, since in these cell types it presents fewer distinctive characteristics. A Golgi element was not recognized in the few secondary spermatocytes examined, nor in cells undergoing second meiotic division. Near the nuclear membrane in primary spermatocytes (Fig. 5) a dark crescentic structure was observed, in which a dark cortex and thin inner medulla could sometimes be distinguished. In addition, a single straight rodlet was often visible in the cytoplasm. This rodlet may be an isolated dictyosome. In several cells undergoing the first meiotic division a number of similar rodlets were observed, lying outside the spindle area, quite distinct from the chromosomes. In one cell in Ringer–Locke solution these rodlets were first observed at the sixth hour after removal (Fig. 7). Four hours later the cell was found to contain several lenticular vacuoles, each bearing a distinctly curved rodlet on one side (Fig. 8), very like dictyosomes. It is not certain that these are Golgi bodies, but they were quite unlike astral rays or mitochondria.

In the unstained spermatogonium the Golgi apparatus could not be satisfactorily distinguished from mitochondria, though occasionally a crescentic body like that of the primary spermatocyte was present. The Golgi element was not observed in living Sertoli cells.

In interstitial cells there was no evidence of a dark Golgi element; but a 'canalicular' network ramified through the cytoplasm (Fig. 6). This network is larger than the Golgi apparatus of impregnated interstitial cells, but has a remarkable similarity to the 'negative Golgi' which sometimes is produced in silver impregnations.

We may conclude, therefore, that with phase-contrast microscopy, in living testicular cells, structures are revealed which resemble the Golgi apparatus of impregnated cells. It would seem that no constant structure can be assigned to the Golgi element: it may appear as straight or curved rodlets, bilaminar crescents, or as a reticulum, depending on cell type.

Finally, it must be remembered that, invaluable as the phase-contrast method is in the study of living cells, interpretation of appearances will require experience and understanding, since spurious images are common (Fig. 1).

I am indebted to Dr. Jonathan Gluckman for the loan of the Cooke phase-contrast microscope used in these studies.

[1] Oettlé, A. G., *S. Afr. J. Sci.*, **37**, 239 (1940).
[2] Gatenby, J. B., and Beams, H. W., *Quart. J. Mic. Sci.*, **78**, 1 (1936).
[3] Baker, J. R., *Quart. J. Mic. Sci.*, **85**, 1 (1944).

PERMEABILITY OF THE MEMBRANES OF THE HEN'S EGG

By Prof. N. KLISSIUNIS

Biochemical Section, School of Hygiene, Athens

Permeability to electrolytes. Under normal conditions the membranes of plant cells are impermeable to electrolytes. But under abnormal conditions (transfer to solutions of pure electrolytes) the electrolytes can pass through (deplasmolysis). In this connexion, if one compares solutions of different electrolytes, one can observe that they follow the Hofmeister series. The series in which the hypotonic solution of electrolytes can cause hæmolysis of the red corpuscles is the same as the Hofmeister series. We have examined these conditions, using hen's egg membranes. According to the experiments of A. Orru[1], the permeability of the vitelline membrane to water was influenced by hydrogen and hydroxyl ions and by the presence of different electrolytes, and that complex ions can pass through as well.

We have examined fresh hen's eggs only a few hours old. In order to establish the permeability of the vitelline membrane to different neutral potassium salts, iso-osmotic solutions were prepared from potassium oxalate, phosphate, sulphate, chloride, bromide, iodide and thiocyanate at − 1·45° C. of an approximate strength of 0·4/mol. The yolk of the egg, contained within an unbroken membrane, was placed in a flask and washed thoroughly with distilled water. 115 ml. were used to form the iso-osmotic solution for each experiment.

At the beginning of each experiment 15 ml. of the solution were extracted from the bottle for the examination of the content in anions of the salt. The bottle was kept throughout in a refrigerator at + 6° C. 5 ml. were taken from the bottle at forty-eight hours and after four days to determine if any fixation of anions had taken place through the yolk. By subtracting the values, which were found after forty-eight hours and four days, from the values of anion obtained at the beginning of the experiment, we could calculate the quantity fixed through the yolk. Also we found that albumin emerges from the yolk when this is in an electrolyte solution. This quantity of albumin was determined in the outer solution. To each 5 ml. of samples that were taken out of the flask, 1 ml. of 20 per cent trichloracetic acid was added. The filtered albumin precipitate was washed until the filtrate showed no detectable traces of the anion under test. The albumin precipitate was then dried at 105° C. and weighed. The determination of chloride, bromide, iodide and thiocyanate in the filtrate was carried out by precipitation methods. The sulphate was determined by the benzidine method, the oxalate through the oxidation method. For examination of permeability outwards the yolk was placed in 100 ml. of distilled water. The flask was also kept at a temperature of + 6° C. The chemical examination of the outer liquid after one, two and twenty-four hours has proved that the albumin reaction with sulphosalicylic acid and the reaction for chloride with silver nitrate was positive and had become far more positive twenty-four hours afterwards. For examination of the permeability of the cuticle we filled the shell with 20 ml. of a cold saturated solution of potassium ferrocyanide and we placed this shell in a cold saturated ferri-ammonium sulphate solution.

The volume of the yolk was increased in the iodide, thiocyanate and oxalate solution. Sometimes a bubble developed full of the liquid in the upper pole of the yolk and the yellow substance was repelled. The outside solution became either yellow or remained clear. The vitelline membrane after remaining for eight days in the potassium iodide solution became harder and split with difficulty. The internal substance became much more viscous. The fixation of anions in the yolk followed the Hofmeister series. The iodides were more fixed than their place in the Hofmeister series would allow. The oxalates were also more fixed, perhaps by damage of the membrane caused by calcium precipitation (see accompanying table). The diffusion of potassium ferrocyanide through the cuticle placed in a ferri-ammonium sulphate solution led to the formation of Prussian blue spots corresponding to the outer exits of the air tubes of the cuticle.

Anion	Anion fixed gm. % ml. 48 hours	Anion fixed gm. % ml. after 4 days	Albumin gm. % ml. 4 days
Oxal.	0·35	0·42	3·0
SO_4	0·04	0·12	0·49
PO_4		0·11	1·34
Cl	0	0·06	0·19
B_2	0·08	0·13	0·14
I	0·25	0·22	0·33
SCN	0·07	0·11	0·99

Permeability to electrolytes in the presence of narcotics. In these experiments, which were made chiefly with potassium iodide, the same materials and methods were used as in the above, the only difference being that the outer solution instead of being pure salt solution was saturated with a narcotic. If we compare the above results with the pure potassium iodide solution and those with the same solution saturated with a narcotic, under the above-mentioned experimental conditions, we do not find significant differences in the fixation of iodine through the vitelline membrane. The differences found are within the range of the individual variations in the permeability of the vitelline membrane of different eggs. In the case of the albumin, in some of the above experiments but not in all, more of it was found in the outer solution than in an experiment with a pure water solution of the salt.

Thanks are due to Prof. Joachimoglu for advice during these investigations.

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[1] Orru, A., *Biol. Abstr.*, 14, 2, 211 (1940); *Chem. Zentralbl.*, 1, 534 (1941); 2, 1462 (1940).

EXCAVATIONS OF A ROMAN HOUSE

DR. FELIX OSWALD has now carried further the story of his years of excavation at Margidunum*. So little remained of the buildings of the first-century camp after the Roman demolitions in Hadrian's reign that at first the excavator seemed faced with a hopeless task; but by the painstaking investigation of every foot of the area concerned, down to the level of the undisturbed subsoil, the greater part of the plan of a building identified as the Commandant's House was revealed. Unfortunately, the eastern rooms of this house lie beneath the Fosse Way, which crosses the centre of the camp at this point, and possibly a hypocaust may lie buried here, as none was found elsewhere.

The usual sequence of two buildings, one of timber and one of stone, was found, the first dating from the time of the foundation of the camp by Ostorius Scapula in A.D. 48, and destroyed during the Boudiccan rebellion, and the second erected, after the lapse of a few years, during the reign of Vespasian or Titus, and remaining in use until the end of the occupation of the camp. The surviving post-holes were too few for the plan of the timber building to be recovered, but the plan of the later house is of a type allied to that of houses known from other forts, and several of the plans of these are illustrated, drawn to the same scale for purposes of comparison. Stables may have existed to the north of the house, and an interesting feature is a pit contemporary with the timber building, which in view of a parallel at Hofheim, the excavator thinks may have been used for preserving oysters in salt water.

The major part of the report is devoted to the description, discussion and illustration of the pottery found on the site. The Terra Sigillata showed no very unusual features; but among the coarse wares of the earliest phase (Claudius–Nero), a large store-jar with an impressed stamp of three stars above two rosettes on its lower half was an unusual discovery, and it is suggested that this may indicate a measure of quantity. The coarse ware of the succeeding phases shows considerable development, and includes frequent imitations of Terra Sigillata forms. Evidence was also found showing that some of the pottery of Vespasianic date was made at the Castor potteries. Any discoveries which help to tie down the dating of the products of these potteries are of particular interest owing to their increasingly wide-spread distribution. Altogether this report makes important additions to the mass of valuable comparative material with which Dr. Oswald has already provided us.

* The Commandant's House at Margidunum. By Dr. Felix Oswald. Pp. 41 (17 plates). (University College, Nottingham, 1948.) 7s. 6d.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS, 1948

AT the invitation of the Mayor and the Corporation of Great Yarmouth, and with the co-operation of the Great Yarmouth Naturalists' Society, the South-Eastern Union of Scientific Societies held its fifty-third annual congress during June 14–19 at Great Yarmouth, under the presidency of Mrs. Jacquetta Hawkes. The Mayor, in his welcome to the Congress at the Town Hall, where accommodation was provided for meetings by the Corporation, said that those who were not versed in 'old buildings' could not appreciate the beauty of them, and that societies such as he was addressing opened the eyes to the reasons why such old buildings as those on the South Quay at Yarmouth should be preserved. Capt. Dannreuther inducted the president, and congratulated her upon being the first lady to hold the office since the foundation of the Union more than fifty years ago.

Mrs. Hawkes, in delivering her address upon "Archæology and the Present", said that two world wars had disturbed the faith in the certainty of progress in a way resembling the questioning of the story of Genesis by the theory of evolution. She believed that archæology provides a sense of comfort by comparisons, such as life in a palæolithic cave with life at Versailles or the compositions of Beethoven. The popularity of the subject is perhaps due to the solace obtained from the study of the solidity of the past compared with the flimsiness of the present and the uncertainty of the future. An education based on classical studies has been a great force in Britain, and it is of utmost importance to salve what is valuable and to adapt it to the changing conditions. Archæology can play its part by saving classical studies from exclusiveness and isolation. It can add intimacy and humanity to the classics to make them acceptable to a greater number.

Mrs. Hawkes said she believes that if the archæological method, in the widest sense of the study of material things through all the periods, can become an accepted part of teaching, the distaste of people of all classes for vulgar architecture and badly designed utensils would lead to an improvement of our environment and thus to the general betterment of all. Archæology could display a vast array of cultures which would help us to decide how to search for new values and to teach us that mechanical gadgets are not essential to the fulfilment of valuable lives.

The Archæological Section of the Union was addressed by its president, Lieut.-Colonel S. E. Glendenning, on "Local Materials and Craftsmanship in Norfolk Buildings", and a paper on "Roman Britain as seen in the Yarmouth Neighbourhood" was read by Mr. P. E. Rumbelow, who also conducted an excursion to the Roman Station at Burgh Castle. Mr. H. J. Howard delivered the presidential address to the Botanical Section on "The Mycetozoa of Sanddunes and Marshland", and Mr. F. O. Whitaker's paper on "The Botany of the Cromer Forest Bed" was read. Joint excursions, with the Zoological Section, were conducted to Fritton Lake, Wheatfen Broad and Norwich.

The Geological Section elected Mr. C. D. Ovey as president, and his address was upon "Foraminifera in Stratigraphy with special reference to the Ecology of Living Forms". A paper was read on "The Geological and Archæological Problems of the Red Crag" by Mr. S. Hazzledine Warren, and Mr. J. E. Sainty gave a paper upon "The Geology of Norfolk". He also arranged and conducted successful excursions to the Norwich and Cromer areas in illustration of his views upon the formation of the district.

The Zoological Section's presidential address was given by Major Maxwell Knight on "The Study of Bird Pellets as a Subject of Interest and Instruction to Amateur Naturalists". A paper was read by Dr. Malcolm Smith on "Some Undetermined Points in the Life-Histories of the British Reptiles".

An evening conversazione was arranged by the Great Yarmouth, Lowestoft and Norwich Naturalists' Societies. A very successful Young Naturalists' evening was held at the Town Hall. Coloured Nature films, specially taken at the London Zoo by Mr. Douglas Fisher, were exhibited. The commentary on the first two, dealing with snakes, lizards, newts, frogs and toads, was given by Dr. Malcolm Smith, and that on the third, concerning the behaviour of the tarsier, was given by Major Maxwell Knight. The remainder of the evening was devoted to a naturalists' brains trust, the arrangements for which were in the capable hands of Major Maxwell Knight, who also acted as question master. His 'brains' were: Capt. T. Dannreuther, Mr. E. A. Ellis, Mr. David Seth-Smith and Dr. Malcolm Smith. Questions were selected from those sent in by schools in the area, a request having been made that they should be debatable rather than factual. Although admission was limited by the issue of tickets, more than a hundred additional young people got into the hall, which, besides giving encouragement to the organisers, should also give hope to those whose theme is the rejuvenation of the local natural history societies. The question master suggested to the delegates present that each of the seventy societies affiliated to the Union might, with advantage, arrange similar evenings.

After the general assembly, the discussion on "The Functions and Organisation of Local Societies", in continuation of that initiated by the British Association, was opened by Mr. G. Gosnell.

The next congress of the Union will be held at Canterbury during Easter 1949.

SMITHSONIAN INSTITUTION

ANNUAL REPORT

THE report of the Secretary of the Smithsonian Institution, Washington, D.C., for the year ended June 30, 1947, which includes reports on the newly established National Air Museum and on the Canal Zone Biological Area, recently placed under the administration of the Institution, records the resumption and, in some directions, expansion of much of the normal research and field-work suspended during the War. Accessions to the National Museum are back to pre-war levels, and the International Exchange Service has considerably reduced the accumulation of material for foreign exchange built up during the war years, and the service will soon be again on a current basis. The two greatest needs of the Institution are additional staff and more building space.

Under the Canal Zone Biological Area Advisory Board, a wide range of studies and tests has been carried out under tropical conditions. Those in progress include an extensive organisation for testing the proofing of wood to termites, the tropical deterioration of plywoods, textiles, and packaging containers, and the effect of fungi on optical glass. Some four hundred publications have been issued on research carried on here in entomology, forestry and medicine with special reference to the control of termites, fruit flies and mosquitoes.

Appended to the secretary's report is the Financial Report of the Executive Committee of the Board of Regents, as well as separate reports on the National Museum, the National Gallery of Art, the National Collection of Fine Arts, the Freer Gallery of Art, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park, the Astrophysical Laboratory, the National Air Museum, the Canal Zone Advisory Board, the library and publications.

The report from the National Museum refers to the resumption of investigations of fifteenth-century historic Indian village sites and some of the early Spanish settlements in the West Indies, to the continuation of the survey of the fishery resources of Guatemala, a botanical survey of St. Vincent, and to field work on the lower cryptogams as part of a biological survey of the Patuxent Research Refuge. Systematic researches under the Bureau of American Ethnology recorded during the year include the River Basin Surveys, aimed at recovering such archæological and palæontological information and materials as will be lost through the construction of dams and creation of large reservoirs in many of the river valleys of the United States. Papers prepared for publication deal with the State names of Mexico, the province names of Canada, and the detailed ethnographical description of the projecting rocks and islands off the coast of California, while a bibliographic project has been initiated having as objective the compilation of an annotated, fully indexed bibliography covering the descriptive, geographical and other scientific literature on the Arctic from the earliest historical writings to those of the present time. A roster of Arctic specialists is also being compiled which will afford a comprehensive record of the experience and specialized knowledge of scientific men, explorers, writers, and Arctic residents who possess first-hand information of value concerning the Arctic and sub-Arctic regions. A joint expedition with the National Geographic Society made an archæological survey of the Pacific coast of the State of Chiapas, Mexico, and the Viru Valley Expedition, attempted to survey thoroughly a single valley of the Peruvian coast as a living unit through some three thousand years, including archæological, geographical and modern community studies.

The report on the National Zoological Park, in addition to listing accessions during the year, gives a complete list of animals in the Park at June 30,

1947. At the Astrophysical Laboratory, the Division of Astrophysical Research has been concerned mainly with appraising the solar-constant values received from its field stations and planning and developing improvements in instruments and methods. Eighteen months of continuous measurement of sun and sky radiation have been completed at Camp Lee, Virginia, and the work is being extended to include measurements and exposures at a wet, sea-level and a dry, high-altitude station. The Division of Radiation and Organisms was concerned with the role of light, especially the wave-length effects on the fixation of carbon by green plants, and with the mechanism of dormancy in seeds sensitive to light and the study of the developmental physiology of grass seedlings. A critical review of the literature dealing with the germination of lettuce seed is in preparation, and studies are in progress on the identification of volatile substances responsible for inhibiting the germination of several species of seeds.

The report on publications lists the titles of twenty-six papers in the Smithsonian Miscellaneous Collection, twenty-two in the general appendix to the Smithsonian Annual Report, and three bulletins from the National Museum.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, July 12—Saturday, July 17

SOCIETY OF CHEMICAL INDUSTRY (at the Assembly Rooms, George Street, Edinburgh).—Annual General Meeting.

Wednesday, July 14

At 9.45 a.m.—Sir John Anderson, F.R.S.: "Science in relation to the Public Services".

Thursday, July 15

At 9.45 a.m.—Sir Robert Robinson, F.R.S.: "The Device of Imitation of Molecules in the Biological Field" (Lister Memorial Lecture).

Wednesday, July 14

ASSOCIATION OF OPTICAL PRACTITIONERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2 p.m.—Dr. Matthew Luckiesh: "Factors Concerned in Vision, Light and Seeing".*

Wednesday, July 14—Friday, July 16

PHYSICAL SOCIETY, ACOUSTICS GROUP (joint meeting with the ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 66 Portland Place, London, W.1), at 10 a.m. and 2.30 p.m. each day—International Conference on "Noise and Sound Transmission".

Wednesday, July 14

At 10 a.m. and 2.15 p.m.—"Sound Transmission".

Thursday, July 15

At 10 a.m.—Papers of Architectural Interest.

Friday, July 16

At 10 a.m.—"Measurement of Noise and Vibration"; at 2.30 p.m.—"Applied Acoustics".

Saturday, July 17

NUTRITION SOCIETY (in the Barnes Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 10.30 a.m.—Conference on "The Nutrition of Athletes".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSIOLOGY (Grade I or II)—The Secretary and Registrar, The University, Bristol (July 17).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (July 17).

UNIVERSITY LECTURER IN BOTANY, to lecture on Mycology or Mycological Plant Pathology—The Secretary, Faculty of Biology "A", Department of Zoology, Downing Street, Cambridge (July 17).

LECTURER IN PHARMACOLOGY—The Registrar, The University, Leeds 2 (July 17).

CHEMIST or PHYSICIST for testing of refractories, a PHYSICIST for physical work connected with gasworks practice, a CHEMIST or PHYSICIST for abstracting, collating and reporting from technical literature, and a CHEMIST to join research staff dealing with problems connected with gas manufacture—The General Manager and Secretary, City of Birmingham Gas Department, The Council House, Birmingham 3 (July 19).

LECTURER IN SURVEYING for Department of Civil Engineering—The Secretary; University College, Gower Street, London, W.C.1 (July 23).

SENIOR LECTURER IN MATHEMATICS in the Department of Aerodynamics—The Registrar, The College of Aeronautics, Cranfield Bletchley, Bucks, marked 'Senior Lecturer in Mathematics' (July 24)

LECTURER IN BIOCHEMISTRY for the Department of Physiology—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (July 26).

SENIOR LECTURER or LECTURER IN BOTANY for the University o Melbourne—The Secretary, Universities Bureau of the British Empire 8 Park Street, London, W.1 (July 31).

PROFESSOR OF BOTANY at Rhodes University College, Grahamstown, South Africa—The Secretary, Universities Bureau of the Britis Empire, 8 Park Street, London, W.1 (July 31).

ASSISTANT DIRECTOR OF RESEARCH with practical experience o computation to work in the Mathematical Laboratory, and a UNIVERSITY DEMONSTRATOR whose primary interest is statistics—The Secretary to the Appointments Committee, Trinity College, Cambridg (July 31).

SENIOR LECTURER or LECTURER IN ANATOMY (Histology)—Th Registrar, The University, Sheffield (July 31).

KEEPER OF ANTIQUITIES—The Director, Museum and Art Gallery New Walk, Leicester (August 30).

CHAIR OF APPLIED MATHEMATICS—The Registrar, Universit College, Southampton (September 20).

AGRICULTURAL EDUCATION ADVISER—The Secretary for Education County Buildings, Shrewsbury.

ASSISTANT LECTURER and DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Socia Science, Campden Hill Road, London, W.8.

CURATOR at the Municipal Museum—The Town Clerk, Town Hall Tunbridge Wells, Kent.

LABORATORY STEWARD at the College, Swindon—The Boroug Education Officer, Education Office, Civic Offices, Swindon, Wilts.

LECTURER IN BIOLOGY—The Clerk to the Governors, South-Eas Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex.

LECTURER IN BIOLOGY in the Senior Technical College—The Principal, Technical College, Luton, Beds.

LECTURER IN CHEMISTRY for Science Department, Municipa Technical College—The Director of Education, Education Offic St. Helens, Lancs.

LECTURER IN MATHEMATICS (male)—The Principal, Acton Technical College, High Street, Acton, London, W.3.

METALLURGIST to take part in investigations on casting of ingot and on ingot mould design and performance—The Personnel Office British Iron and Steel Research Association, 11 Park Lane, Londo W.1.

METEOROLOGICAL FORECASTERS for the East African and We African Meteorological Services—The Director of Recruitment (Coloni Service), 15 Victoria Street, London, S.W.1.

PHYSICIST or CHEMIST to undertake research on adhesional an related properties of rubber, and a PHYSICAL CHEMIST to undertak research on latex—The Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.

RESEARCH FELLOWSHIPS (2) IN EDUCATION, within the Institut of Education—The Secretary, The University, Edmund Stree Birmingham 3.

SENIOR ASSISTANT IN THE ENGINEERING DEPARTMENT, Coun Technical College, Wednesbury—The Director of Education (Dep F.E.), County Education Offices, Stafford.

SENIOR LECTURER in component and detail STRESSING OF AIRCRAFT STRUCTURES in the Department of Aircraft Design—T Registrar, The College of Aeronautics, Cranfield, Bletchley, Buck marked 'Senior Lecturer in Aircraft Stressing'.

TECHNICIAN FOR THE DEPARTMENT OF PHYSIOLOGY AND PHARMA COLOGY—The Secretary, St. Mary's Hospital Medical School, Paddin ton, London, W.2.

TIMBER MARKETING OFFICER by Government of Nigeria, Commer and Industries Department—Crown Agents for the Colonies, 4 Mil bank, London, S.W.1, quoting M/N/17860/3E.

LECTURER IN CHEMISTRY and a LECTURER IN PHYSICS—The Pri cipal, County Technical College, St. James's Road, Kingston-upo Thames, Surrey.

LECTURER IN CIVIL ENGINEERING—The Director, Robert Gordon Technical College, Aberdeen.

LECTURER IN MATHEMATICS and a LECTURER IN CHEMISTRY f Municipal Technical College—The Director of Education, Educati Offices, Library Street, Blackburn.

LECTURER IN MECHANICAL ENGINEERING—The Principal, Hand worth Technical College, Golds Hill Road, Handsworth, Birmingha 21.

LECTURER IN MECHANICAL ENGINEERING—The Principal, Technic College, Queen Street South, Huddersfield.

LECTURER IN PHYSICS—The Principal, Birmingham Central Tec nical College, Suffolk Street, Birmingham 1.

LECTURER IN PHYSICS—The Clerk to the Governors, Chelsea Pol technic, London, S.W.3.

SENIOR ASSISTANT LECTURER IN THE DEPARTMENT OF MECHANIC ENGINEERING—The Principal, Borough Polytechnic, Borough Roa London, S.E.1.

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Other Countries

Government of Palestine: Board of Scientific and Industr Research. Problems of Heat Physiology in Palestine. Report to t Colonial Medical Research Committee by Dr. W. S. S. Ladell. Pp. 100 mils; 2*s*. Survey of Literature on the Influence of Ions on Plan and Soils. Compiled by Dr. A. Mibashen. Pp. 46. 200 mils; 4 (Jerusalem: Board for Scientific and Industrial Research, 1948.) [1

NATURE

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ABBREVIATIONS

In one of those fanciful stories for children included in the "Just So Stories", Rudyard Kipling takes us in imagination back to Neolithic times and describes how an alphabet might have been devised. A stranger came upon a man and his small daughter, and the little girl thought she could send a message back to her mother by the stranger. Her message consisted of 'pictures' scratched on birch bark, but unhappily the pictures were completely misunderstood, with sad consequences for the stranger. As a result of this misadventure, the little girl started to draw signs to represent sounds, and in a short time with the help of her father produced an alphabet —it may seem curious that this alphabet should consist of the very letters used in modern English, but any other would clearly be pointless in a child's story written in English. Kipling must have realized when he wrote these two fascinating little stories, one showing the inadequacy of the picture language, and the other purporting to describe the origins of writing, the natural attraction of signs and symbols for children. The simplicity of the symbol in contrast with the complexity of a pictorial representation for conveying a message has always attracted children, and in these stories he gives the child struggling with the alphabet something tangible on which to base the written characters it is trying to recognize and reproduce.

The primary difficulties of spelling and writing simple words are normally overcome at an early age, and then comes a phase when they are used in play. 'Secret messages' become a feature of games, which very soon develop into the construction of simple codes, with all the delights of conveying information from one to another without their elders' understanding. The obvious development in the world of adults is the preparation and use of more elaborate codes for various purposes. Mention must also be made here of the anagrams adopted by the alchemists and other natural philosophers for concealing their results from all but the initiated. With the growth of knowledge the use of anagrams died out ; but what are we to make of the tendency in much modern scientific and other writing to sprinkle the page with symbols and abbreviations ? Has the pendulum swung back again ?

Going back to the child's delight in the use of 'secret messages', it is worth while recalling the pleasure with which many have learned the recognized symbols of the chemical elements, and delighted in their use with algebraic symbols to formulate chemical equations describing chemical reactions—alas, at first, many reactions which could never take place in man's chemical laboratories. But with this use of symbols came the warning of the careful teacher, that the symbols had a quantitative meaning, and while they might pass as abbreviations in private notes, they must not be used in writing up descriptive accounts of chemical work. With the progress of chemistry, and particularly of organic chemistry, it became extremely useful to denote certain definite groups of elements which pass from compound to compound apparently as units with special symbols; thus in addition to the symbols of the elements, we have 'Me' to represent the methyl group or radical, 'Ph' the phenyl group, and so on. Nevertheless, it was unusual to find such abbreviations in the text of chemical books and papers. Even more complicated substances are now being identified, particularly in the field of biochemistry, and with each new compound the urge to find and use abbreviations seems to grow. Adenosine triphosphate soon became 'ATP'; then there was 'ADP' (adenosine diphosphate); many others will come to mind. No one can blame workers in the rush of discovery jotting down abbreviations in their own notes, or even using them in writing down a reaction in symbols. But should they be used in the text of a paper? The symbols of the elements are internationally recognized, but many of these new groups of letters represent merely the initial letters of the English names of parts of a compound. Can it be accepted that such names will receive international approval, even if the constitution indicated be not disputed?

This use of symbols as abbreviations is, however, going further than the naming of compounds. Authors sometimes adopt their own abbreviation for a substance and seem to think that because they have defined it once at the beginning of a paper, they can then use it freely—and sometimes they do so without even the formality of a preliminary definition; we have seen in a communication submitted as a "Letter to the Editors" the symbol 'F', which on careful study was found to signify 'formaldehyde'. Another tendency is to use symbols as nouns, with the result that we find such phrases as 'an R_u of higher value'; the use of *p*H as a noun is perhaps sanctioned by long usage. It is apparently overlooked that very often a pronoun could adequately be used in place of the abbreviation. Attention to such matters might go some way towards meeting recent criticisms that scientific workers are unable to write intelligible English.

It must not be thought that chemists are the only offenders. Physicists have for many years used E.M.F., A.C., D.C., and more recently we have had 'h.f.' for 'high frequency' and 'r.f.' for 'radio frequency'; and there are symbols common to all the physical sciences such as N.T.P. and the various abbreviations, most of them well known and widely accepted, for weights and measures. But there does not seem to be the same urge to devise new abbreviations in this field.

The practice of using initial letters instead of the full names has come into increasing use in daily life during recent years. It is difficult to suggest where it started, though perhaps the Services must take a share in the blame; its placarding of camps with notice-boards having perhaps up to half a dozen letters indicating the whereabouts of officials whose functions were thereby indicated must have initiated many a recruit into the habit. Indeed, it became a point of honour to be able to talk to one's fellows in these 'letter' terms—whether this was a return to the secret-message game or due to the need for brevity need not be discussed. The names of institutions and bodies in civilian life have been similarly treated. We need only mention the Association of Special Libraries and Information Bureaux, widely known as 'ASLIB', or the Universities Federation for Animal Welfare, which is reduced to 'UFAW'. The ugly appearance of a succession of capital letters in a line of printed text is apparent, and possibly for this reason the tendency has been to use an initial capital letter only; the abbreviation then becomes a word, but not an elegant one in appearance or sound. The Department of Scientific and Industrial Research and the National Physical Laboratory are perhaps fortunate in that the initial letters do not form pronounceable words. The examples quoted are, of course, British, but equally curious names have been invented in other countries.

In the international field the same tendency has been apparent. The United Nations Organisation quickly became 'UNO' and then 'Uno'; the United Nations Relief and Rehabilitation Administration became 'UNRRA' and 'Unrra'. The United Nations Educational, Scientific and Cultural Organisation has become 'Unesco'. Now we have the World Health Organisation, which is heading its publications 'WHO'. The Students International Clinical Congress now in session in London, Oxford and Birmingham opens a descriptive programme with an article entitled "A welcome to SICC delegates"!

The examples, from many fields of activity, could easily be multiplied. What is the remedy? Or, perhaps, what can be done to check the appearance in various languages of artificial words, which usually happen to be ugly in appearance and uncouth in sound? Words which have already passed into general use will no doubt stand or fall by virtue of their suitability to express a particular function or object. In devising titles of new institutions or bodies, however, consideration should be given to the possibility that initial letters may be used in abbreviation, and suitable steps taken. It should not be beyond the wit of man to provide titles which are conveniently short or capable of reasonable abbreviation.

THE ART OF WRITING

The Alphabet

A Key to the History of Mankind. By Dr. David Diringer. Pp. 607. (London: Hutchinson's Scientific and Technical Publications, n.d.) 50*s*. net.

THIS exhaustive work incorporates the substance of the author's "L'alfabeto nella storia della civiltà" (Florence, 1937) and includes all non-alphabetic systems of writing, as well as the great family of true alphabets derived, so the author believes, from a single source in Phœnicia or North Syria. The two systems are curiously separate in their history, and it is no accident that the true alphabet originated in one of the very few regions where, by a series of historical accidents, the Cuneiform, Hieroglyphic, and probably also the Minoan systems overlaid each other, and set people thinking about a revolutionary change.

Each group of scripts is introduced by a short account of their region and people of origin, and supplied with a select bibliography. Theories of origin or derivation are summarized, and usually Dr. Diringer has his own reasoned conclusions. On the priority of Egyptian or Sumerian pictorial writing, he reserves judgment. He shows (p. 61) how narrowly Egypt missed a truly alphabetic script, and by what steps, having done so, they supplemented their mperfectly syllabic script.

The account of the Cretan or 'Minoan' scripts is disappointing, for it has escaped recent revision, and does not mention Pugliese-Carretelli's admirable edition of the 'Linear A' tablets from Hagia Triada, or the discovery of 'Linear B' archives near Pylos on he Greek mainland. The tables of signs are imperfect and confused with commodity-signs, masons'-marks, ligatures, and other symbols. Dr. Diringer describes the unique Phaestos Disk as a 'stamp or big die', whereas it is itself printed with movable ype. He confuses 'Pictographic Class A' with Linear Class A' (Fig. 7*a*), and exaggerates the number of tablets found at Knossos (p. 76). He regards he Cretan system as essentially indigenous, though nfluenced by Egyptian hieroglyphic. Of the source of clay-tablet writing, with punctuation, in Crete, he says nothing. He is probably right in regarding the language as not Indo-European, but akin to languages of later Asia Minor, like many words in Greek; and he notes, without emphasis, the resemblances of Cretan to Phœnician signs. On Hrozny's Indo-European theories he reserves judgment. In the account of Cretan ethnology (p. 74) 'Hawkes' should be 'Hawes', as in the bibliography.

It is still too early to write confidently about the script of the Indus Valley civilization. Dr. Diringer nclines to the lower dates proposed by Frankfort and Piggott (middle third millennium); and rejects de Hevesy's comparison with the inscriptions of Easter Island (p. 198).

For Hittite script—a thorny subject—Dr. Diringer inclines to a deliberate imitation of Egyptian writing, but with Anatolian or Syrian pictographs, about the middle of the second millennium. He mentions, without favour (p. 96), resemblances with Cretan signs, noting the discordant dates.

The immense duration and complexity of Chinese writing are clearly set out, down to modern attempts o simplify or supersede it, and there is a concise urvey of the scripts of Central America and Mexico, of Southern China, of West Africa, and Easter Island. Fully syllabic writings, at Byblus, in Bronze Age and Classical Cyprus, in Japan, and among ribes of West Africa and North America, are treated summarily, and lead to the Persian and Meroitic cripts which are described as quasi-alphabetic only, and are therefore discussed separately here.

The alphabetic systems, very numerous and widepread, offer fewer problems, except the central question, 'where did alphabetic writing originate?' After reviewing older theories, Dr. Diringer adopts Dunand's derivation from the 'pseudo-hieroglyphic' script of Byblus (pp. 158, 205), which is traced back to the twelfth or thirteenth Egyptian dynasty (c. 2000–500 B.C.). If this is maintained, the current 'Sinaitic' derivation falls into place as one of several attempts o adapt Egyptian writing to local needs; and probably the Minoan script is another, modified, however, profoundly by the adoption of clay-tablet technique.

It is impossible here to examine in detail the relations between the derivative alphabets. The main thesis that they all go back to the Syrian archetype seems to be well founded, in contrast with the multiple origins of hieroglyphic and syllabic writing.

Though not without weak points, this book will be the main work of reference in this field for some time to come.

J. L. MYRES

WAR-TIME RADIO RESEARCH AT HARVARD UNIVERSITY

Very High-Frequency Techniques

Compiled by the Staff of the Radio Research Laboratory, Harvard University. Vol. 1. Pp. xvii+554. Vol. 2. Pp. viii+555–1057. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 2 vols., 84*s*.

IN compiling the text of these two volumes, the staff of the Radio Research Laboratory of Harvard University has followed the practice established in some recent books by which the different sections are written by separate authors, each being a specialist in his own domain. In this case the individual contributions have been welded together into a fairly comprehensive treatment of the whole field under the editorship of Dr. H. J. Reich and a group of assistant editors. As mentioned by Dr. Reich in his preface, the book should not be regarded as a text-book but rather as a reference work or hand-book which will serve as a valuable source of information to research physicists and engineers working in this field, and to future authors of text-books.

The Radio Research Laboratory at Harvard was primarily responsible for developing counter-measures to enemy radar: thus, throughout the work, particular emphasis has been given to conditions permitting broad-band or tunable operation of the techniques described, in contrast to the fixed-frequency operation of radar. In this way a new and interesting point of view is brought to bear upon the problems involved in the generation, transmission and reception of very high-frequency electromagnetic waves.

Volume 1 contains twenty-two chapters, of which the first eight are chiefly given to a discussion of the various types of antennæ in use at frequencies greater than 100 Mc./sec., with the overriding requirement of broad-band frequency characteristics. The principles of direction finding are then introduced, followed by a description of antennæ and indicators suitable for radio direction finding and of the devices employed in the rather specialized form of the latter known as 'homing'. These twelve chapters may be regarded as a part of the book sensibly complete in itself, and the remaining sections of Vol. 1 are concerned, in turn with the various types of very high-frequency oscillators for use in transmitters giving relatively medium- and high-power outputs. Attention is also given to the requirements for amplitude and frequency modulation, and in the last three chapters the principles and characteristics of the magnetron are enumerated and discussed.

The externally tuned magnetron oscillator is treated at the beginning of Volume 2; afterwards, the methods of ultra-high-frequency power measurement are reviewed and the general principles of receiver performance dealt with. At this stage, transmission line filters are introduced, leading to a consideration of tuning systems for microwave receivers and an adequate discussion of detectors, mixers, local oscillators, and intermediate frequency amplifiers. In conclusion, some examples of receiver circuits and associated measuring equipment are given, together with a supplementary bibliography of recent articles relating to the matters discussed.

The difficulties confronting the editors of a book of this nature, which covers a wide field in great detail, are admittedly formidable, and much thought has obviously been given to the arrangement and integration of the various sections. Nevertheless, there is some repetition of material in the separate contributions which could have been avoided had the basic work been presented in certain chapters of a general introductory character. The second chapter, dealing with ultra-high-frequency measurements, might well have served as an introduction to the section devoted to antennæ arrangements, while discussion of the latter prior to a consideration of the methods of generating and detecting very high-frequency waves appears to be somewhat out of place.

Some of the subject-matter has already appeared, scattered throughout the technical literature of the past few years, and the authors are to be complimented for having produced in an integrated form the information and experience which they and their colleagues have gained during the war-time years of intense activity in the microwave field. Also, some of the material is new, and as such constitutes a valuable addition to the knowledge of these recently acquired techniques.

Having been compiled by a group of specialists, the book is essentially practical in content, and the experimenter will undoubtedly find therein many useful guides towards the design and successful operation of his apparatus; this, in a more academic treatise, might have been overlooked.

Although the reader may sometimes be critical of the way in which the material is presented, he will not dispute that the numerous techniques are discussed in a complete and concise manner. The authors are clearly masters of the methods which they describe, and many readers will be grateful to them for having produced this detailed account of their technical experiences.
JOHN LAMB

THE PIGMENTARY EFFECTOR SYSTEM

Animal Colour Changes and their Neurohumours

A Survey of Investigations, 1910–1943. By George Howard Parker. Pp. x + 377. (Cambridge: At the University Press, 1948.) 30*s*. net.

THIS is a very valuable compilation of literature on chromatic function which, together with previous reviews by Fuchs (1910) and Hogben (1924), makes readily accessible all references on the subject from antiquity to recent times. The introductory chapter deals with distribution and types of chromatophores, with their activities and methods of measuring them. This is followed by a systematic survey of chromatic response in cephalopods, Crustacea and cold-blooded vertebrates; seasonal coat changes in birds and mammals are not discussed. The final chapters consider development, genetics and 'special activities' of vertebrate chromatophores. The bibliography of more than 1,200 titles is conveniently arranged under three heads, namely, surveys, publications (chiefly historical) before 1910, and a complete list from 1910 to 1943 inclusive. As we have learned to expect from Prof. Parker, the script is lucidly and persuasively written.

This review is particularly valuable at present because, despite Prof. Parker's modest disclaimer, it is evident that he has had access to much material that has escaped the notice of most British workers during the war years. But this work is, of course, much more than a compilation, and woven into the review is the author's well-known neurohumoral interpretation of pigmentary activity. The critical part of the work is clearly, and for the most part impartially, stated, but it calls for criticism on several counts.

The introduction makes it clear that Parker is now less intransigent with regard to the value of the Hogben melanophore index for obtaining data essential for critical judgment on certain disputed issues; but his criticism of Neill's work on the ground that he confused 'morphological' and 'physiological' changes makes it equally clear that the value of the melanophore index for discriminating between these two types of change has escaped him. Neill used the melanophore index and consequently his plottings represent physiological change only.

From a statement on p. 104, in which Prof. Parker says the *W*-hormone "appears to be the effective agent in the blanching of many elasmobranchs", it would appear that he has weighed the evidence for the two-hormone ('*B*' and '*W*') hypothesis and is now more sympathetic towards it, but on p. 206 we find that because "the blood of a normally pale frog when injected into a dark one will not cause the dark one to blanch", he concludes that "the blood of a normally blanched frog contains no agent concerned with the concentration of its melanophore pigment". This shows (as is admitted by implication on p. 97) failure to grasp the full implications of the two-hormone hypothesis. According to this hypothesis, on a black background '*B*' is being secreted maximally, and on a white background both '*B*' and '*W*' are secreted maximally; but (as shown by melanophore index readings) '*W*' does not fully override '*B*'. Hence, an intact pale animal will never have an effective excess of '*W*' and so it could not be demonstrated in the way proposed by Parker.

Prof. Parker has re-stated his experiments on nerve-cutting. The novel feature of his interpretation of these is his belief that when nerves are cut in a pale teleost the dark bands evoked are due to persistent prepotent stimulation of 'expanding' fibres. Much ingeniously devised evidence is marshalled in favour of this view and it may well prove correct; but a quantitative study after similar procedures on hypophysectomized fish would dispose (or otherwise) of a simpler interpretation, namely, that when released from nervous stimulation the melanophores expand under the influence of pituitary hormones in circulation.

Parker's writings on neurohumoralism fall into two distinct categories: (*a*) experiments on teleost specie in which there is undoubtedly 'direct' nervous control of melanophores—it is claimed that nerve ending in close proximity to the melanophores influenc their effectors by liberation of neurohumors; (*b* arguments to show that there is no valid distinctio between humoral and nervous co-ordination. I melanophores are influenced by the liberation o drug-like substances (neurohumors) from nerve end ings in close proximity to them, the fact is of considerable physiological importance and Parker's work in this connexion is of great interest. But co-ordination by a blood-circulated hormone has different physiological attributes from nervous co-ordination; and it is therefore a purely verbal compromise between issues which are not factually consistent to claim that in the light of the neurohumoral hypothesis the distinction of a nervous and humoral excitation really vanishes "because both rely for their effectiveness on liberated substances which from a near or far source reach and excite a given colour cell".

The book is attractively produced on paper of unusually high quality. It is certain to remain the standard work on the subject for several years.

H. WARING

NUMERICAL METHODS

The Differential Analyser

By J. Crank. Pp. viii+137+4 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 10*s*. 6*d*. net.

Computing Mechanisms and Linkages

By Antonín Svoboda. Edited by Hubert M. James. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 27.) Pp. xii+359. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 27*s*.

THE growing importance of numerical methods in scientific research is reflected in the beginnings of a separate literature. These two books are concerned not with methods, but with tools, and are welcome additions to the small number of books dealing with this field. They are both concerned with what have been called analogue machines, and not with the digital type of calculator which is now exciting a good deal of attention. Although they are both concerned with analogue devices, the scope of the two books is very different. Mr. Crank describes the differential analyser, which is used for the solution of differential equations, and is purposely designed to cover a wide variety of problems, and Prof. Svoboda is concerned with the design of simple mechanisms to represent specific functions.

Mr. Crank's little book is adequate without being heavy, and not unreasonably expensive. The author worked on the differential analyser at the University of Manchester, and later took charge of the very similar machine at Cambridge. He speaks with the authority of working experience of this equipment, and the description both of the machine and methods of its use is simple and clear. The needs of the research worker who wishes to understand and use the differential analyser have been fully met, so far as they can be without practical demonstration on the machine itself; and the author goes a long way to help the isolated worker, without access to an existing machine or to experienced guidance, who wishes to design a machine of moderate accuracy and cost for himself. The amount of useful knowledge packed into this small book is quite remarkable.

Two minor points of criticism, which are rather matters of personal preference, might be noted for a future edition. The long list of references at the end of Chapter 6 on 'applications' would be more convenient if arranged in alphabetical order of the authors; and in his description of the new differential analyser at the Massachusetts Institute of Technology, the author would have done well to include a reference to Prof. S. H. Caldwell's D.Sc. thesis; in this thesis there are also some interesting remarks on method which should not be forgotten.

Prof. Svoboda's book is No. 27 of the Massachusetts Institute of Technology's Radiation Laboratory Series, and is, in fact, an essay in the neglected subject of kinematics devoted to a severely practical need. Prof. Svoboda is concerned with bar linkage mechanisms and their use for the approximate generation of functions required in connexion with fire control, in particular gun predictors. He shows that with two basic mechanisms, the harmonic transformer and the three-bar linkage, it is possible to perform the fundamental operations of arithmetic, addition, subtraction, multiplication and division, and to generate ballistic functions. The interesting point that arises in this book is that although the field of functions which can be generated exactly by a combination of these two mechanisms is limited, if one is satisfied with an approximate description and works to definite tolerances, a wide variety of functions can be generated within these limits of accuracy. Prof. Svoboda describes a definite design method. He shows how a crude approximation may be refined in successive stages until the desired degree of accuracy is reached.

The theory of these mechanisms is fully developed in the book, and excellent charts and tables are given for those who wish to use its methods. The book also has the virtue of being complete in itself. Although well written and clearly expressed, it might be difficult reading for the engineer. Nevertheless, the reviewer is convinced that the theory here developed will have useful engineering applications apart from the war-time applications described.

JOHN WOMERSLEY

WILD ANIMALS AND THE LAND

Wild Animals and the Land

By F. Howard Lancum. Pp. 136 + 29 plates. (London: Crosby Lockwood and Son, Ltd., 1947.) 10*s*. 6*d*. net.

MR. HOWARD LANCUM in this book writes primarily for men of the land who wish to know something of the status of British wild animals in relation to agriculture, horticulture and food production, and has produced an attractive book, illustrated by excellent photographs. Some of the animals he describes are the fox, the badger, the otter, rabbit and hare, the hedgehog and squirrel, rat, vole, mice and shrew. It is good to see that he mentions the good, as well as the harm, animals do. For example (p. 32), we are told of the fondness of the badger for wasps' grubs. When a wasps' nest had to be tackled, "it was a common occurrence for a deputation of youngsters to present itself at the door of the house of Brocky's [the tame badger's] master, with the request, 'Can we borrow Brocky, please?' Brocky was ever ready to be borrowed, for none knew better than he what was afoot. He would be duly led away with collar and chain until the company came within sight of the offending wasps' nest. As soon as he saw the flying wasps his hackles would rise, and he was released from the chain while the children remained at a safe distance. In an almost incredibly short time Brocky would have that nest out of the ground, and would be feasting royally on fat, juicy wasp grubs, meanwhile uncaring for, or impervious to, the stings of the outraged wasps."

The author (p. 33) has investigated during his life nearly a hundred supposed instances of the killing of poultry by badgers, and in only two instances was it possible to prove that the damage was the work of badgers—in most of the other instances he discovered that a fox was the culprit. He therefore makes a strong plea for the better protection of this, one of the most attractive of British mammals. He mentions (p. 57) that owing to the setting of its eyes the hare is often unable to see right ahead of it. I recall a remarkable example of this in the blue hare, which on one occasion allowed three persons to approach and photograph it in the open without apparently being aware of their presence; then, after about half an hour, became suddenly conscious of it and rushed off in a panic. Hares, usually timid, can be brave in defence of their young, and on page 59 the author mentions that on a memorable occasion he saw a doe hare kick a stoat to a distance of several feet. His account of a squirrel 'freezing' (p. 64) on the appearance of a buzzard seems to point to the fact that the buzzard, like the golden eagle, may on occasion take squirrels for food. I recall a pair of golden eagles which regularly brought squirrels to the eyrie for food for their two eaglets.

Mr. Lancum's account (p. 73) of a stoat swimming reminds me that on one occasion when fishing I saw a stoat unhesitatingly take to the water on a cold spring day in order to avoid a scramble up a grassy bank. The author has a good word even for the stoat, because it can kill a rat without difficulty, and kills mice in great numbers. SETON GORDON

UP-TO-DATE TREATMENT OF VENEREAL DISEASES

The Venereal Diseases

A Manual for Practitioners and Students. By Dr. James Marshall. Second edition. Pp. xvi+370. (London: Macmillan and Co., Ltd., 1948.) 21s. net.

OF making many books there is no end, but this is not true of text-books on venereal diseases published in Great Britain; for this reason Dr. Marshall's manual is particularly welcome, more especially as it is full of sound teaching which should be valuable both to the student and to the practitioner. Venereal diseases have been with us since time immemorial, nor have they changed very much; but their treatment is constantly changing, and this has been most marked since the introduction of the sulphonamides and penicillin. No doubt this was largely the reason for the production of a second edition so soon after the first. This second edition contains a number of minor changes and improvements, but is of chief importance in that it brings the therapeutic use of penicillin up to date and at the same time introduces new matter on intensive and semi-intensive arsenotherapy, non-gonococcal urethritis, which was so prevalent in most armies during the War, and Reiter's syndrome, which, if it is not venereal in origin, certainly brings many patients to venereal diseases clinics. Those who are not familiar with this condition will do well to read what Dr. Marshall has to say about it, because no doubt it is one which has been frequently missed in the past and is probably commoner than many suppose; moreover, treatment is far from satisfactory, and patients are often rendered incapable of work for many weeks by the painful arthritis which is one of the prominent features.

What will appeal most to readers, however, is the latest information about the use of penicillin in treating venereal diseases; for the treatment of acute gonorrhœa the author prefers four or five injections, each of 50,000 or 40,000 units in aqueous solution, given at intervals of three or two hours, though he admits that a single injection of 300,000 units in oil-wax suspension is permissible, and no doubt this is much the most convenient method in a civilian venereal disease clinic, because few patients are willing or able to wait several hours or visit a clinic several times in one day. The objection to the penicillin treatment of gonorrhœa is the risk of masking a concurrently acquired syphilitic infection; by no means all patients can be relied on to attend regularly for blood tests for a period of six months. For this reason there is much to be said for treating acute gonorrhœa with sulphonamides and only resorting to penicillin if these fail. Where complications are present, much larger doses of penicillin are necessary, and in such cases it is pointed out that there is a good deal to be said for giving an amount, such as 3 mega units, which will have a reasonable chance of curing an incubating syphilis.

For the treatment of early syphilis it is recommended that arsenic, bismuth and penicillin should be employed concurrently; ten weeks of arsenic and bismuth together with 3 mega units of penicillin in aqueous solution by means of three-hourly injections—but for ambulant patients, and these will represent the vast majority of cases, he advises 300,000 units in oil-wax daily for ten days.

Very wisely the views expressed concerning the treatment of late syphilis, including neuro-syphilis, are extremely guarded because not enough time has yet elapsed to assess results; but, in general, penicillin in heavy dosage is recommended in addition to arsenic, bismuth and, if necessary, fever.

Of the arsenicals, mapharside or neohalarsine is preferred to neoarsphenamine if the patient can attend for injections twice weekly; in this the author tends to follow American rather than British custom; the two former may be safer from the point of view of toxic reactions, but it is doubtful if they are as therapeutically effective as neoarsphenamine, and there are many advantages, particularly from the patient's point of view, in attending only once weekly. Non-gonococcal arthritis is so common and so difficult to cure that many readers would welcome more details of treatment, and much the same applies to *Trichomonas vaginalis* infestation, which may account for half the attendances at a female clinic; no doubt limitations of space had to be taken into account, for it must be very difficult to deal adequately with all the venereal and allied conditions in the space of three hundred and fifty pages. The average reader is not concerned with the structural formulæ of the various arsenicals and sulphonamides: the omission of these would give room for matter of more practical interest.

If this book is not a literary masterpiece it is certainly full of sound teaching, gives the practitioner all the information which he requires for the management of his patients suffering from venereal disease and, if carefully studied, will get the student through his examinations; the section devoted to "Practical Instructions" is particularly helpful.

T. E. OSMOND

Introduction to the Theory of Equations

By Assoc. Prof. Lois Wilfred Griffiths. Second edition. Pp. ix+278. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 18*s.* net.

THE contents of this volume fall into three clearly marked sections. Chapters 1–4 (pp. 1–105) lead up to the location and calculation of the real roots of a real algebraic equation; the cubic and quartic equations are studied in Chapter 2, as a preliminary to theorems on the general equation. Sturm's theorem provides for locating the roots of the general equation, but the only method of calculation expounded is that of Horner, explained very lucidly with attention to the justification of contracted processes. Chapters 5–7 (pp. 106–235) deal with determinants, introduced for orders 2 and 3 and extended to order *n*, and with systems of linear equations. The connexion between a set of solutions of such a system and the rank of the augmented matrix of the system is set out carefully; but some hints on what can be done to alleviate the tedious process of solving a numerical set of linear equations would have been welcome. Chapter 8 sets out the axiomatic theory of the complex number, familiarity with the technique having been assumed in the early chapters. Chapter 9 deals with symmetric functions of the roots of an algebraic equation, a topic the academic elegance of which has caused it to be over-elaborated in some text-books; Prof. Griffiths rightly relegates it to the subordinate position it should occupy in an introductory account.

Chemical and Physical Investigations on Dairy Products

By H. Eilers, R. N. J. Saal and M. van der Waarden. (Monographs on the Progress of Research in Holland.) Pp. xv+215. (New York and Amsterdam: Elsevier Publishing Co.; London: Cleaver-Hume Press, Ltd., 1947.) 21*s.* net.

THE series of publications, of which this book on dairy research is one, deals with the investigations carried on by Dutch scientific workers during the German occupation of the Netherlands. The Dutch are a pertinacious people, and the 'mere trifles' of enemy occupation, oppression and near-starvation do not seem very seriously to have depressed the high quality, although they may have somewhat diminished the quantity, of their research in dairy chemistry and physics.

This volume contains, in effect, three communications. The first, by Eilers, deals with the colloid chemistry of skim milk, and includes studies of the calcium-casein-phosphate complex, the proteins in milk denaturable by heat, and the physical and physico-chemical changes occurring in skim milk on concentration. The second, by Saal and Heukelom, is concerned with the oxidation-reduction potential of the complicated biological system of milk and the only slightly less difficult system of butter-plasma. The third, by van der Waarden, approaches the commercially important, as well as academically interesting, group of problems associated with the chemical processes underlying the deterioration of butter.

Each article provides a short but well-documented survey of the field (though for obvious reasons there are few references after 1939) and each presents a considerable body of original research. This well-written and eminently readable volume is commended to every chemist or physical chemist interested in dairy research or dairy technology. H. D. K.

The Skyscraper Hive

By Father M. Dugat. Authorized translation of "La Ruche Gratteciel à Plusiers Reines" by Norman C. Reeves. Pp. xvi + 78 + 4 plates. (London: Faber and Faber, Ltd., 1948.) 8*s.* 6*d.* net.

ALTHOUGH no competent beekeeper is likely to disagree with the general statement that "The secret of large surpluses (of honey) is large colonies", a good many beekeepers will heartily disagree with M. Dugat's system of colony management. His system is indeed little more than an extension of the two-queen system of management which has been tried out very thoroughly in the United States and other countries since at least the beginning of this century, and has not been found to yield any notable increase in honey crop *per queen* over various single-queen systems.

All the data at present available as a result of much experimentation lead one to suggest that the success which M. Dugat has achieved is not so much due to his multi-queen system as to those other methods of management which he employed with his 'skyscraper' hives, and which are equally applicable to single-queen colonies. Such methods, which involve the partial separation of young bees from the older field bees and, by giving the queen every encouragement to lay to her full capacity, lead to the development of very powerful colonies, and at the same time help to control swarming, have long been known to give good results.

One cannot help but feel that M. Dugat might have obtained even larger crops of honey if he had avoided the once popular but now largely discredited practice of completely de-queening his colonies just before the honey-flow, a practice which frequently results in a loss of what may perhaps be termed 'colony morale'. COLIN G. BUTLER

Principles and Practice of the Rorschach Personality Test

By W. Mons. Pp. 164. (London: Faber and Faber, Ltd., 1947.) 12*s.* 6*d.* net.

SINCE the Swiss psychiatrist, H. Rorschach, published his fascinating "Psychodiagnostik" in 1932, considerable effort has been devoted in several countries to elaborating the methods of scoring and interpreting the test responses. Nevertheless, the somewhat forbidding notation in current use has given the accumulated mass of data the semblance of esoteric lore and the test itself has acquired what the late William Stern called a "monosymptomatic despotism". It is refreshing, therefore, to read Dr. Mons' clear and restrained account of the techniques and interpretation of the Rorschach 'ink-blot' test, an account based on extensive experience with Service and civilian patients and on the examination of a thousand clerical records.

With the difficulties of the novice in mind, Dr. Mons painstakingly explains how to administer the test, how to classify the responses according to a widely used, though somewhat pretentious, notation, and how to evaluate the significance of the responses so as to yield an assessment of the personality, particularly its 'structural' features. Several new formulæ useful for diagnostic purposes are suggested.

It is to be hoped that this useful manual will stimulate workers to pursue much more rigorously than hitherto methods of validating the test which could greatly improve its potential value as a diagnostic tool. JOHN COHEN

SPECIFIC CRYSTALLINE PROTEIN AND NUCLEOPROTEIN FROM A PLANT VIRUS HAVING INSECT VECTORS

By Dr. ROY MARKHAM, Dr. R. E. F. MATTHEWS
AND
Dr. KENNETH M. SMITH, F.R.S.
Agricultural Research Council, Plant Virus Research Unit, Molteno Institute, University of Cambridge

Introduction

IT is now more than ten years since Bawden and Pirie[1] showed that the tobacco mosaic virus is a nucleoprotein. Since that date several other plant viruses have been isolated, and as all seem to be nucleoproteins, the nucleoprotein nature of viruses has been widely accepted.

From plants infected with the turnip yellow mosaic virus[2,3], we have isolated and crystallized both a nucleoprotein and a protein free from nucleic acid, both specific to the disease and similar in many ways. In this virus disease we appear to have a borderline case, a naturally occurring link between the virus proteins and the non-virus proteins, and we have obtained direct evidence for the widely held belief that nucleic acid is essential for the multiplication of plant viruses.

The turnip yellow mosaic virus is also of interest in its mode of transmission. As already reported[4], it is unique among crystallizable viruses in being transmitted by an insect—and a biting insect at that. It now appears that it may be transmitted by a large variety of insects provided that they have biting mouth parts and, apparently, no salivary glands. The insect–virus relationship does not seem to be purely mechanical, as a preliminary delay in the development of infective power of about one day is usually necessary. Using purified virus mixed with sucrose, it is possible to feed the insects artificially and to study the host-virus relationships in this way.

Properties of the Virus Proteins

The original method of purification of the turnip yellow mosaic virus described by Markham and Smith has been found unsuitable during the summertime, so a simpler method has been developed which is reliable at all times of the year and is not dependent upon the temperature of the laboratory. The sap from turnip or Chinese cabbage is clarified by the addition of exactly 300 ml. of 90 per cent alcohol to each litre, followed by spinning. Under these conditions the virus is still in the supernatant liquid, and is precipitated from it as octahedral crystals by the addition of half a volume of saturated ammonium sulphate solution. Further purification may be effected by recrystallization from salt solutions, a large number of salts being suitable for this purpose, all depositing the virus as octahedra, or by recrystallization from an acid solution (pH 3·8) of the virus in 20 per cent ethyl alcohol. The latter crystallization must be carried out in the cold at a temperature of 5° or less. The virus is then deposited as fine needles which frequently form globular clusters. These pack down on the bottom of the container, and after a couple of days the mother liquor may be decanted without loss of crystals. Yields of as much as 1 gm. per litre of sap have been obtained from field turnips by these methods.

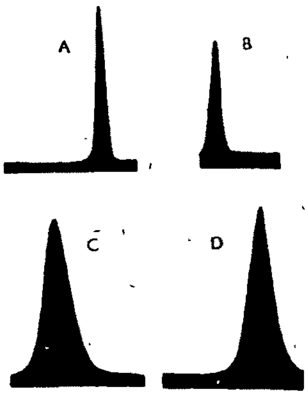

Fig. 1. Electrophoretic patterns obtained on the Tiselius apparatus: concentrations 5 mgm./ml. *A* and *B* stationary at pH 3·78 after 3 hr. at 2·33 volts/cm. *C* descending and *D* ascending at pH 4·16 after 5 hr. at 5·48 volts/cm.

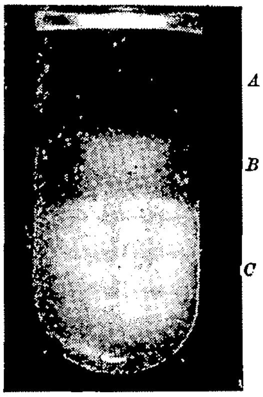

Fig. 2. Celluloid centrifuge tube after spinning at 12,000 r.p.m. for two hours, photographed by light scattered from virus proteins. *A*, solvent layer; *B*, virus protein; *C*, virus protein plus nucleoprotein

Virus preparations of this type are highly infectious and are quite uniform in composition. They contain some 15 per cent nitrogen, 2·15 per cent phosphorus and 5 per cent of purine-bound pentose, the latter two being entirely in the form of nucleic acid. On electrophoresis the solutions are isoelectric at pH 3·75 and contain only one homogeneous component at several pH's (Fig. 1). The examination of this material in the ultracentrifuge, carried out by R. Cecil and A. G. Ogston at Oxford, revealed the presence of two components differing in the ratio of about 1 : 2 in sedimentation constant, the slower or 'top' component comprising some 20 per cent of the whole.

The Oxford workers were kind enough to prepare for us about 8 mgm. of pure (95 per cent) top component using the separation cell of Tiselius, Pedersen and Svedberg[5]; and when we examined it, it was evident that the top and bottom components were different in some of their chemical properties.

Eventually we found that, when solutions containing more than 10 mgm./ml. of virus-protein were spun in a Sorvall S.S.1 centrifuge, boundaries formed (Fig. 2) and were sufficiently stable to allow the top component to be removed by a pipette. The material so obtained is only 75–80 per cent pure top component, but this purity may be increased to 80–85 per cent by a second spin. In this case only the top boundary forms, and the top half of the solution is sampled.

By this means we were able to prepare large quantities of the top component in a state of purity sufficient for most work, and in a similar way we have increased the purity of the bottom component to 90–95 per cent.

Top and bottom components of turnip yellow mosaic virus are similar if not identical in the following respects. Both crystallize from salt solutions as octahedra (Fig. 3) and under the electron microscope are spheres of similar size, while they both can form micro-crystals on the electron microscope grids (Cosslett and Markham[6], and unpublished). In solution, too, they seem to be the same size, and both are resistant to digestion by pancreatic enzymes. The bottom component, however, is the only one containing nucleic acid, and the absorption spectra of the two are consequently very different (Fig. 4). Although complete amino-acid analyses are not yet available, preliminary paper chromatography[7] using several solvents indicates that both proteins contain the same amino-acids in similar proportions. All the evidence which we have suggests that the protein parts of both components are identical and that the bottom component differs only in having some 28 per cent of pentose nucleic acid by weight embedded in it in such a way that it takes no part in forming the electrostatic surface of the molecules. The comparatively acid isoelectric point of both proteins seems to be due to the relative preponderance of the dicarboxylic amino-acids in the protein, a fact which may seem in contradiction to the orthodox conception of nucleoproteins. The top component is therefore the first native virus protein which has been obtained free of nucleic acid.

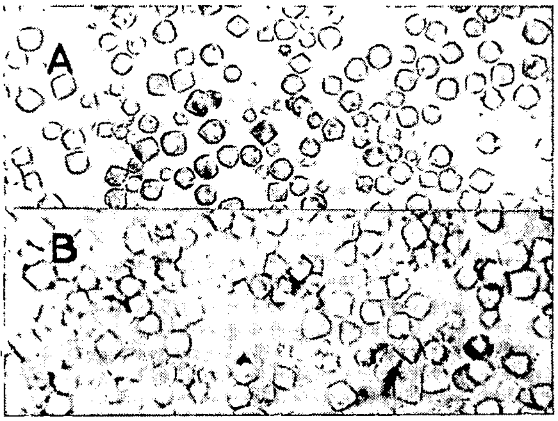

Fig. 3. *A*, CRYSTALS OF TURNIP YELLOW MOSAIC VIRUS PROTEIN ; *B*, CRYSTALS OF THE VIRUS NUCLEOPROTEIN

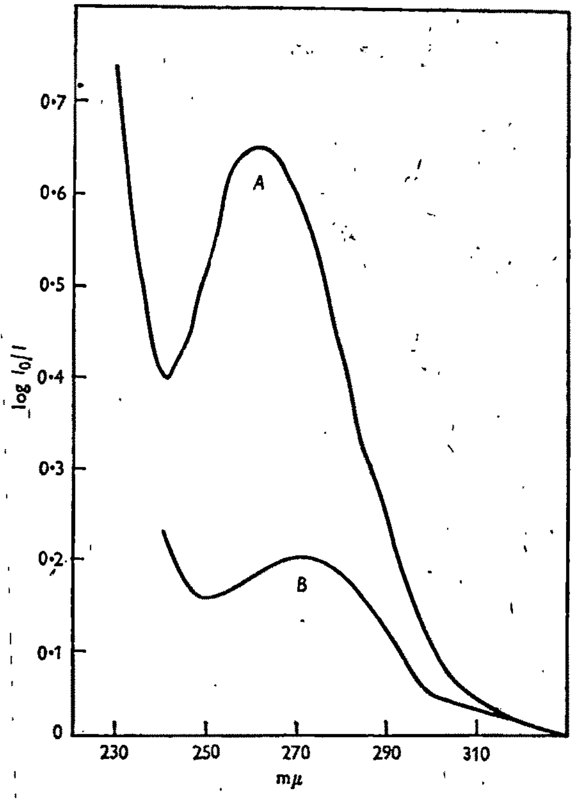

Fig. 4. ULTRA-VIOLET LIGHT ABSORPTION SPECTRA OF WHOLE VIRUS PREPARATION, *A*, AND TOP COMPONENT, *B*, AT A CONCENTRATION OF 0·1 MGM./ML. IN A 1-CM. CELL

By comparing the properties of these two proteins, we have discovered two distinct biological functions of nucleic acid in a plant virus nucleoprotein. First, all the infectivity of our preparations appears to reside in the nucleoprotein fraction, since the top component, even when freshly prepared, does not seem to be infectious. However, experiments using different isolation techniques which control the effects of our isolation procedure at each stage indicate that infection with the nucleoprotein results in the production of the top component as well as a larger quantity of nucleoprotein. As yet we can only speculate as to the origin of the top component. It may represent a stage in the synthesis or the breakdown of the nucleoprotein, or might even be the result of an abortive attempt at multiplication. Secondly, a single intravenous injection into rabbits of as little as 0·01 mgm. of the nucleoprotein results in the production in a fortnight of a precipitating serum of titre about 1 : 16. Sera of extremely high antibody content result after injection of larger quantities. On the other hand, the top component is very much less antigenic, the antibody production in response to an injection being not appreciably greater than could be accounted for by the small but inevitable quantity of nucleoprotein contaminating even our best preparations. When solutions of the two proteins are made up in equivalent concentrations, however, it is not possible to distinguish between them by means of antisera produced in response to the injection of the nucleoprotein.

Using several antisera from different rabbits, the times for precipitation and the position of the optima are the same for both components. Over a range of antiserum-virus protein ratios in the region of antibody excess, the weight of antibody combining with unit weight of *protein* is the same within the limits of the experimental methods. Thus there is no indication that there are any antigenic groupings in the nucleoprotein in which nucleic acid is involved. This is difficult to reconcile with the fact that presence of the nucleic acid greatly enhances the power of the protein to stimulate antibody production.

Although the two proteins are found in our preparations, we have been unable to convert the nucleoprotein into native protein plus nucleic acid. In every case where nucleic acid is liberated, the protein is denatured. It is of interest to note here that the protein is denatured in the cold at pH 7 in solutions containing more than 30 per cent alcohol by volume, and the nucleic acid is left in solution. When prepared in this way, the nucleic acid solutions evidently contain large thread-like molecules, and if the concentration is as much as a few milligrams per millilitre they set into jellies. In this way the nucleic acid resembles that of tobacco mosaic virus[8]; but the method of isolation is even less drastic and is, in fact, the mildest method for the isolation of a pentose nucleic acid which we know.

Insect Relationships of the Virus

The method of transmission of this virus in the field differs from that of all other known plant viruses; the insect vector being a flea beetle (*Phyllotreta* spp.) with biting mouth parts instead of the usual sap-sucking type of insect, such as aphides or leaf-hoppers. This is also the first time a crystallizable plant virus has been shown to have an insect vector. The relationship between the virus and the insect which transmits it has not yet been completely worked out, but certain interesting facts have been elucidated. Whereas in Nature the transmitting insects are one or more species of flea beetle which feed on the turnip plant, under experimental conditions several entirely different types of insect will transmit the virus. These include three or four species of beetles, including *Phœdon cochleariæ*, the mustard beetle and its larva, the common earwig and two species of grasshoppers. These insects have, however, one characteristic in common, namely, they all have biting mouth parts. A large number of transmission experiments, mostly with the larva of the mustard beetle, including some using artificial feeding methods, have been carried out. For the artificial feeding the larvæ were desiccated slightly by starving them for twenty-four hours. They were then allowed to feed upon drops of purified virus solution to which had been added a little sucrose.

These experiments have shown that, as a rule, an insect does not become infective after feeding on a source of virus until after the lapse of a period of 24–48 hours. On the other hand, there are exceptions to this, in which the processes of feeding on the source of virus and infecting the healthy plant can be carried out in a total period of ten to fifteen minutes.

For these two types of virus transmission, we suggest the following explanation. The rapid type of infection can be explained on the assumption that the mouth parts are contaminated with virus which is thus passively transferred to the healthy plant. Some other explanation, however, is necessary for the delay of 24–48 hours before infection and the subsequent retention of infective power by the insect for one or two days more. It seems to be a fact that most beetles and their larvæ do not possess salivary glands, and digestion of plant tissue is aided during mastication by regurgitation of some of the contents of the foregut. During this process some of the virus previously ingested would be brought into contact with the healthy tissue and thus cause infection of the plant. This would explain both the delay in the development of infective power and the retention of the ability to infect. Some support for this hypothesis is given by the fact that in most of the transmitting insects, besides the beetles, the salivary glands appear to be missing or rudimentary.

Detailed accounts of this and other work on this virus will be published elsewhere.

Our thanks are due to Mr. R. Cecil and Dr. A. G. Ogston for their co-operation in this work.

Summary

(1) Some of the unusual properties of turnip yellow mosaic virus are described.

(2) This virus is transmitted by biting insects only, and there appears to be a correlation between the ability of an insect to transmit the virus and the absence of salivary glands which necessitates regurgitation of the contents of the foregut. Artificial feeding methods have been successful.

(3) Two proteins have been isolated from plants infected with this disease and both have been crystallized. One is a nucleoprotein containing 28 per cent of pentose nucleic acid, and the other appears to be the same protein without the nucleic acid.

(4) The nucleic acid may be obtained from the virus by a method milder than any so far employed for the isolation of a pentose nucleic acid. The nucleic acid is a very large molecule, probably rod-shaped.

(5) It is not possible to differentiate between the two proteins by means of serological precipitation, but, when injected into rabbits, the nucleoprotein is many times as antigenic as the protein.

(6) Only the nucleoprotein is infectious to plants and the presence of combined nucleic acid would appear to be necessary for virus multiplication.

(7) Both proteins are the same size and shape and have identical electrophoretic mobilities.

(8) This is the first time that a virus protein has been obtained in a native condition, free from nucleic acid.

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CHEMICAL RESEARCH LABORATORY, TEDDINGTON

THE Chemical Research Laboratory of the Department of Scientific and Industrial Research has again held a very successful series of 'open days'. On June 29 the Laboratory was visited by the Lord President of the Council, Mr. Herbert Morrison, who was received by Sir Edward Appleton, secretary of the Department, Dr. R. P. Linstead, director of the Laboratory, and Sir Norman Haworth, chairman of the Chemistry Research Board. During the remainder of the week there were nearly a thousand visitors, including chemists from industry, university laboratories, technical colleges, research and trade associations and Government establishments. These visits serve to keep the chemical community aware of the work of the Laboratory, and enable problems of common interest to be discussed. They supplement the published reports of the Laboratory and its Advisory Board. It may be noted that the reports for the years 1938–46 have recently appeared*.

The exhibits on view in the Laboratory covered the whole range of its activities, which include organic chemistry; inorganic chemistry, including radiochemistry; corrosion of metals, including microbiological corrosion, and high polymers and plastics. The semi-scale laboratories and engineering workshops were also open to inspection.

The research work of the Corrosion Section attracted a large number of visitors. The main equipment of the Section, namely, the high- and low-speed rotor assemblies and the moving-belt apparatus for achieving accelerated corrosion, were on show. In the field of atmospheric corrosion, attention was particularly directed to a new 'condensation' type of test whereby comparisons can be made of protective methods; also to studies of special alloy steels. Electrochemical studies of immersed corrosion were on view, and recent advances in the technique of stripping natural protective films were demonstrated. Interesting discoveries have recently been made at the Laboratory on organic corrosion inhibitors. The inclusion of these in cooling liquids for internal combustion engines and wrapping materials was demonstrated. A particularly interesting exhibit showed the incorporation of an organic inhibitor into rubber latex.

The Microbiology Section illustrated the problem set by the external corrosion of iron pipes in clay soils. This is especially serious to-day because of the extensive post-war programme for laying rural water mains and gas and water systems for new housing estates. The virulent type of corrosion which occurs in clay is due primarily to the activity of anaerobic sulphate-reducing bacteria. Recent work at Teddington suggests that these bacteria may also be responsible for much of the internal corrosion experienced with soft moorland waters. The exhibits illustrated the fundamental properties of the bacteria, which are facultative autotrophs. Their remarkable morphological changes were shown by electron micrographs. Laboratory and field work on protective measures were also demonstrated.

Research in organic chemistry at the Laboratory covers a wide field, and investigations in coal tar have been in progress for more than twenty years. This work is now being concentrated in three directions. One group is concerned with the isolation and identification of the individual constituents of various coal tar fractions. For this purpose extensive use is made of high-efficiency fractional distillation. A notable exhibit comprised a battery of packed distillation columns all operating at pre-selected constant pressures and capable of a very high standard of performance. A second team is concerned with the collection of fundamental reference data for pure compounds.

Chemical processes and the design of chemical plant depend to-day to an ever-increasing extent on the availability of reliable physico-chemical data. These are very scanty in the field of coal tar constituents, and this part of the Laboratory's programme aims at filling the gap. Research in this field was illustrated for pyridine of 99·9 per cent purity. The composite all-glass apparatus used for the manipulation and transference of pure compounds under vacuum and for the measurement of boiling point, freezing point, vapour pressure, etc., was on view. This equipment incorporates an automatic barostat which will maintain pressures constant to at least 0·025 mm. mercury. Other apparatus displayed included an automatic recorder for freezing point determination and an ebulliometer, both of which employ a thermistor for the detection of small temperature changes. In this way differences of temperature of 0·001° C. can readily be recorded, and the equipment can be applied to the measurement of chemical purity. One exhibit which excited special interest was a miniature platinum resistance thermometer capable of reading temperatures to 0·001° C. This has been constructed in collaboration with the Physics Division, National Physical Laboratory.

The objective of the third group is to develop new industrial outlets for neglected constituents of coal tar. This was illustrated by work on the dehydrogenation of acenaphthene and the conversion of the product, acenaphthylene, into polymers of interest to the plastics industry. Among the exhibits by this group was a reference collection of more than a hundred pure coal tar compounds.

The Laboratory is now preparing to synthesize organic intermediates on a small scale in order to assist in the application of isotopic tracers to chemical, medical and biological problems. Work is in hand on both heavy and radioactive carbon; this involves the synthesis of useful compounds from simple carbon sources such as barium carbonate or potassium cyanide in which a proportion of the carbon consists of C^{13} or C^{14}. Syntheses with the radioactive isotope C^{14} have been undertaken in collaboration with the Radiochemical Centre, Amersham, members of the staff of which are at present working at Teddington. The elaborate apparatus required for these studies was on view; it demonstrated the value of the Laboratory's skilled glass-blowing service.

Other exhibits in the organic chemical field illustrated the part played by the Laboratory in the early development of the new synthetic fibre 'Terylene' (polyethylene terephthalate). The work of the Laboratory in the preparation and purification of methyl-silicon intermediates was illustrated and samples of a heat-resistant material were on show. The ability of methyl chlorosilanes to render glass and cellulose water-repellent were strikingly demonstrated.

Inorganic chemistry has of late been a comparatively neglected branch of the science; but many recent technological developments, including the discovery of atomic energy, have helped to revive interest greatly. This revival was illustrated at the Laboratory by a number of exhibits, prominent among which was one on recent work on the analytical chemistry of uranium and thorium. Examples of the increased interest in very pure and less common metals were provided by exhibits of recent work on pure vanadium, gallium and germanium.

Great interest was shown by visitors in the Laboratory's work on high polymers and plastics. Recent research on ion-exchange resins, originally discovered at Teddington in 1935, was illustrated. An attractive exhibit showed the preparation of sulphonated cross-linked polystyrene in bead form. Work on the problem of swelling of polymers, and on the mechanical properties of reinforced plastics, was also on view; and the very successful recent development of synthetic adhesives at the Laboratory was illustrated.

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* Chemistry Research, 1938 to 1946. (London: H.M. Stationery Office.)

Special attention is given at the Laboratory to the development of physical and other special techniques of general usefulness. This was illustrated by demonstrations of spectrographic equipment, including a double-beam infra-red spectrograph, radiometric methods, microanalysis, chromatography, polarography and other modern techniques.

IMMUNITY TO VIRUS DISEASES

ON July 1 at Cambridge, during the course of the scientific meeting of the British Medical Association, the Section of Pathology discussed "The Prophylaxis of Virus Infections with Special Reference to the Use of Vaccines".

For some human virus infections, such as rubella and infectious jaundice, there is not yet available a susceptible laboratory animal—or even a susceptible egg !—and vaccines are thus at present unattainable. For others, such as (within limitations) influenza, inactivated vaccines are available; these are safe, but do not give enduring immunity. For others, such as smallpox and yellow-fever, living attenuated viruses are available, and these give rise to immunity of longer duration. Dr. C. H. Andrewes, who opened the discussion, held up the 17*D* strain of yellow-fever as an example of an ideal vaccinating agent, a standard to which we should like all vaccines to attain. It gives but trifling reactions, and immunity is long-lasting after a single dose. Later in the discussion, however, Dr. G. W. M. Findlay pointed out one flaw in its perfections—a difficulty in preserving its potency without rigorous attention to technique.

Dr. Andrewes devoted chief attention to the complications introduced by the existence of serological races of some viruses, particularly influenza and poliomyelitis. Within the two distinct groups of influenza viruses, *A* and *B*, there exist serological races, sufficiently divergent to be of importance from the points of view of epidemiology and vaccine-prophylaxis. Very potent vaccines can be made from embryonic fluids of infected fertile eggs, inactivated with formalin. In 1943 such vaccines effected four-fold reduction in the incidence of influenza *A* in trials in a number of centres in America; in 1945–46 they had done even better in a *B* outbreak, apparently decreasing incidence ten- to twenty-fold. In 1947 they were quite, or almost, useless against the prevailing influenza *A* both in America and in Britain. This failure was almost certainly due to an antigenic divergence of the current *A* strain from those incorporated in the vaccine. More work on the potentialities of the influenza viruses for antigenic variation is necessary, before one can advocate general use of vaccines. In particular, there is ignorance as to whether there are limited numbers of defined types or whether the viruses are antigenically labile; also as to whether 'new' races spread about from country to country. To study this latter aspect, the World Health Organisation has lately set up a World Influenza Centre in London with the function of collecting, distributing and studying strains from all over the world.

Dr. Andrewes briefly discussed the possible application of the 'interference phenomenon' in control of virus infections and mentioned experiments in ferrets by Dr. Gledhill and himself; in these an innocuous influenza *B* strain had suppressed the symptoms of infection by an active *A* strain given within the next two or three days.

Prof. R. Hare, who followed, took a very pessimistic view of the prospects of successful vaccination, particularly against influenza. He emphasized past failures, particularly of vaccine trials in 1947, even going so far as to wonder whether killed viruses would ever be of value in immunizing man. Various methods of improving their activity have been reported—the use of the intradermal route, adsorption on to calcium phosphate and other substances, and mixture with oil. The amount of virus in vaccines has been increased by various concentrating procedures. Yet no consistent success can be reported. Antigenic variation among the viruses further confuses the issue. Prof. Hare felt that, if this is all vaccines made in eggs can do, he would rather have the eggs to eat. Despite his gloom, he did not dispel the thought that if the vagaries of antigenic variation of influenza virus could be understood, the prospects might be a good deal brighter.

Prof. W. I. B. Beveridge, the recently appointed professor of animal pathology at Cambridge, thought that much depends on how effective is the contact between an attacking virus and antibody. Against general infections such as the exanthemata and most insect-borne virus diseases, such contact is good and prompt; immunity is enduring and the possibility of vaccination good. Viruses like the common cold and influenza, which probably never reach the blood-stream, make poorer contacts and the prospects are, therefore, less favourable. He believes that allergy plays an important part in mobilizing the body's defences quickly, and he discussed methods of procuring such a favourable allergic state. Attenuation of viruses to make an effective, safe vaccine is a noble ideal, but is a process difficult to control. There may, as in rinderpest, be a rapid transit from a state of insufficient attenuation to one in which immunizing power also is lost. A degree of attenuation just right for some breeds of cattle may be too drastic or not drastic enough where other breeds are concerned. He thinks that, as regards living viruses, recall or 'booster' doses of vaccine may achieve no immunity-boost unless and until the recipient's immunity has fallen to quite a low level.

Dr. Stoker discussed reasons for failures of immunization against smallpox, such as neglect of many people to be revaccinated after infancy. He particularly stressed that the so-called immune response was an index of sensitivity, not immunity, and should be regarded as equivalent to failure to 'take'. Only with vesiculation accompanying a take of primary or accelerated type does immunity rise satisfactorily. Vaccinia preparations contain an agglutinin for certain red blood cells, and antibodies to this hæmagglutinin develop in immune people. Increase in such anti-hæmagglutinin titres of serum may be a useful guide to what is happening after revaccination. Vaccinia grown in fertile eggs should be given more trials. It is perhaps less stable than calf lymph, but on the other hand could be produced much more rapidly in an emergency. Dr. Stoker also referred briefly to Kaposi's varicelliform eruption, some cases of which he thinks are due to generalized vaccinia in eczematous contacts of vaccinated people. Some of Dr. Stoker's remarks might have afforded useful propaganda for an anti-vaccinationist, had he not begun with the warning that they applied only to failures of vaccination in individuals: its value in inducing herd-immunity was not in doubt.

In the subsequent discussion, Dr. Findlay ranged over several centuries in search of apt news-items about viruses. He also pointed out that yellow-fever immunization in West Africa had been of crucial strategic importance during the Second World War. There was discussion by several speakers of the twenty-year-old theory that immunity persists only while live virus persists in the body—a theory which may be held as a dogma but certainly awaits proof. The role of contaminating hyaluronidase-producing cocci in improving vaccinia 'takes' was discussed by Dr. Lack and others. A number of speakers emphasized that future progress in active immunization against viruses is closely bound up with exploitation of the fertile hen's egg. Progress hitherto has been chiefly noteworthy overseas. Speakers hoped that commercial firms in Britain would see to it that we do not lag behind in this important field of endeavour.

This was an active and useful discussion, not least because, unlike those in some other sections—or so we are told—speakers commendably kept within the prescribed time-limits for their speeches.

OBITUARIES

Sir D'Arcy Thompson, C.B., F.R.S.

WHEN D'Arcy Wentworth Thompson died at the age of eighty-eight, in his home in St. Andrews on June 21, his passing left a gap in many circles that had few points of contact with each other, for he had a wider range of intellectual interests and attainments than almost any other scientific man of our time. By profession he was a zoologist, and there have been few more learned; but he had a quite unusual familiarity with the whole circle of the sciences, joined to an inherited aptitude for, and love of, the classical tongues, and he was constantly surprising his friends by his unexpected knowledge of recondite corners of literature, history and art. He wrote and spoke in a style of effortless felicity, a trifle Victorian perhaps, but, as some of us think, none the worse for that. He loved teaching and he taught to the very last, for even in his final illness he gathered his honours students in his sick-room for talks that none of them will forget.

It is impossible here even to summarize the activities, so varied, of so long a life. He was born on May 2, 1860, at Edinburgh. His father, also D'Arcy Wentworth, was classical master in the Edinburgh Academy and afterwards professor of Greek in Queen's College, Galway; he is still remembered by lovers of a polished style and of liberal ideas on education for his "Day-dreams of a Schoolmaster". His mother, Fanny Gamgee (who died when he was born), belonged to a family distinguished in science and in medicine. After preparatory schooling (which included informal 'Nature study' on Saturday afternoons long before the term was invented) he was sent to Edinburgh Academy, a school the pupils of which have gained fame in all walks of life. He himself has recorded that of his own classmates one was awarded the Victoria Cross, one received a peerage and a seat in the Cabinet, four became fellows of the Royal Society and one a Royal Academician.

On leaving school at the age of seventeen, he matriculated as a medical student in the University of Edinburgh, where he was introduced to scientific zoology by Sir Wyville Thomson, then lately returned from the *Challenger* expedition. But it was with a classical scholarship that, two years later, he went up to Trinity College, Cambridge, and while there he helped to 'work his passage' by coaching men in Greek. He was one of the band of eager students who gathered round F. M. Balfour and Michael Foster, then laying the foundations of the modern Cambridge school of biology. He took a first class in Part II of the Natural Sciences Tripos and for a year demonstrated in Michael Foster's laboratory.

In 1884, at the early age of twenty-four, D'Arcy Thompson was appointed professor of biology (later altered to natural history) in the recently founded University College in Dundee. When, in 1897, after embittered disputes and litigation, the College was made one of the constituent colleges of the University of St. Andrews, he became a member of the Senate, and, twenty years later, on the retirement of Prof. W. C. M'Intosh, he was translated to the senior chair in the United College at St. Andrews. His tenure of the chairs at Dundee and St. Andrews extended to sixty-four years, a record that, under modern conditions, will not be repeated.

Some dates alone must stand for the stages of his scientific career. In 1896 and again in 1897 he went to the Bering Sea as member of the British – American inquiry into the fur-seal fishery, and in the latter year he was British representative on the international conference on the subject at Washington. For these services he received the C.B. in 1898. In the latter year he was appointed to the Fishery Board for Scotland and remained a member until the abolition of the Board in 1939. He was one of the British representatives on the International Council for the Study of the Sea from its beginning in 1902, and he edited and contributed largely to the Scottish section of its reports. He also wrote many papers on fishery statistics and oceanography in the "Scientific Investigations" of the Scottish Fishery Board from 1913 until 1931.

When D'Arcy Thompson went to Dundee, he at once began to assemble a teaching collection for the illustration of his lectures, which were never bound by the fetters of the 'type system'. At that time the Dundee whaling industry had not quite come to an end, and several of the whaling skippers were persuaded to bring back to him a large amount of vertebrate and invertebrate material, much of it of great value and interest. With the addition of collections obtained on his visits to the Bering Sea he got together a museum of arctic zoology which at the time had no equal in Britain.

It was in 1908 that a short paper in *Nature* on "The Shapes of Eggs and the Causes which Determine Them" gave the first published intimation of a line of inquiry that had long engaged his thought and on which he had accumulated masses of notes. In 1917 he published his book "On Growth and Form". This remarkable work at once attracted attention, not so much for the novel ideas it contained (though these were many) as for the mass of illustrative material it brought together from writers ancient and modern, many of whom the average zoologist had never heard of. The perfect pellucidity of its writing and the way in which it made problems, essentially mathematical, comprehensible to the non-mathematician, attracted many readers. It speedily went out of print and had the distinction, rare for a scientific book, of appearing in second-hand book catalogues at ten times its published price. Its central theme is the inquiry how far the form and structure of living things can be interpreted in terms of the physical forces acting within the life-time of the individual organism. It appeared at a time when increasing attention was being paid to this 'causal morphology' as distinguished from the 'historical morphology' which was the almost exclusive study of the period that preceded it. Sir D'Arcy was much too wise and experienced a naturalist to imagine that such an interpretation would take us all the way, but some of his followers were less cautious. In his second, much enlarged, edition, published in 1942, he has to add a warning; in the end, he says, "the twofold problem of accumulated inheritance, and of perfect structural adaptation, confronts us once again and passes all our understanding".

A striking testimony to the influence of this book on a younger generation of biologists is given by the volume of "Essays on Growth and Form presented to D'Arcy Wentworth Thompson", edited by Prof. W. E. Le Gros Clark and Prof. P. B. Medawar, published by the Clarendon Press in 1945.

This is not the place, even if I had the knowledge necessary, to assess the value of Sir D'Arcy's studies on the natural history of the ancient world. His "Glossary of Greek Birds" appeared in 1895, and a second edition in 1942: his translation of Aristotle's "Historia Animalium" was published in 1910 and his "Glossary of Greek Fishes" in 1945; the repute of these and his numerous shorter papers on classical subjects may be gathered from the fact that he was president of the Classical Association in 1929 and of the Scottish Classical Association in 1935. The list of his honorary degrees, honorary memberships, lectureships, medals and so forth is far too lengthy to be given here, ranging, as it does, from Aberdeen to Johannesburg and from Boston to Delhi. He was elected to the Royal Society in 1916, was a vice-president during 1931–33, and awarded the Darwin Medal in 1946. He was president of the Royal Society of Edinburgh during 1934–39. He flew to India at the end of 1946 as one of the four delegates sent by the Royal Society to the meeting of the Indian Science Congress in Delhi; but the strain of the journey was too much for his years and he never completely recovered his health. He was knighted in 1937.

Sir D'Arcy was a man of very striking presence with a resonant and beautifully modulated voice which made his lectures and addresses a pleasure to listen to.

Lady Thompson and her three daughters are assured of the sympathy of his innumerable pupils and friends in all quarters of the globe.

W. T. Calman

Sir D'Arcy Thompson was not the only man of science in his generation who 'kept up his classics' and pursued them in connexion with his professional work. Other biologists were Sir Edward Poulton and Dr. F. A. Dixey. But Sir D'Arcy's studies were on an ampler scale. Both his "Glossary of Greek Birds", published forty years ago and recently in a well-groomed second edition, and his "Glossary of Greek Fishes", reviewed in these columns only a few months since, are the classical books of reference in their subject, and illustrate his wide range of literary scholarship as well as his tireless industry. They are supported by a rich flow of smaller articles and notes covering a wider field, and by invaluable services as a member of the staff of the revised "Liddell and Scott". Two examples will illustrate his range and versatility. He was the first to make geometrical sense of Herodotus' description of the Great Pyramid, and to show how its form was related to the processes of its construction. And his knowledge was at his instant disposal. I referred to him some years ago, at the request of a distinguished surgeon, the Homeric description of the death-struggle of Nestor's chariot horse, struck through the forehead by an arrow. The reply came by return of post—"written in the laboratory": the arrow had grazed the cerebellum, and the convulsive movements of the limbs, causing the horse to roll over and over, were precisely what were to be expected. He had seen the same death-struggle in a rabbit, and dissected out the fatal pellet from an identical wound.

On the low shore of Lake Superior, the train nearly left behind three of the party, plucking wild raspberries. My snapshot bears the legend, "Berries and beavers".

John L. Myres

Prof. B. E. Livingston

With the passing of Burton Edward Livingston early this year, plant physiology in the United States has lost a distinguished figure. Himself an indefatigable investigator, he devoted much time and energy to the stimulation of scientific research and the promotion of co-operation and intercourse among his fellow men of science. From 1920 onwards he was a member of the executive of the American Association for the Advancement of Science, for fourteen years as secretary, and became its chairman in 1941. He served on the National Research Council. Among many other activities he took a prominent part in the foundation, in 1924, of the American Society of Plant Physiologists; he was elected one of its first vice-presidents and was the first to be elected life member under the Charles Reid Barnes Foundation. The esteem in which the Society held him as an investigator was very appropriately indicated when in 1946 it conferred on him the Stephen Hales Award, since his chosen field was the quantitative study of the water relations of plants, in which Stephen Hales was the pioneer.

Livingston's interest in this aspect of plant physiology was established at the very beginning of his career. Having graduated at Michigan in 1898, he went to Chicago as fellow and assistant in plant physiology. Five years later, at the age of twenty-eight, he published his book on "The Role of Diffusion and Osmotic Pressure in Plants". A visit in the summer of 1904 to the recently established Desert Laboratory of the Carnegie Institution at Tucson, Arizona, provided the material for his "Relation of Desert Plants to Soil Moisture and to Evaporation" (1906), in which the scheme of his later work was foreshadowed. A short period with the U.S. Bureau of Soils and three years at Tucson preceded his appointment in 1909 to the chair of plant physiology at the Johns Hopkins University, which he occupied until his retirement in 1940.

Livingston's contributions were marked by comprehensive grasp and clarity of analysis. He emphasized from the first the dynamic aspect of the relations between plants and their environment. His approach was primarily that of a physiological ecologist: the influence of Schimper is evident in his early work. He was impressed by the complexity of the environment and the interaction of factors in their influence upon the plant. He held the separate measurement of those factors to be insufficient in the study of plant distribution and adaptation; so he sought methods of assessing their integrated effects. He introduced the dynamic concepts of the water-supplying power of the soil and the evaporating power of the air. His porous porcelain atmometers (evaporimeters) with standardized spherical bulbs have been very widely used. He sought to measure the water-supplying power of the soil by inserting osmometers in it. Although he may have over-estimated the mobility of capillary water, his experimental approach was sound and stimulating. Connected with these investigations was his introduction of the auto-irrigator, a porous pot supplying water to the soil at a predetermined capillary potential.

As physiologist he sought to express the water relations of plants in terms of quantitative physical laws, as affected by variations of water content and internal resistances as well as by external factors. As ecologist he aimed at correlating the distribution of vegetation with the quantitative data and at giving precision to otherwise vaguely defined distinctions. This is the keynote of "The Distribution of Vegetation in the United States as related to Climatic Conditions", which he published with Forrest Shreve in 1921.

The long series of papers which emanated from Baltimore during the thirty years of his tenure are ample proof of the stimulus of his leadership.

D. Thoday

NEWS and VIEWS

Egyptology in the University of Liverpool: Prof. A. M. Blackman

With the retirement, on reaching the age-limit, of Dr. Aylward M. Blackman from the Brunner chair of Egyptology, which he has held since 1934, the University of Liverpool loses a fruitful teacher and a valued contributor to a number of branches of ancient Egyptian studies. Born at Norwich in 1883, and a keen student of Egyptology from the age of sixteen, Dr. Blackman was educated first privately, then at St. Paul's School, London, and Queen's College, Oxford, where in 1906 he took a first class in Oriental Studies. During 1906–14 and 1920–21 he took part in or directed excavations and recording in Egypt (Oxyrhynchus, Abydos, Meir, El-Amarnah) and the Sudan (Survey of Nubia, Buhen, Faras, Sesebi). During 1912–18 he was Laycock Student of Egyptology of Worcester College, Oxford. Since 1935 he has been joint editor, with Prof. J. P. Droop, of the *Annals of Archæology and Anthropology*, and during 1922–35 was a member of the Council of the Royal Asiatic Society. From 1936 on he has been special lecturer in Egyptology in the University of Manchester. His publications have been numerous; chief among them are four volumes on "The Rock Tombs of Meir" (1914–24), with about eighty plates drawn by himself, and volumes on the Lower Nubian temples of Dendûr, Derr and Bîgeh. Other works deal especially with Egyptian myth and ritual. He has done much to present Ancient Egypt to a wide public. All Egyptologists will hope that it will be possible for Dr. Blackman to continue his Egyptological researches for many years to come.

Mr. H. W. Fairman

Dr. Blackman's successor is Mr. Herbert Walter Fairman, who has been an active worker in the field since 1929 (war-service excepted). Mr. Fairman was born at Clare, Suffolk, in 1907; but he spent his early years in Egypt, where his father was a missionary. He was educated at Goudhurst School, Kent, going eventually to the University of Liverpool, where he studied Egyptology under the late Prof. Peet. For the next ten years he took part in excavations conducted in Egypt and the Sudan by the Egypt Exploration Society—at the cemetery of the Buchis bulls at Armant, 1929–31; at El-Amarnah, 1930–36; at Sesebi, 1936–38; at Amarah West, 1938–39 and 1947–48. In 1937 he became the Society's field director. At Armant and El-Amarnah he was primarily responsible for the publication of the inscriptions. The need to interpret the difficult late writing of the Ptolemaic and Roman inscriptions relating to the Buchis bulls led him to specialize in the texts of those periods, and he has become one of the very few contemporary authorities on them. During 1940–47 he was engaged in war-time duties at the British Embassy, Cairo, and while there he gave many lectures on Ancient Egypt to troops in his spare time. It is hoped that his teaching duties at Liverpool will leave him opportunities to continue his researches into the texts of the latest periods, which contain many remarkable matters not generally known even to Egyptologists.

Chemistry at the University College of North Wales, Bangor: Dr. Stanley Peat, F.R.S.

Dr. Stanley Peat, reader in organic chemistry in the University of Birmingham, has been elected to the chair of chemistry at the University College of North Wales, Bangor, University of Wales, in succession to Prof. E. D. Hughes, who is going to University College, London (*Nature*, April 3, p. 511). Dr. Peat had a distinguished career as a student of King's College, Newcastle, University of Durham, which he entered with a State Scholarship and the Earl Grey Scholarship in 1921. He graduated with first-class honours in the University of Durham in 1924 and was awarded the Saville Shaw and the Freire-Marreco Medals on graduation. He there joined the research school of Sir Norman Haworth, and eventually followed him to the University of Birmingham. His first joint publication in 1926 was on a revision of the structural formula of glucose. After obtaining his doctorate he was appointed lecturer in the Department of Physiology in the Medical School of Birmingham under Prof. I. de Burgh Daly, and published several papers in physiological journals on histamine. In 1934 he transferred to the teaching staff of the Department of Chemistry at Birmingham and engaged in constitutional studies of the polysaccharides. Outstanding among his publications are: his proof by synthesis of the configuration of glucosamine, the constitution of maltose, the studies of the mechanism of inversion of configuration in the sugar group, and especially the study of the enzyme systems responsible for the synthesis and degradation of starch. This latter work has led to the isolation of the *Q*-enzyme which is responsible for the biosynthesis in the presence of phosphorylase of the major component of starch, amylopectin. He has shown, moreover, that the *Q*-enzyme from potato converts the amylose to amylopectin, and he has devised an elegant method for the separation of the two components of starch. His more recent work has been on the photochemical degradation of carbohydrates, which has opened up what is practically a new field of investigation, the main features of which appear to be an indication of the reversal of the photosynthesis of starch. He has served as the English editor of the international publication "Advances in Carbohydrate Chemistry".

Royal Society of Medicine : Sir Henry Dale, O.M., G.B.E., F.R.S.

THE Royal Society of Medicine elects its president annually, and he may be re-elected for a second year. The practice has been to offer the presidency in turn to a physician, a surgeon and a specialist. This year it has been the turn of the specialist, and Sir Henry Dale, the distinguished former director of the National Institute for Medical Research, and president during 1940–45 of the Royal Society, has been elected; this is the first time that a man whose chief claim to distinction has been in the field of pure science has been elected. The Royal Society of Medicine, like so many learned bodies, originated from meetings of a group of young men in London eager to discuss their work. It was founded in 1805, and its chief purpose has always been "the cultivation and promotion of physic and surgery, and all the branches of science connected with them". It received a Royal Charter in 1834. During its first century, the Society was mainly active in London, but in 1907 a number of medical societies joined forces with the Royal Medico-Chirurgical Society of London, as it was then called, to form the present well-established body, and a Supplemental Charter was given it. The Society now has some 9,000 fellows, of whom more than 1,200 are overseas ; all nationalities are represented. The Society functions through twenty-four specialized sections, which hold some two hundred meetings between them every year. Members of the Society are justly proud of its library, which has a record of great activity. Apart from the provision of books, it has been able, through a grant from the Rockefeller Foundation, to give substantial assistance in the restoration of medical libraries which had suffered through the War, by providing microfilm copies of journals now out of print.

Air Photography and Archæology

THE importance of air photography for the archæologist cannot be exaggerated. Not only does it permit accurate plotting of the visible monuments of an area to be made when detailed maps of the district are inaccurate or non-existent, but further it frequently indicates where ancient monuments now disappeared had once stood. Let us suppose a building, say, a Roman villa, once occupied an area of ground. Where the foundations had been dug the soil would have been disturbed, and, though perhaps nothing is visible now above ground, below the soil much brickwork, etc., would still occur. Corn or other crops on the field where the villa had been would grow somewhat differently as to height and density where the foundations lie, and would thus mark out as it were on a plan where they were. On the ground nothing can be seen ; from the air the whole is clearly set out. Messrs. Kodak are to be congratulated on the exhibition of such photographs which has been arranged at their premises in Regent Street, London, and is open to the public until July 21. An excellent explanatory pamphlet by Dr. J. K. St. Joseph, illustrated by a number of actual air photographs, has been issued. There are also maps showing where the various sites appearing in the exhibition occur. Such well-known localities as Stonehenge and Avebury have been included.

Biological Research Institute, Tihany

THE Director-General of Unesco, Dr. Julian Huxley, during his four-day visit to Hungary as guest of the Hungarian Government, spent June 13 at the Biological Research Institute at Tihany, Lake Balaton (see *Nature*, **158**, 456 ; 1946). Dr. Huxley was interested in the success of the efforts, made immediately after the cessation of fighting and during the inflation, which have resulted in a Research Institute capable of publishing, each year since 1945, the Archiva Biologica Hungarica, containing some thirty-five papers in congress languages (mostly in English). He approved the idea which had here been followed of assembling in one Institute the greatest possible variety of biological disciplines, and showed himself keenly aware of the many advantages of such a system, especially in small countries. Dr. Huxley was interested to hear that several research workers were to go to the Institute for a period. Two places are reserved for invited Russian biologists ; two English men of science are going for the summer and autumn and two Finnish biologists are also expected.

Exchange of War-time Periodicals with Germany

EFFORTS are still being made by the Foreign Office to make possible the exchange in bulk of periodicals issued during the Second World War by British learned societies, universities, and other institutions with those published by similar bodies in Germany. These efforts are more likely to be effective if information concerning the numbers of publications involved can be supplied. Interested librarians are accordingly asked to notify either the Director of the Association of Special Libraries and Information Bureaux, 52 Bloomsbury Street, London, W.C.1, or the Secretary of the Library Association, if they have not already done so : (*a*) of the total number of volumes or parts of periodicals issued during the War and held by them for exchange with German institutions, and (*b*) of the numbers which they should receive in return, indicating clearly whether it is known that these German publications are available for exchange purposes. The returns should be headed : "German exchange". It should be understood that the information asked for relates only to the war-time accumulation of periodicals for exchange. Future exchanges must be arranged by institutions in the two countries privately.

Benjamin Franklin as Printer and Publisher

VOL. 92, No. 2 of the *Proceedings of the American Philosophical Society* (1948) is devoted to studies of historical documents in the library of the Society at Philadelphia. Chief among these is a paper by W. E. Lingelbach on new source material regarding Benjamin Franklin's activities as printer and publisher both during the first half of his life and in his later years. Much of the material relates to his interests in Philadelphia during 1728–66, the most interesting being concerned with his printing activities in Passy. This latter includes a unique collection of more than four hundred brass stencils, apparently used by Franklin in the study and designing of type, as well as inventories of fonts cast at Passy and of type and other printing materials purchased from the leading English, French and possibly Dutch type-founders. Other articles in this number include Prof. G. Chinard's study of Franklin as negotiator, December 1777, Prof. P. A. W. Wallace's appreciation of H. E. Muhlenberg's work as botanist, Prof. T. D. Cope's note "Collecting Some Material about Charles Mason and Jeremiah Dixon", the astronomers and geodetic surveyors, and Prof. I. J. Cox's account of the Freeman Red River Expedition of 1806.

Establishment of Hardwoods in Britain

MANY will welcome the small Forestry Commission pamphlet No. 2 of the Forest Operations Series (who invents these cumbersome titles ?) on the "Establishment of Hardwoods" (London : H.M. Stationery Office. 9*d.* net). The small area of 35,000 acres only was afforested or replanted in Britain with various hardwoods during the first twenty-five years of the Forestry Commission. A bulletin recording the information so far gathered on the subject of sowing and planting to form the new plantations was in the press just before the outbreak of war, but was destroyed during the bombing of London. The present one has been prepared from a report of Mr. A. H. Popert, acting conservator in the south-west of England, as a result of a tour of the Commission's hardwood plantations. It is perfectly well known that the raising and tending of young hardwood crops, save in exceptionally favourable circumstances of habitat, are more difficult and call for more experience than is required for conifers. The bulletin gives notes on the chief timber species—oak, beech, ash, sycamore, sweet chestnut, birch and alder. It also deals with the treatment of coppice woods and devastated woodlands ; on these latter subjects, some who have lived with and studied coppice areas may differ from the views contained in the paper. As a result of war-time and present-day fellings of the fine hardwoods, it is noted that the "Establishment of broad-leaved trees is likely to assume increasing importance in British Forestry".

"Not poppy, nor mandragora . . ."

"An Index of Modern Remedies", by William Mair, has, since it was first published in 1941, been useful to the medical and pharmaceutical professions, to whom alone it is issued. The appearance of a new edition (Fourth Series, 1948. *Scottish Chemist*, 240 Albert Drive, Pollokshields, Glasgow, S.1 ; and from Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, London. 3*s.*) will therefore be welcomed. This new edition contains, as well as a few recently coined names of remedies, a valuable article on the 1948 edition of the British Pharmacopœia, with lists of the 250 new admissions to this publication and of the omissions from it. There is also a useful list of costly and essential drugs now exempted from the purchase tax. As Mr. Mair rightly says in his introductory note, no physician or pharmacist can nowadays be familiar with the names, composition and action of all the pharmaceutical preparations on the market, and he has set out to give this information in a handy and well-indexed form. He also gives, by means of a key, the names and addresses of manufacturing chemists and the preparations which they make. Using this book, one realizes how many names some drugs nowadays have, the changes these names have undergone and how different they may be in different countries. Pentothal, for example, is now thiopentone soluble B.P. and U.S.P., and aminacrine hydrochloride B.P. used to be, and no doubt still is in some quarters, acramine, monacrin or acramine yellow. The maze of names given to the antimalarial drugs and to the sulphonamides and their derivatives are here sorted out, and a short supplement lists special injection solutions for parenteral therapy. More than half the book is devoted to a classification of various remedies according to their mode of action. In this section the statement that phenothiazine is an anthelmintic of low toxicity needs modification. As Prof. J. H. Gaddum says in his foreword, this book is a valuable guide and provides information not easily obtained elsewhere, even in more expensive books.

Pfund Issue of the *Journal of the Optical Society of America*

THE October 1947 issue of the *Journal of the Optical Society of America* is the largest issue of the journal ever to be published and was specially called the "Pfund Issue". It consists of articles written by Prof. A. H. Pfund's former students and colleagues and is a tribute to him on his retirement from active teaching at the Johns Hopkins University. An advance copy of this issue, together with a 'scrap-book' containing the letters which accompanied the manuscripts of the articles when they were submitted for publication, was presented to Prof. Pfund at the dinner held during the thirty-second annual meeting of the Society in October last. A photograph of Prof. Pfund is on the opening page, and the first of the twenty-three articles in the issue is by Prof. R. W. Wood, who writes on "The Use of Echelette Gratings in High Orders". Two of the articles are actually by Prof. Pfund himself and co-workers, but he was unaware that his colleagues had submitted the papers for a special issue of the *Journal.* They deal with selective infra-red gas analysers and with optical scattering by dielectric powders. The other articles include : a historical note on the rate of a moving clock by H. E. Ives ; a spark light-source of short duration by J. W. Beams and others ; an optical study of acoustic fields near diffraction edges by J. C. Hubbard and others ; and practical methods of making and using multilayer filters by Mary Banning.

Hot-wire Vacuum Switches

SUNVIC CONTROLS, LTD., 10 Essex Street, Strand, London, W.C.2, manufacturers of vacuum switches, temperature control and associated equipment, have recently issued a 16-page illustrated pamphlet describing their hot-wire vacuum switches. The Sunvic hot-wire vacuum switch is contained within an evacuated glass tube not much larger than an ordinary radio valve, and is a non-arcing electric relay, the operation of which depends on the fact that when an electric current is interrupted by the separation of two surfaces in a vacuum no arc is formed. The movement necessary to close or open the switch is quite small and is provided by the thermal expansion of a special steel wire through which a control current of some 25–60 m.amp. is passed. The switch contacts are tungsten and are normally held apart against a compressed spring, which is released by the expansion of the hot wire. The operating characteristics of many different forms of hot-wire vacuum switches with various time delays, closing currents and current-carrying capacities are listed, and twelve different standard circuit and wiring diagrams are shown. The hot-wire vacuum switch is capable, in various sizes, of handling up to 10 kW. at 440 volts, and is suitable for controlling alternating or direct currents up to 30 amp. and voltages from 10 to 600.

J. J. Thomson on "Cathode Rays"

THE text of J. J. Thomson's historic Royal Institution lecture of April 30, 1897, on "Cathode Rays", has been reproduced in full in the November–December issue of the *American Journal of Physics* as the contribution of the American Association of Physics Teachers to the Electron Jubilee celebrations (see also *Nature*, **160**, 776; 1947). It will be recalled that it was in this lecture that J. J. Thomson, after discussing Lenard's, Perrin's and some of his own experiments on the charges carried by cathode rays, concluded that "the size of the carriers [of electrical charge] must be small compared with the dimensions of ordinary atoms and molecules". Further, that from his experiments on the deflexion of cathode rays, he was able to deduce a value for m/e which, quoting from the final words of the lecture, was "of the same order as the value 10^{-7} deduced by Zeeman from his experiments on the effect of a magnetic field on the period of the sodium atom".

Italian Polar Research Institute

A NEW polar institute, Istituto Geografico Polare, has been formed in Italy under the directorship of Dr. S. Zavatti. The *Polar Record* for January–July announces that the aims of the institute are: (1) to widen knowledge of all polar areas; (2) to encourage interest in polar affairs in Italy and to publish Italian contributions to polar knowledge; (3) to form a polar library; (4) to publish a monthly periodical, *Il Polo*; and (5) to publish maps of scientific value on polar regions and a series of "Polar Classics". The first number of *Il Polo* came out in February 1946. The address of the new institute is Istituto Geografico Polare, Porto Potenza Picena, Macerata.

Pathogenicity of *Aspergillus nidulans*

THERE are numerous reports in medical literature of infection of man and other animals by species of the fungal genus *Aspergillus*. Pathogenicity of *A. fumigatus* is comparatively well known, and *A. nidulans* has occurred in circumstances which seemed to implicate it as a cause of disease. Dr. Charles H. Drake has studied the latter species in a recent paper (*Mycopathologia*, 4, Fasc. 2, pp. 103; 1948). He finds that the fungus is pathogenic to rabbits, causing initially a purulent inflammation with abscess formation. Subsequent injections may give rise directly to tubercles, in which the fungus changes morphologically to give actinomycetoid granules. Cell-sap of *A. nidulans* is not toxic to rabbits, but stimulates the formation of precipitins. This species does not appear to be pathogenic to guinea pigs, which fact might explain some earlier uncertainty about its disease-producing character.

Land-mine Detectors

FOLLOWING a request, received early in 1940, by the Scientific Advisory Committee of G.H.Q. Middle East for work to be undertaken on the design and construction of land-mine detectors, Dr. Lawrence Balls, then chairman of the Committee, together with Mr. J. H. Cole, and with the assistance of military personnel, produced, and tried out in actual operations, several successful models. In an article entitled "Land-mine Detectors designed at Giza", which Dr. Balls contributes to the June number of *Reme*, the journal of the Corps of Royal Electrical and Mechanical Engineers, details are given of the construction, performance and characteristic features of these land-mine detectors. They were of various sizes, the large models suitable for road clearance, and the smallest for surgical applications, such as shrapnel detection in wounds. The Mark IV design was first used, but was superseded by an original design due to Dr. Balls, consisting of twin search-coils, thus giving double sensitivity. Coils of about 12-in. diameter were found convenient for ordinary field detectors, and of about ⅜-in. for surgical use. Operating on the heterodyne principle, a frequency of one megacycle per second proved most useful, with a frequency ratio of two-thirds to produce the audio-frequency beat-note. Segmented screening, twin oscillators, and a low-loss chassis were the three main characteristics of the 'twin' design. The earthed screen surrounding a search-coil was cut, usually, into twelve segments, each segment being separately connected by a thin wire to a central earth on the chassis. The two identical search-coils, mounted together in the same plane, were inductances of separate oscillatory circuits, driven from a single twin-triode valve. Passage of the coils over a metal object caused the beat-note, somewhat lower than middle C, to be altered downward by one coil and upward by the other, thus causing the headphone note to change suddenly from a progressively lowering growl to a falling high shriek as the object passed from one coil to the other. The weight of a one-man detector is naturally a matter of practical importance, and a prototype, of which two copies were flown to Britain in 1943 but too late to be considered for production, and which was made of wax-boiled wood though designed for production in plastics, weighed only 14½ lb., of which the batteries accounted for more than half.

Mathematical Tables for Science and Industry

THE lack of the relevant mathematical tables for investigations in the physical, chemical and engineering sciences, in mathematics and in industry may well delay progress, and steps are being taken to meet the difficulty. Much work in this field has been done, and tables of a fundamental nature have been produced by the British Association through its Mathematical Tables Committee. These activities have now been transferred to the Royal Society on the invitation of the British Association, and a special Royal Society Mathematical Tables Committee has been established to continue and extend the earlier work. The Committee would be glad to receive suggestions from industrial research groups, from individual investigators and from Service departments relating to existing needs in their special fields. Requests for assistance may be met either by advice as to the most economical way of producing the desired tables, or by an undertaking to produce the tables under the auspices of the Royal Society, or, in exceptional cases, by a grant towards the cost of tabulation or to make possible the publication of important tables which may exist only in manuscript. In the first instance inquiries should be addressed to the Assistant Secretary, Royal Society, Burlington House, London, W.1.

Congress of the Universities of the Commonwealth

THE sixth Congress of Universities of the Commonwealth will be held at Oxford during July 19–23. Some three hundred delegates are expected to attend, and observers have been appointed by Unesco, the United States and various learned institutions. Among the topics to be discussed are: relations of the State and the universities; inter-university relations; a critical review, from the points of view of a historian, a philosopher and a sociologist, of the structural and moral changes produced in modern society by scientific and technological advance; the balance of research and teaching in universities; general plan for colonial higher education; extension of the university secondment scheme. The Congress s being preceded by a private conference, held at Bristol during the past week, of executive heads of universities.

Fifth Commonwealth Entomological Conference

PRIOR to the War, Imperial Entomological Conferences were held in London at five-yearly intervals, but because of the War it is now thirteen years since the last one assembled. The Fifth Commonwealth Entomological Conference, to be held in London during July 22–30, will be attended by forty-wo delegates, eleven representing the United Kingdom, nine the Dominions and twenty-two the Colonies, Protectorates, Dependencies and Southern Rhodesia. All meetings, with the exception of certain business meetings to be held on July 22 and 30, will be open to the public. The Conference has been convened by the Executive Council of the Commonwealth Agricultural Bureaux and organised by the Commonwealth Institute of Entomology, which is one of the constituent bodies of the former organisaion. With the exception of one meeting to discuss plant quarantine, all other topics selected for discussion have been chosen because they relate to some branch of applied entomology in which outtanding developments have occurred since the last Conference which met in 1935; they include insecticides, biological control, estimation of insect populations in the field, control of insects in stored products, tsetse control, locusts and grasshoppers. Further particulars can be obtained from the director of the Commonwealth Institute of Entomology, British Museum (Natural History), Cromwell Road, London, S.W.7.

Conference on Biology and Civil Engineering

A Conference on Biology and Civil Engineering will be held at the Institution of Civil Engineers during September 21–23. This conference is intended primarily for members of the Institution and others engaged in civil engineering work where the problem of the effect of vegetation is an important factor. Papers will deal with research and other work carried out not only in Great Britain, but also in New Zealand, South Africa, Holland and the British West Indies. Among the topics for discussion are: causes, effect and prevention of soil erosion; effect of vegetation on drainage and floods; effect of vegetation in stabilizing artificial slopes; use of vegetation to tabilize sand dunes; effect of vegetation on the settlement of roads and structures; algal growth and ngineering design. All meetings will be held at the nstitution of Civil Engineers, from which further particulars can be obtained.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. J. L. D'Silva, reader in physiology at St. Bartholomew's Hospital Medical College, to the University chair of physiology tenable at the London Hospital Medical College, as from October 1; Mr. C. H. Gray, lecturer in biochemistry at King's College Hospital Medical School, to the University chair of chemical pathology tenable at the School, as from April 1; Dr. H. A. Magnus, director of the Pathology Department and morbid anatomist to King's College Hospital and to the Medical School, to the University chair of morbid anatomy tenable at King's College Hospital Medical School, as from April 1.

University of Sheffield

MR. S. C. GOODWIN has provided £600 per annum, under covenant for seven years, to provide, through the Cutlers' Company, a fellowship in the University of Sheffield which will be known as the Goodwin Fellowship for postgraduate work in engineering or metallurgy, to be offered in each of the next seven years. Each fellowship will be awarded by the Cutlers' Company, on the recommendation of the Senate of the University. The value of each fellowship will be £300 a year, tenable for two years.

The Council of the University of Sheffield has made the following appointments: C. R. K. Blundell, lecturer in geology; T. Summerfield King, lecturer in anatomy; A. A. Carlyle, lecturer in physiology; John Fiddes, assistant lecturer in physics; Gilbert Y. Kennedy, research worker in the Department of Pathology under the auspices of the British Empire Cancer Campaign.

University of Aberdeen

THE honorary degree of doctor of laws has been conferred by the University of Aberdeen on the following, among others: Dr. G. A. Currie, vice-chancellor of the University of Western Australia; Lord Dudley Gordon, president of the Institution of Mechanical Engineers; and Sir John Boyd Orr, director-general, United Nations Food and Agriculture Organisation.

The degree of doctor of philosophy has been conferred on the following, the title of the thesis presented appearing in brackets: C. H. Gimingham ("Life-Form in Plants and the Structure of Plant Communities"); N. Grassie ("A Study of the Thermal Degradation of Polymethyl-methacrylate"); H. G. M. Hardie ("Studies on Phosphate Fixation in Soil"); R. J. Hay ("The Kinetics of the Gas Phase Polymerisation of some Vinyl Derivatives"); Shih-Chen Liang ("The Study of Wood Anatomy within the Genus *Larix* and the Influence of Internal and External Factors Thereon"); Muriel Mackay ("Some Aspects of the Photo-polymerisation of Methylmethacrylate"); A. McLaren ("Certain Aspects of Free-radical-initiated Polymerisations"); C. R. Masson ("Osmometry of High Polymer Solutions"); Gargestwari Narayana Subba Rao ("Physico-chemical Investigations on the Muscle Proteins of some Commercial Species of Fish caught in North-East Scottish Waters"); J. C. Robb ("The Kinetics of the Interaction of Atomic Hydrogen with Olefines"); J. D. Stewart ("A Comprehensive Survey of the Mathematical Education of Engineers"); R. B. Whyte ("The Photosensitisation of Polymerisation in the Liquid Phase"); G. W. Youngson ("The Synthesis of Branched-chain Polymers").

Royal Commission for the Exhibition of 1851: Awards

The Commissioners for the Exhibition of 1851 have announced the award of Overseas Science Research Scholarships for 1948 to the following (the subject and place of research are given in brackets). On the recommendation of the University of Toronto: A. C. Hollis-Hallett (physics, University of Cambridge). On the recommendation of the University of Melbourne: N. N. Greenwood (physical chemistry, University of Cambridge). On the recommendation of the University of Sydney: Miss D. C. Davison (plant biochemistry, University of Cambridge); and P. B. Treacy (nuclear physics, University of Cambridge). On the recommendation of the University of New Zealand: C. F. Coleman (nuclear physics, University of Cambridge or Birmingham); D. S. Coombs (geology, University of Cambridge); and E. O. Hall (physics, University of Cambridge). On the recommendation of the University of Delhi: R. P. Bambah (mathematics, University of Cambridge or London). On the recommendation of the University of the Punjab: Miss M. Mehtab (cytology, University of Edinburgh).

Institution of Electrical Engineers: Officers for 1948–49

The following officers and new members of Council of the Institution of Electrical Engineers have been elected to take office on September 30: *President:* Mr. T. Graeme N. Haldane; *Vice-Presidents:* Mr. A. J. Gill, Col. B. H. Leeson; *Honorary Treasurer:* Mr. E. Leete; *New Members of Council:* Mr. S. E. Goodall, Mr. H. W. Grimmitt, Mr. J. Hall, Dr. W. G. Radley, Dr. H. W. H. Warren, Mr. E. L. E. Wheatcroft, Mr. M. W. Humphrey Davies, Mr. A. V. Milton.

Douglas Lea Memorial Lecture

As a memorial to the late Dr. Douglas Edward Lea, the Hospital Physicists Association has decided to found a memorial lecture, to be given biennially during one of the meetings of the Association, by a worker of distinction in the field to which Dr. Lea had made many outstanding contributions, namely, the actions of radiation on living cells. The lectures will be open to the public, and the Association has set up a Trust Fund to cover the expenses of these lectures in perpetuity. Any income in excess of that required to meet the expenses of the lectures will be devoted to scientific research or publication. Friends of the late Dr. D. E. Lea who may wish to contribute to this Fund are asked to communicate in the first place with Mr. J. W. Boag, Medical Research Council, Hammersmith Hospital, London, W.12, who will notify them of the way in which contributions should be made.

Announcements

The King in Council has approved of a charter granting full university status to the University College of Nottingham. Lord Trent, president of the College, will be the first chancellor; Mr. B. L. Hallward, head master of Clifton College, will be vice-chancellor.

The Hungarian Academy of Science has established an Eötvös Medal in commemoration of the hundredth anniversary of the birth of the famous Hungarian physicist, Loránd Eötvös. The first Eötvös Medal has been awarded to Prof. J. Barnóthy and Dr. M. Forró for their outstanding achievements in the realm of cosmic radiation.

The James Scott Prize for 1948 of the Roya Society of Edinburgh was presented to Prof. Herber Dingle at the ordinary meeting of the Society held o July 5, 1948, at which, in terms of the Prize, Prof Dingle delivered an address on "The Nature o Scientific Philosophy". The Neill Prize (1945–47 was presented *in absentia* to Dr. Robert Broom, fo his contributions to our knowledge of the foss vertebrates of the Karroo Beds of South Africa.

Dr. S. L. Hora, director of the Zoological Surve of India, has been appointed an honorary member o " 's Lands Plantentuin" by the staff of the scientifi institutes of south-east Asia constituting this body The letter from Dr. L. G. M. Bass Becking, directo of the Botanic Gardens, Buitenzorg, giving this announcement, makes appreciative reference to Dr Hora's contributions to tropical zoology, to the spiri of co-operation and friendship he is always able t convey to colleagues abroad, and to the need fo scientific men in south-east Asia to join forces in promoting reconstruction measures.

The managers of the Royal Institution have mad the first appointment to the Science Researc Scholarships of the Institution offered to candidate from overseas universities. One of these scholarship is to be awarded each year on the advice and recommendation of the Science Scholarships Committee o the Royal Commission for the Exhibition of 1851 and the award for 1948 has been made to Mis Philippa Marion Glasgow; Miss Glasgow is a physica chemist, and holds the degree of M.Sc. of the University of New Zealand.

The following have been elected to Beit Fellowship for Scientific Research of the value of £400 pe annum each, tenable at the Imperial College o Science and Technology: P. W. M. Jacobs, fo research in physical chemistry under the directio of Prof. H. V. A. Briscoe; M. J. M. Bernal, fo research in applied physical chemistry under th direction of Sir Alfred Egerton.

The Flatford Mill Field Centre of the Council fo the Promotion of Field Studies, 10 Exhibition Road London, S.W.7, will be formally opened by the chairman of the Carnegie United Kingdom Trust, Mr E. Salter Davies, on July 23.

We have received a copy of No. 1 of Vol. 2 o *Quarterly Reviews*, published by the Chemical Societ (price to non-fellows, 8*s*. per number or 25*s*. pe annum). It contains, in 91 pages, articles by H. N Wilson and J. G. M. Bremner on "Disproportionation in Inorganic Compounds", by D. V. N. Hardy an N. J. L. Megson on "The Chemistry of Silicon Polymers", by L. J. Haynes on "Physiologically Active Unsaturated Lactones", and by A. D. Walsh on "Far Ultra-Violet Spectra, Ionisation Potentials and their Significance in Chemistry". The publication is intended to be of interest to chemists generally and not only to workers in the fields reviewed. A limited number of additional subscriptions for Vol. can be accepted.

Erratum. We regret that the illustration accompanying the communication entitled "Eye Movements During Monocular Fixation" by Drs. Mary P Lord and W. D. Wright (*Nature*, July 3, p. 25) ha been printed upside down.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

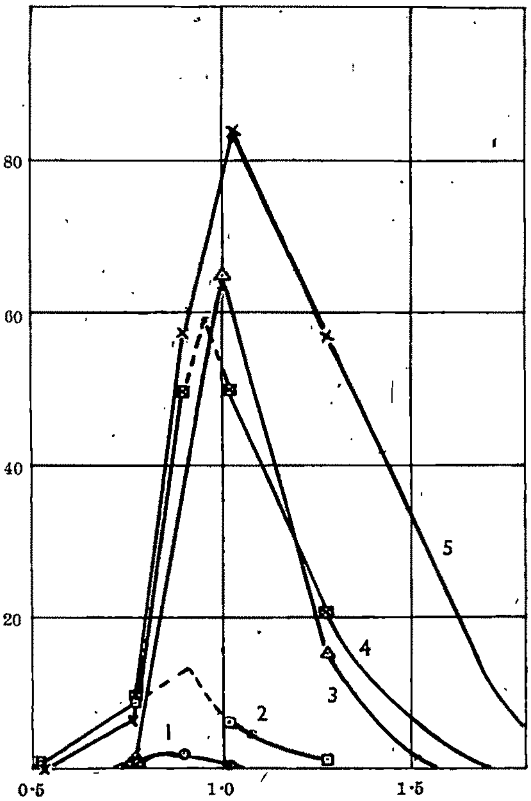
Role of the Hydroxyl Group in the Gelation of Aluminium Soaps in Hydrocarbons

IN most of the early investigations, aluminium soaps were prepared by aqueous metathesis between a soluble soap and an aluminium salt. As pointed out by McBain[1], the result of reaction between a weak acid and a weak base is not likely to produce a stable salt. The tendency of aqueous solutions of aluminium salts to precipitate aluminium hydroxide over a range of *p*H is well known, so some at least of soap prepared by aqueous metathesis is likely to consist of fatty acid adsorbed on to precipitated aluminium hydroxide. Analogous to the alumino silicates, alums, etc., one could associate a co-ordination number of four or six with aluminium, giving many different possibilities of co-ordination with fatty acid radical, undissociated fatty acid and water. When the effect of *p*H, heat and method of preparation on such a heterogeneous system[2] is considered, it is not surprising that results are difficult to duplicate.

At ordinary temperatures, soaps prepared by the above method have a negligible solubility in hydrocarbons, and tend to gel. On the other hand, a fatty acid and an aluminium alcoholate, when moisture is igorously excluded, react exothermically to give a product which is extremely soluble in benzene and does not gel. A study of benzene solutions of these aluminium 'soaps' prepared in the absence of water has given some interesting results. In each case the 'soap' is prepared *in situ*, and so the solution contains some free alcohol.

(1) The addition of very small amounts of water auses a marked gelling and increase in viscosity even at low concentrations of soap. A quantitative study of this is presented in the accompanying graph. n this case the equivalent of two molecules of fatty acid per molecule of aluminium alcoholate, $\mathrm{Al}(\mathrm{O}R)_3$, was allowed to react in a solution containing 2·66 per cent aluminium *sec.* butylate, and the viscosity was plotted against the number of molecules of water per atom of aluminium. The viscosity is anomalous and is therefore given as the time of fall of a 3/32-in. diameter steel ball through 5 cm. of the system. Within experimental error, it can be seen that in ach case the viscosity rises to a steep maximum at the equivalent of one molecule of water per atom of aluminium, and then falls sharply until at about he equivalent of 2 moles of water precipitation of soap begins. The position of the maximum viscosity is independent of the relative or total amounts of fatty acid and alcoholate allowed to react together; however, in the region of 1·0 mole of fatty acid per mole of alcoholate, precipitation and heterogeneity make results unreliable. The highest maximum is produced by 2 moles of fatty acid per mole of alcoholate.

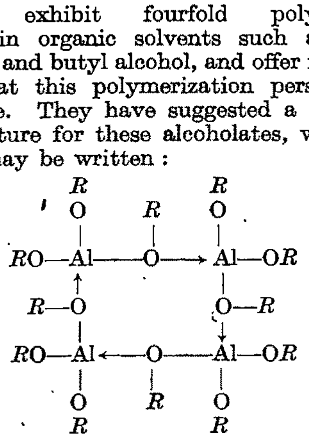
(2) It is possible to obtain reproducible, rather unstable solid monolayers by spreading on water a benzene solution of soap, prepared anhydrously as above. The compressed monolayers, which will tand pressures up to 50 dynes per cm. for a few minutes, show an area of 19 A.^{2} per molecule of fatty acid, provided the molecular ratio of fatty acid to alcoholate exceeds 1·5. Below this, a considerable decrease in area is observed, indicating that fatty acid has been removed from the surface.



CURVE 1, BUTYRATE ; 2, CAPROATE ; 3, DECANOATE ; 4, LAURATE ; 5, PALMITATE

Results further confirm the conclusions of other workers[1,3] that the aluminium tri-soap, empirically $\mathrm{Al}(\mathrm{O}F)_3$, does not exist, and that at most two fatty acid molecules react with one of alcoholate to give a di-soap mono-alcoholate $\mathrm{Al}(\mathrm{O}F)_2\mathrm{O}R$. The change in viscosity, on addition of water to the freely flowing solution of the anhydrously prepared soap, demonstrates the essential part played by the hydroxyl group in the gelation of aluminium soaps in hydrocarbons. The fact that the water reacts exothermically, releasing alcohol, and that the product of reaction is similar in all properties to the di-soap prepared by aqueous metathesis, leaves little doubt that a hydroxy compound is being formed.

Robinson and Peak[4] have shown that aluminium alcoholates exhibit fourfold polymerization, $[\mathrm{Al}(\mathrm{O}R)_3]_4$, in organic solvents such as benzene, naphthalene and butyl alcohol, and offer inconclusive evidence that this polymerization persists in the vapour state. They have suggested a stable octahedral structure for these alcoholates, which, when modified[3], may be written:



$$\begin{array}{ccccc} & R & & R & \\ & \mathrm{O} & R & \mathrm{O} & \\ & | & | & | & \\ R\mathrm{O}- & \mathrm{Al} & -\mathrm{O}\rightarrow & \mathrm{Al} & -\mathrm{O}R \\ & \uparrow & & | & \\ R- & \mathrm{O} & & \mathrm{O} & -R \\ & | & & \downarrow & \\ R\mathrm{O}- & \mathrm{Al} & \leftarrow\mathrm{O}- & \mathrm{Al} & -\mathrm{O}R \\ & | & | & | & \\ & \mathrm{O} & R & \mathrm{O} & \\ & R & & R & \end{array}$$

This structure would account satisfactorily for the stability, low melting points and boiling points and other properties of aluminium alcoholates. It indicates, too, that two alcoholate groups would react differently from a third; this partially steric effect could account for the difficulty of replacing three alcoholate groups by fatty acid.

On replacement of —OR by —OH, a more strongly electronegative group, the co-ordinate bond $\overset{R}{—\mathrm{O}}\rightarrow\mathrm{Al}$ is enormously weakened, allowing the possibility of disruption of the closed-ring polymer and the formation of long chains by hydroxyl bonding. Obviously this chain formation, and so gelling, is at a maximum when one —OH group is attached to each aluminium atom, and begins to fall off as other compounds such as water, amines, phenols, etc., which compete for hydroxyl bonds, are introduced. This agrees with practice. The lack of gelling power shown by aluminium mono-soaps can be explained by intra-molecular hydroxyl bonding.

An aluminium soap hydrocarbon gel can then be considered as made up of very large molecules loosely held together by (1) hydroxyl bonds, (2) Van der Waals attraction of long hydrocarbon chains. That a balance between these two types of bond exists is shown by the fact that equal concentrations (by weight) of soaps of varying chain-length show little variance in visco-elastic properties, as compared with the large differences shown by the equimolecular concentrations of the different long-chain soaps (see accompanying graph).

The influence of a third possible linkage, from the carboxyl group of the soap, C=O→Al, is being investigated. Details will be published elsewhere.

We are grateful to the chief scientist, Ministry of Supply, for permission to publish this communication.

T. S. McRoberts
J. H. Schulman

Department of Colloid Science,
University, Cambridge.
March 10.

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Processing Thick Emulsions for Nuclear Research

In the application of the photographic method to research in cosmic-ray and nuclear physics, the need has always been felt for emulsions of thickness comparable with the range of the particles to be recorded. The use of thick emulsions has been greatly restricted, however, by the difficulties met in processing them. It has been possible to use plates with emulsions 200 μ thick but, using conventional methods, the degree of development is found to be much greater at the top than at the bottom of the emulsion. It follows that the grain density, in the tracks of particles of the same ionizing power, varies with the depth of the track; a result which leads to great difficulty in interpreting the experimental material even in experiments where it is possible to use short exposures so that complications due to fading are not present. We give here a brief outline of a method of processing which has enabled us to produce a nearly uniform development of emulsions 300 μ thick, so that the grain density in the tracks o particles in regions of equal ionization does not var by more than 10 per cent from the top to the bottom of the emulsion.

To secure uniform development, we must in principle make sure that the developer has time to permeate the emulsion before it acts. This might b achieved by soaking for a long time in a develope which acts very slowly (by reason, for example, o low concentration of alkali, high concentration o restrainer, or low temperature). Alternatively, w may attempt to separate the processes of permeatio and development. We have done this by cold soaking followed by rise of temperature, making use of th fact that the rate of permeation has a lower temperature coefficient than the rate of development.

The procedure is as follows: the plates are first soaked in water and then in cold developer. The temperature is next raised with the plates protected from a further increase in the concentration of th developing agent. After a suitable period of development, further action is checked in a cold stop bath, and the fixing is begun in a cold solution, the temperature of which is afterwards raised (see Fig. 1).

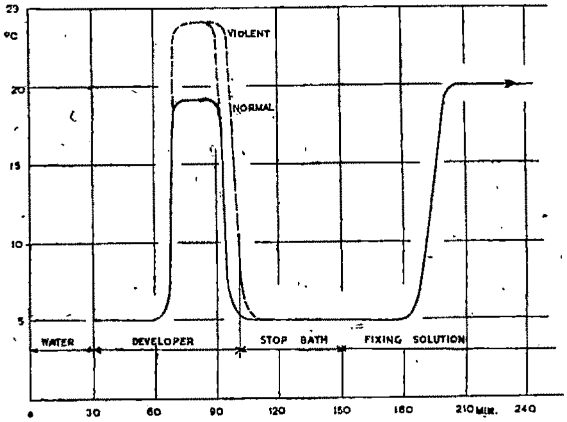
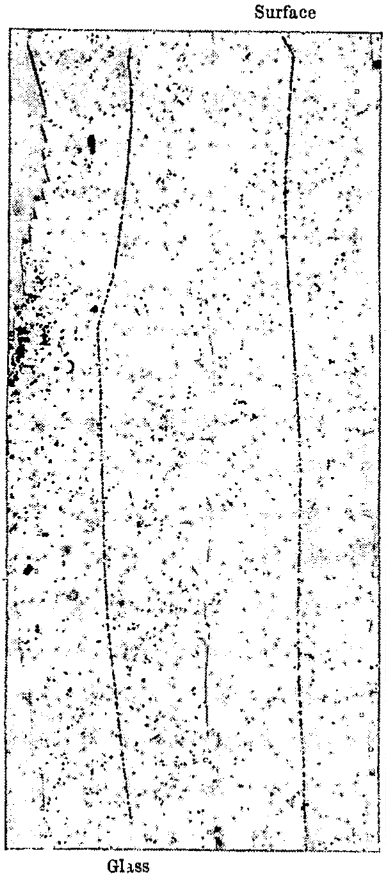


Fig. 1. Graph of typical operation for 300-micron plates

The accompanying photomicrographs (Fig. 2) show proton tracks at different depths in an emulsion 300 μ thick. The number of grains in the last 200 μ is 37 for the surface track and 361 for that which start at the glass.

This method, which we call 'temperature development' (T.D.), has a greater flexibility than that commonly employed. The conditions of development i the ordinary method are determined more by th time that must be allowed for the penetration of th solution into the emulsion than by any other factor. In temperature development, most of the development takes place when the temperature is high, afte the solution is nearly uniformly distributed throug the plate. This makes it possible to achieve differen degrees of 'discrimination' in the same type o emulsion, by varying the temperature and time o development and the composition of the develope

A stringent test of the advantages of the metho has been given by observations on β-ray tracks i the new Kodak X-ray emulsions[1]. Since the electro is highly scattered, it is difficult to find the complet track of a 100 keV. electron in an emulsion 50 thick. In the 100 μ and 200 μ emulsions, temperatur development made it possible to follow the β-ra tracks to greater lengths than in normally develope plates. Moreover, by 'violent' uniform developmen



(a) Fig. 2 (b)

Fig. 2. PROTON TRACKS IN A 300-MICRON PLATE. RECOIL PROTONS FROM NEUTRONS FROM A RADIUM–BERYLLIUM SOURCE. γ-RAY BACKGROUND

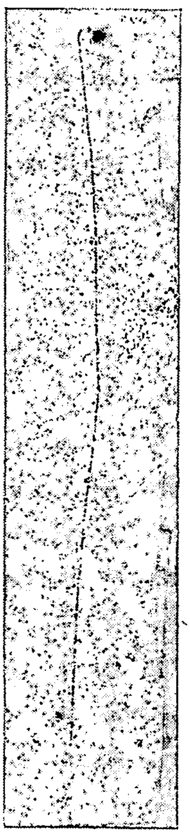


Fig. 3

Fig. 3. PROTON TRACK IN A 700-MICRON PLATE. AVERAGE DEPTH OF TRACK, 680 MICRONS. HEAVY γ-RAY BACKGROUND

it is possible to detect the last grains of electron tracks at every depth, even in the Ilford emulsions.

We cannot give here a standard development procedure, for in the experimental plates on which we have been working the optimum conditions vary from batch to batch of the same nominal type of emulsion, and must therefore be found by trial and error. The strength of the developer must be adjusted to achieve penetration with little development during the cold stage, and the temperature raised for a time between 10 and 40 min., to between 18° and 30° C., according to the degree of discrimination required and to the composition of the plate. Boron 'loaded' plates always show considerable unevenness in development. The presence of local concentrations of the 'loading' salt results in 'islands' in the tracks, regions of exceptionally high grain density, and blistering due to local swelling. These drawbacks tend to offset the advantages which have been claimed for the use of these plates in cosmic-ray work[2].

By diminishing the activity of the developer, and increasing the time of cold soaking, 700 μ plates were processed without great difficulty (Fig. 3).

At such depths, the optical conditions become critical. Inhomogeneities and impurities in the upper layers of the emulsion impair the image in the microscope and lead to apparent 'scattering' of the tracks below. If the number of 'events' in the emulsion is too high, 'deep' tracks may be completely obscured. Some of the impurities can be removed by thorough washing in distilled water. The translucency of the emulsion can also be improved by immersing it in a second strong fixing solution after it has been washed and dried in the normal way. When it is possible to look from the other side of the emulsion[3], which can be done with an ordinary microscope if either a stripped emulsion or one backed by thin celluloid is used, the maximum thickness which it is possible to observe can be doubled. It seems now that the limit to the use of very thick emulsion is set by optical, rather than processing, difficulties.

We wish to express our gratitude to Dr. C. F. Powell for helpful discussions during the work; to Mr. C. Waller of Ilford, Ltd., and to Dr. W. F. Berg, Dr. R. W. Berriman, Dr. R. H. Herz and Dr. G. W. W. Stevens of Kodak, Ltd., who prepared the special emulsions for us. We wish also to thank Mr. E. Samuel for his invaluable help with the photomicrographs.

C. C. DILWORTH
G. P. S. OCCHIALINI
R. M. PAYNE*
H. H. Wills Physical Laboratory,
Bristol.
May 20.

* Now at Associated Electrical Industries Laboratory, Aldermaston.

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[2] Lattes, Occhialini and Powell, *Nature*, 160, 458 (1947). Leprince-Ringuet, Krakow Symposium (October 1947).

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Steric Hindrance in Vinyl-Mesitylene

A NUMBER of workers have observed various anomalous properties in nuclear-substituted derivatives of mesitylene, such anomalies usually being ascribed to restricted rotation about the bond connecting the substituent to the benzene ring caused by the two *ortho*-methyl - groups. In particular, Adams and Theobald[1] have resolved β-bromo-β-(3-bromo-2,4,6-trimethylphenyl)-acrylic acid and the corresponding β-chloro - compound into optically active forms, and have shown the half-life period of the latter to be much greater for the bromo- than for the chloro - compound (64 hr. and 200 min. respectively). Substitution of hydrogen for the halogen atom would clearly make resolution impossible. However, we have recently shown that restriction of rotation is still appreciable even with such a small 'blocking' group as hydrogen, by a study of the simplest possible compound of this class, namely, vinyl-mesitylene.

The abnormality of this hydrocarbon, as compared with similar compounds in which the vinyl group is not 'blocked' by two *ortho*-methyl - groups, is apparent in the values of most of its physical constants such as freezing point, boiling point, refractive index and specific dispersion. The ultra-violet absorption spectrum shows the typical reduced absorption observed by various workers for mesitylene compounds containing larger groups, such as aceto-[2], and nitro-[3], substituted in the benzene nucleus. The infra-red absorption spectrum shows differences from the spectra of styrene and *meta*- and *para*-methylstyrene in the regions characteristic of vibrations of the vinyl group, supporting the hypothesis that 'blocking' in the *ortho* - positions affects the electronic structure. These effects can best be explained in terms of restricted rotation about the C—C bond which attaches the vinyl - group to the nucleus, thus hindering the assumption of a coplanar configuration and hence the resonance of the external double bond with the nucleus.

The most remarkable manifestation of this effect is the greatly reduced tendency of this hydrocarbon to polymerize, which was first noticed by Klages[4]. It has been found to undergo no measurable change in two weeks at 100° C., whereas the polymerization of styrene and other nuclear-methylated homologues containing at least one unsubstituted position *ortho*- to the vinyl - group is about 90 per cent complete after two or three days at this temperature. Polymerization to an extremely brittle polymer of low molecular weight was effected by heating at 190° C. for several days, and also at room temperature in the presence of about 1 per cent of stannic chloride as catalyst.

Since 2,6-dichloro-styrene has been reported to polymerize readily[5], it is possible that some electronic interaction, such as the reversed field effect of the *ortho*-methyl - groups[6], is also of importance in causing the stability of vinyl-mesitylene.

There is a close analogy in steric terms between vinyl-mesitylene and α-methyl-styrene, for, in the former, the relevant rotation is hindered by the two *ortho*-methyl - groups, and in the latter the two *ortho*-hydrogen atoms interfere with the methyl - group on the rotating propenyl - group. This analogy extends to the physical properties and polymerization characteristics of the two compounds[7].

We are indebted to Dr. H. W. Thompson for the infra-red measurements, and to the directors of Trinidad Leaseholds, Ltd., for permission to publish this note; a full account of the work will be published elsewhere.

F. R. Buck
G. T. Kennedy
F. Morton
E. M. Tanner

Trinidad Leaseholds, Limited,
Central Laboratory,
King's Langley,
Herts.
March 30.

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Electric Dipole Moments of Some Styrenes

THE electric dipole moments, in benzene solution at 25° C., of the following nuclear methylated styrenes have been measured:

(I)	*p*-methyl-styrene	0·38 ± 0·1 *D*
(II)	*m*-methyl-styrene	0·36 ± 0·1 *D*
(III)	2,4,5-trimethyl-styrene	0·45 ± 0·1 *D*
(IV)	2,4,6-trimethyl-styrene	0·42 ± 0·1 *D*

These values are approximately corrected for atom polarization. Otto and Wenzke[1] report a value of 0·63 *D* for (I). The others appear not to have been examined.

The moment of toluene is 0·35 *D* in the gas phase, corrected for atom polarization[2]; so the values found for (I), (II) and (III) are consistent with the moment of styrene being very small, and with there being very little induction of a moment in the vinyl- grouping by the *o*-methyl - group in (III). Direct measurements on styrene leave uncertainty about its moment; but this is probably not greater than 0·37 *D*[1,3,4,5].

The moment of (IV) is therefore larger than is consistent with the other values. The most obvious cause of this anomaly (see preceding communication; cf. Hampson and co-workers)[6] is that in (IV) the *o*-methyl - groups prevent the vinyl - group assuming a configuration co-planar with the benzene ring, as it would need to do to be in the best position for forming π-bonds therewith.

This explanation implies that the moment of the styrene molecule in which π-bonding is prevented may be as large as 0·4 *D*, though there is no evidence as yet to show which pole is nearer to the benzene ring.

If this be so, then whichever is the direction, the moment is different from that actually found for styrene, and this indicates that the π-bonding in the latter causes a moment which may be *c.* + 0·1 to + 0·4, or − 0·4 to − 0·7 *D*; that is, there is a permanent electron drift tending to cause either *ortho-*, *para-* or *meta* - direction in the ring. The latter seems to us unlikely, but until the direction of the moment of (IV) has been established, no certain answer can be given to this question.

A further implication is that in the 'inhibited' styrene either the σ-bond skeleton is polar, or the moment of the C—H bond is different in benzene and in ethylene, or both are true.

There appears also to be a difference between the moments of styrene and of triphenylethylene (0·6 *D* [3]), which may arise in the same way.

We are indebted to Mr. G. T. Kennedy for bringing this problem to our notice, and for supplying the compounds.

K. B. Everard
L. E. Sutton

Physical Chemistry Laboratory,
Oxford.
March 30.

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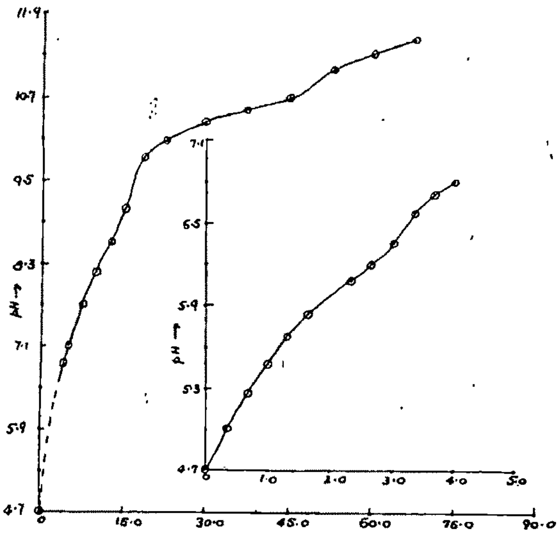
Titration Curves of Hydrogen Micas

THE titration curves of a number of micas have been studied as a part of a scheme of work on the electrochemistry of structurally well-known crystals in finely ground states. Some typical results obtained with muscovite are given below. Details will be published elsewhere.

The finely ground material having particles with 'equivalent spherical diameters' smaller than 2·0 microns was leached with dilute hydrochloric acid to obtain the hydrogen- or acid-mica by the replacement of the exposed potassiums by hydrogen ions. Potentiometric titration curves of hydrosols of this hydrogen mica with bases show three inflexions, the first of which is often very weak while the other two are quite prominent. The *p*H values at the inflexions as well as the form of the titration curve depend, to some extent, on the nature of the base used. Titration with sodium or potassium hydroxide gives the first inflexion at a *p*H between 6·15 and



m.e. KOH per 100 gm. hydrogen mica

7·3; the second and third inflexions occur near pH 9·0 and 10·5, respectively. A typical titration curve obtained on titrating a 1·0 per cent sol with potassium is shown in the accompanying graph. The initial (dotted) portion of the curve, drawn separately on a different scale to bring out the first (weak) inflexion clearly, resembles that of a weak acid. Pauling[1], on the other hand, had predicted a very strong acid character of hydrogen mica.

Practically all the buffer action of the sol, especially the buffering beyond the first inflexion, is observed at pH values much higher than the range of pH (approximately 4·14–5·0) within which aluminium hydroxide is precipitated[2]. No aluminium could be detected in the clear supernatant liquid of a mixture of the sol and potassium chloride in which the concentration of the salt was as high as 1·0 N. This supernatant liquid had a much lower pH than the pure sol, and it contained an amount of titratable acid which is approximately equal to—in some cases, it is appreciably less but never greater than—that obtained at the first inflexion of the titration curve of the pure sol with potassium hydroxide.

The acidity value calculated at the second inflexion of the titration curve of the sol in terms of milli-equivalents per 100 gm. of dry matter is, in all cases, equivalent to the quantity of potassium ions displaced from the ground muscovite in preparing the hydrogen system, and it indicates that this inflexion marks the completion of the neutralization of hydrogen ions acquired by the surface in exchange for the exposed potassium ions of the platelets. The acidity values calculated at the third and second inflexions are as 3 : 1, the actual values in the case of the specimen the titration curve of which is reproduced being, respectively, 16·0 and 47·5 milli-equiv. per 100 gm. This is just what would be expected if the two hydroxyl groups reckoned for each hydrogen ion of the above category in the hydrogen mica (to which the formula $H(Al_2)(Al\,Si_3)O_{10}(OH)_2$ can be given in the case of muscovite) reacted with the base at the third, or final, inflexion. Actually, for each such H ion, two structurally identical OH groups are available for interaction with the base through hexagonal rings of oxygens. The portion of the titration curve between the second and third inflexions, therefore, appears to indicate the neutralization of hydrogen ions dissociated from these hydroxyl groups.

The bearing of the above results on the question of the nature of heterogeneous acid systems and, in particular, on the buffer action and cation-binding power of clays and clay minerals which also have a micaceous structure, will be fully discussed elsewhere.

R. P. MITRA
K. S. RAJAGOPALAN

Chemical Laboratories,
University of Delhi.

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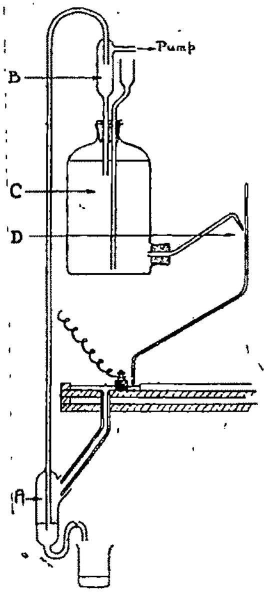
A Modified Ionophoresis Apparatus

Consden, Gordon and Martin[1] have described an apparatus for the electrophoretic separation of molecules of low molecular weight in a solid medium. They show that rapid perfusion of the electrodes of such an apparatus is essential, in order that, even after the potential has been applied for some considerable time, there may be no appreciable change in pH at the gel/liquid interface due to increased ionic concentration at this point. In the apparatus described in their paper, the perfusion buffer is lost, since, after bathing the electrodes, it passes into the cooling chamber beneath the gel trough, and so to waste. Two considerations led me to explore the possibilities of separating these two liquids.

First, it appeared desirable in certain cases to be able to obtain in solution amino-acids which had run the full length of the gel, by collecting fractions of the perfusate as the bands reached the electrode compartments. Secondly, since the time taken for the first band to traverse the length of the gel might be a period of many hours, and similar intervals might occur between successive bands, it appeared desirable to conserve the buffer solution during those periods when no amino-acids were passing across the gel/buffer interface. With this in view, various alterations and additions were made to the apparatus as described by Consden *et al.*



CIRCULATING DEVICE FOR CONTINUOUS ELECTRODE PERFUSION

A tube was inserted in the base of the electrode compartment in place of the aperture giving direct access to the cooling trough. Through this the buffer was able to flow directly into a sump (A) beneath the apparatus. The surface of the liquid in this sump was maintained at a constant level by means of an intermittent air-lift pump connecting the sump by means of a vertical tube having a diagonally ground tip, with a subsidiary reservoir (B) above the Marriotte bottle (C) containing the main store of buffer. The decreased pressure activating the air-lift device was provided by a water pump connected to the reservoir, from the base of which a tube led into the Marriotte bottle, terminating below the surface of the liquid. Provision was made for maintaining the volume of buffer in the system by combining a funnel with the vertical tube in the Marriotte bottle which governed the flow of liquid from the jet. This jet (*D*) was allowed to impinge on the surface of a glass rod which led the buffer into the electrode compartment. Such an arrangement permitted the rate of flow to be accurately controlled, since the difference in levels between the jet and the bottom of the funnel stem could be altered at will without affecting the rest of the apparatus. Variations in the water pressure to the pump were shown to cause the level of liquid in the sump to rise to such a height above the tip of the vertical tube that air was no longer able to enter at the bottom, with the resultant stoppage of circulation. This was obviated by the incorporation of a syphon in the sump to maintain the surface of the liquid at the level of the tip of the vertical tube. Two sets of apparatus, one for each electrode compartment, were attached to the same vacuum line, in order that the rate of flow to each electrode might be identical.

In runs of eight hours or more, using a neutral gel and phosphate buffers, the *p*H of the perfusates was not found to vary by more than 0·1 *p*H unit, except during those periods when acidic or basic amino-acids were leaving the gel. These fractions, and those of other amino-acids, were collected by interrupting the return of the buffer to the reservoir and substituting a receiver for the sump. The arrival of any band at the gel/buffer interface was calculated from the relative displacements of the bands as determined by the 'printing' method of the original authors. Two such prints were taken at intervals during the course of a run; this necessitated the use of a trough without a lid, but no trouble due to swelling or contraction of the gel was encountered. It was found that the ionic concentration in the gel remained sufficiently constant during any one run for the relationship between time and distance to be taken as linear.

DAVID A. HALL

Department of Biochemistry,
School of Medicine,
Leeds.
March 18.

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[1] Consden, Gordon and Martin, *Biochem. J.*, 40, 33 (1946).

Absorption of Ultrasonic Waves in Acetic Acid

THERE are broadly three possible causes of absorption of ultrasonic waves in liquids. The first two are viscosity[1] and conduction of heat[2]; these give rise to an absorption the coefficient α of which varies as the square of the frequency ν at all frequencies[3,4]. The third general cause is the perturbation by the wave of any equilibrium that may be set up in the liquid, if the new equilibrium state is attained exponentially, with a 'relaxation' time constant. The equilibrium may be chemical[5], or one involving the various degrees of freedom contributing to the specific heat[3], or between molecules arranged in an orderly structure and others arranged at random[6]. Whatever the mechanism responsible for the relaxation time, Kneser[7] has shown that it will contribute an additional absorption α, which is a function of the frequency ν. He has shown that for frequencies considerably below a relaxation frequency, α varies strictly as ν^2; considerably above this frequency it becomes constant; the quantity $\mu = \alpha\lambda = \alpha.c/\nu$ reaches a maximum value at the relaxation frequency.

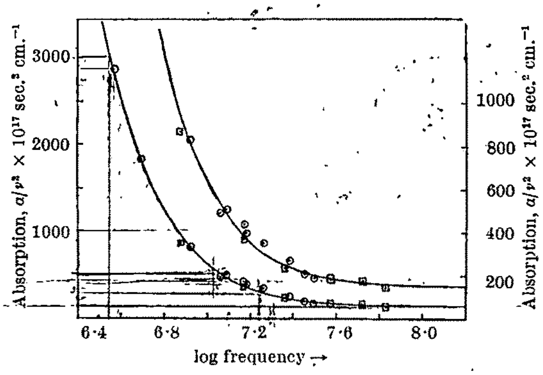

Fig. 1. ABSORPTION IN ACETIC ACID. POINTS IN CIRCLES, BAZULIN'S RESULTS; POINTS IN SQUARES, AUTHOR'S RESULTS. UPPER CURVE REPRESENTS PART OF THE LOWER CURVE ON A LARGER SCALE

If we find a case where α is not strictly proportional to ν^2, then it may be possible to distinguish between differing causes of absorption acting at the same time in the liquid. A good example is provided by acetic acid. A plot of α/ν^2 against log ν (Fig. 1) for this liquid shows that at high frequencies α/ν^2 tends to a constant value of about 155×10^{-17} sec.^{2} cm.$^{-1}$. At lower frequencies it rises greatly, suggesting a relaxation frequency at some lower frequency. The experimental results are due to Bazulin[8] and some recent measurements I have made, which are in good agreement with one another. The temperature was 16–17° C. for most of the observations.

If we postulate that the value of 155×10^{-17} represents the absorption due to viscosity, heat conduction and any relaxation process the relaxation frequency of which is well above 10^8 c.p.s., then it is permissible to subtract this amount from the values of α/ν^2 at all frequencies below 10^8 c.p.s. The remaining attenuation is then presumably due to a single relaxation process at around 2×10^6 c.p.s., and it is possible to make a quantitative test of Kneser's equation (14)[7]:

$$\alpha/\nu^2 = \frac{2\mu_m}{c\,.\,\nu_m\,(1 + (\nu/\nu_m)^2)}.$$

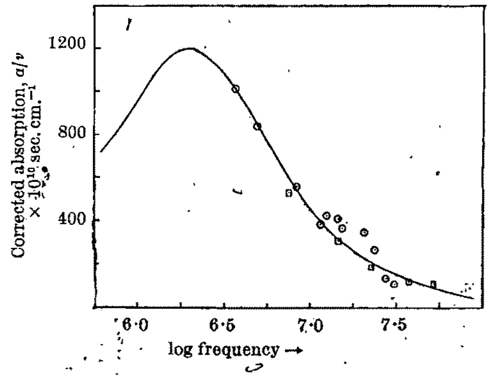

Fig. 2. RESIDUAL ABSORPTION α/ν, AFTER SUBTRACTION OF ABSORPTION CORRESPONDING TO $\alpha/\nu^2 = 155 \times 10^{-17}$. THEORETICAL VALUES ON CURVE. POINTS IN CIRCLES, BAZULIN'S RESULTS; POINTS IN SQUARES, AUTHOR'S RESULTS

At low frequencies $\alpha/\nu^2 \approx 2\mu_m/c.\nu_m = A$, say. Kneser's[7] equation can then be put in the form

$$1/\alpha = 1/A(1/\nu^2 + 1/\nu_m^2),$$

and may be tested by plotting $1/\alpha$ against $1/\nu^2$. This plot yields the best values of A and ν_m to fit the experimental points; from the plot we find $A = 12{,}000 \times 10^{-17}$ sec.^{2} cm.$^{-1}$ and $\nu_m = 2{\cdot}0 \times 10^6$ c.p.s. These constants can be used to calculate the theoretical variation of α/ν, which is proportional to μ. In Fig. 2 the expected variation of α/ν as a function of log ν is represented by the solid line, and the points are observed values of α/ν, after subtraction of the absorption corresponding to $\alpha/\nu^2 = 155 \times 10^{-17}$ sec.^{2} cm.$^{-1}$. The agreement with theory is good and suggests that the extra absorption is correctly ascribed to some phenomenon with a relaxation time of 5×10^{-7} sec.

The process responsible for the absorption in this case is very probably the chemical equilibrium between the dimer and the monomer of acetic acid. The rate of this reaction, and consequently ν_m, should increase rapidly with temperature. Experiments to find the temperature dependence of ν_m are in progress.

Kneser's relation (11) also enables an estimate to be made of the total change in velocity to be expected corresponding to the fall in α/ν^2. For

$$\frac{\Delta c}{c} \approx \frac{\mu_m}{\pi} = \frac{\alpha c \nu_m}{\pi \nu_m^2} = A \cdot \frac{c \nu_m}{2\pi}.$$

Using the values of A and ν_m quoted above, and putting $c \approx 1 \times 10^5$ cm. sec.$^{-1}$, we find

$$\frac{\Delta c}{c} \approx 4 \times 10^{-3}.$$

It seems likely that such a small change in velocity will be hard to find, due to the heavy absorption in the frequency-range concerned. The 1 per cent dispersion reported by Spakowski[9] between 0·2 and 3 Mc./s. appears to be roughly confirmed.

J. M. M. PINKERTON

Cavendish Laboratory,
Cambridge.
March 19.

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Crystal Structure of *B*-Starch from X-Ray Fibre Diagrams

IN recent papers[1], Kreger has published fibre data rom the *B*(tuber)-modification of starch. Though his technique is new and interesting, Kreger's results mainly confirm data which were published some years ago[2]. Apparently the earlier fibre diagrams were more highly orientated than Kreger's, since the ibre spacing (10·6 ± 0·1 kX.) could be obtained unambiguously from these diagrams. More recently, both *B* and *A* (cereal-type) fibres have been prepared by new techniques with truly extraordinary orientations[3]. The fibre spacing of the *A*-modification (10·5 kX.) is substantially equal to that of the *B*-modification, a result not unexpected, since Bear and French established a very close relationship between these modifications of starch[4].

From the fibre diagrams a unit cell and rough structure for the *B*-modification of starch have been proposed[2]. The orthorhombic unit, $a = 16{\cdot}0$, b (fibre) $= 10{\cdot}6$, $c = 9{\cdot}1$ kX., is essentially the same as suggested in Kreger's first paper. More recently, Kreger has criticized this unit on the grounds that it leads to an X-ray density (1·60) no greater than the observed density of starch under water (1·60–1·63)[1]. The X-ray density was calculated assuming that the hydration of *B*-starch amounts to one water molecule per glucose residue.

The degree of hydration assumed by Kreger is apparently about right for the *A* modification of starch; but there is considerable reason for believing that the ideal hydration of the *B*-modification is higher. Thus, air-dried corn starch and the cereal starches contain about 10 per cent moisture, while tapioca, potato and other tuber starches normally contain about 15–20 per cent (between 1½–2 water molecules per glucose residue[5]). Moreover, it has been noted that the tuber starches especially yield much sharper X-ray diagrams when thoroughly wet with water[4], indicating that a very high degree of hydration is ideal for the crystalline portions of *B*-starch. It seems not unreasonable that at the ideal composition of the *B*-modification there are as many as two water molecules per glucose residue. In this case, the X-ray density would be 1·67, certainly high enough for a carbohydrate and in very satisfactory agreement with observed densities of starch under water (1·60–1·63)[1].

The difficulty in understanding the fibre spacing of starch, noted by Kreger[1], has been discussed before[2]. However, the lower fibre spacing found from space models is sensitive to angles in the glucose ring and in the glucosidic bond, and the proposed structure cannot be eliminated by considerations of only those models which have tetrahedral or other idealized angles.

In considering the possibility of an error in the suggested unit cell for *B*-starch, it seems well to point out that the difficulties in interpretation of fibre diagrams usually arise from screw axes or centring which eliminate the first-order spacings of the non-fibre axes. The *B*-modification of starch, in the present interpretation, has a screw axis only along the fibre axis, the spacing of which is not in doubt. The *a*-axis of the proposed unit cell is just the Bragg spacing of the lowest-order reflexion on the equator of the fibre diagram. This leaves no further room for manipulation of lattice parameters from fibre data for an orthorhombic unit, and makes it nearly certain that no simpler unit for the *B*-modification can be found.

R. E. RUNDLE

Department of Chemistry,
Iowa State College,
Ames, Iowa.
March 11.

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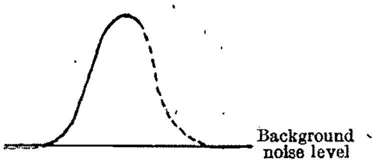
Shape of Pulses of Radio-frequency Radiation from the Sun

DURING some 400 hours observations of solar radiation on 75 Mc./s., the variation of the second detector anode current was recorded with a portable vibration galvanometer tuned to resonance at about 45 c./s. and damped less than critically, but so that the spot became stationary after sudden deflexions in less than 0·25 sec. Records were taken on 35-mm. film moving 12·1 mm./min. The gain was adjusted so that the current due to noise generated in the receiver was about 15 per cent of the maximum allowable, to avoid distortion in all but exceptional cases.

Ninety-nine single pulses of radiation lasting a few seconds each were observed sufficiently clear of overlapping pulses to give reason to believe that their shape on the film was a faithful record (by the linear detector) of the variation of radiated power from the source of the solar noise.

The 'tail' of such a pulse may indicate the manner of decrease in radiation by the source when it is no longer subject to the influence of an exciting agency, or, if the decay of the source under such conditions is very rapid, the curve will simply reflect the decrease in influence of the exciting agency. An analysis of the shape of the 'tails' of 78 such pulses was made after projecting the record, with magnification about 30 ×, and tracing the centre line of the photographic trace of the galvanometer spot. Twenty-one were not analysed, for the reason that the height of the pulse peak above background was less than 25 per cent of the background value, and too short a length of falling slope was available to enable significant measurements to be made. Fifty-eight were found to be very probably exponential in shape, eleven less probably so, four probably not so and five definitely not.

Between three-quarters and nine-tenths of the portion of the broken-line curve in the accompanying figure was analysed, and the deviation from average of the factor x in $\exp(-xt)$ was less than ± 15 per cent for those assumed to have exponential form.



TYPICAL PULSE SHAPE. PORTION OF CURVE EXAMINED, - - - -

The times taken for radiated power to decrease to half in the pulses of exponential shape are tabulated below :

Half-life (sec.)	0·4–0·6	0·6–0·8	0·8–1·0	1·0–1·2	1·2–1·4	1·4–1·6	1·6–1·8	1·8–2·0	2·0–2·2	Over 2·2
No. of pulses	5	8	12	13	8	7	3	0	2	nil

Included in the table above are thirty pulses occurring either consecutively, or within a short interval. These follow :

Date	Time interval	Half-value times (sec.)
27.5.47	30 sec. (con.)	0·75, 0·65
4.6.47	30 sec. (con.)	1·4, 0·9
22.7.47	30 sec. (con.)	0·9, 0·9
23.7.47	1 min. (con.)	1·2, 0·85
25.7.47	30 sec. (con.)	1·1, 1·1
7.8.47	30 sec. (con.)	0·7, 0·8
7.8.47	30 sec. (con.)	0·8, 1·3
12.8.47	40 sec.	1·2, 1·75, 1·35
30.9.47	5 min.	1·0, 0·85, 0·9, 1·0, 0·5, 1·1
30.9.47	1 min.	0·9, 1·05, 1·0
30.9.47	30 sec. (con.)	1·7, 1·1
30.9.47	30 sec.	0·9, 1·8

Although it might be assumed that pulses clos connected in time come from the same region a should therefore show similar half-value times, t results given above do not offer firm support f such a hypothesis.

No success was obtained from attempts to interp the rising portion of the pulse curve in terms exponential functions.

S. E. WILLIAMS

Physics Department,
University of Western Australia,
Nedlands, Western Australia.
Dec. 12.

Spectrum of Iodine Oxide (IO) in Flames

BANDS attributed to iodine oxide (IO) w observed by Vaidya[1] in a flame of methyl iodide, a analysed into two systems, A and B. More recent Blake and Iredale[2] have published a revised analy for system A ; when this formula was used to arran the bands, an obviously unsatisfactory intensity d tribution was obtained. We have re-measured t bands, and extended the system to longer wa lengths. It is now found that all the bands can arranged into one system instead of two, this syst being an extension of the B system, with modifi values of v''. The bands are listed in the accompan ing table ; intensities are visual estimates maki some allowance for variations of plate sensitivi with wave-length.

BAND HEADS OF IO

λ	Int.	ν	v',v''	λ	Int.	ν	v',v
4189·0	5 v.d.	23865	5,0	5208·8	5	19193	2,5
4286·2	7 d	23422·5	4,0	5248·7	1	19047	3,6
4355·9	9	22951	3,0	5307·5	10	18836	0,4
4396·7	6 d	22738	4,1	5345	1	18704	1,5
4448·7	7	22472	2,0	5385·5	2	18563	2,6
4487·7	10	22277	3,1	5422	4	18438	3,7
4548·1	3	21981	1,0	5495	9	18192	0,5
4586·7	10	21796	2,1	5533	7	18069	1,6
4624·9	5	21616	3,2	5655·5	2	17677	4,9
4668·3	2	21415	4,3	5692	7	17565	0,6
4693·5	9	21300	1,1	5730	8	17447	1,7
4731·2	7	21130·5	2,2	5767	4	17334	2,8
4763·3	4 d	20988	3,3?	5900	5	16945	0,7
4806·1	3	20801	0,1	5939	6	16832	1,8
4844·5	10	20636	1,2	5976	7	16729	2,9
4920·9	3	20316	3,4	6152·5	3	16240	1,9
4963·6	6	20141	0,2	6193	4	16142	2,1
5002·3	6	19985	1,3	6231·5	4	16043	3,1
5049·8	2	19797	2,4	6273	3 d	15937	4,1
5131·0	9	19484	0,3				

d = diffuse. v.d. = very diffuse.

The following are the molecular constants :

$$\nu_e = 21{,}565 \text{ cm.}^{-1} \quad \omega_e'' = 687 \text{ cm.}^{-1} \quad x_e''\omega_e'' = 5 \text{ cm}$$
$$\omega_e' = 512 \text{ cm.}^{-1} \quad x_e'\omega' = 5 \text{ cm}$$

A graphical Birge – Sponer extrapolation gives dissociation energy for the ground-state, $D_0 = 1{\cdot}9$ 0·2 eV. or 44 k.cal. Bands with $v' = 4$ are diffu and the 5,0 band is very diffuse; this is probab due to pre-dissociation. The band system for is now closely analogous to the systems recent reported[3,4] for ClO and BrO. This analysis gives normal vibrational intensity distribution as shown Fig. 2. The IO bands have been obtained wh iodine is added to an oxyhydrogen flame, thus su porting the assignment to IO and eliminating CI.

When iodine is added to a methyl alcohol/air fla a strong band, or region of continuum, with a sha ad at 4045 A., degraded to shorter wave-lengths, obtained. A similar but weaker band, at about 70 A., is obtained when bromine is introduced into methyl alcohol flame. The emitters of the bands e not known.

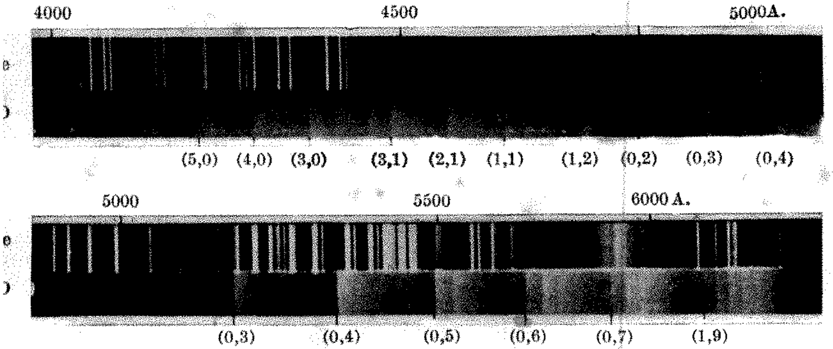


Fig. 1. SPECTRUM OF FLAME OF METHYL IODIDE PLUS HYDROGEN IN OXYGEN

v' \ v''	0	1	2	3	4	5	6	7	8	9	10	11	12
0	·	3	6	9	10	9	7	5	·	·	·	·	·
1	3	9	10	3	·	1	7	8	6	3	·	·	·
2	7	10	7	·	2	5	2	·	4	7	4	·	·
3	9	10	5	4?	3	·	1	4	·	·	·	4	·
4	7	6	·	2	·	·	·	·	·	2	·	·	3
5	5	·	·	·	·	·	·	·	·	·	·	·	·

Fig. 2

One of us (E. H. C.) is indebted to the director of the Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organisation for permission to publish this communication.

E. H. COLEMAN
A. G. GAYDON
W. M. VAIDYA

Chemical Engineering Department,
Imperial College of Science and Technology,
London, S.W.7.
March 17.

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Hydride and Deuteride Bands of Aluminium, Copper, Silver and Gold

AN investigation of the spectra mentioned above has been undertaken with a water-cooled hollow cathode of Schüler type with helium filling. The break-off in the CuH-band λ 4280 found by Schüler and Gollnow is unique, and does not appear in any of the spectra of the above-mentioned metals. The experimental results show that the interpretation given by Herzberg and Mundie is correct.

On long exposure at the lowest possible pressure (0·03 mm.), the AlH-band λ 4240 shows a very sharp break-off with $P(19)$ as the last line in the P branch.

A detailed account of these experiments is to be published elsewhere.

BENGT E. NILSSON

Physics Institute,
University, Stockholm.
March 16.

Relation Between the Brunauer–Emmett–Teller and Harkins–Jura Isotherms

H. K. LIVINGSTON[1] has recently attempted to relate the Brunauer – Emmett – Teller and Harkins – Jura equations by means of the Gibbs adsorption isotherm for solid surfaces. However, he has only applied his method to one of the limiting conditions of the Brunauer – Emmett – Teller equation. We have extended this method to include the complete form of the equation, in order to direct attention to the great importance of the value of constant n in these relations.

The Harkins – Jura equation

$$\log p = B - A/v^2 \qquad (1)$$

(v is the volume of gas adsorbed at pressure p, A and B are constants) was obtained by substitution in the equation of state for condensed films:

$$\pi = b - a\sigma \qquad (2)$$

(where π is surface pressure, σ is area per molecule of adsorbate, and a and b are constants).

The Brunauer – Emmett – Teller equation may be expressed in the complete form:

$$v = \frac{v_m c.p}{p_0 - p} \cdot \frac{p_0{}^{n+1} - p_0.p^n(n+1) + n.p^{n+1}}{p_0{}^{n+1} + p.p_0{}^n(c-1) - c.p^{n+1}} \qquad (3)$$

or in two limiting forms:

$$n = 1;\ v = \frac{v_m c.p}{p_0 + c.p};$$

$$n = \infty;\ v = \frac{v_m c.p.p_0}{(p_0 - p)(p_0 - p + c.p)}. \qquad (4) \text{ and } (5)$$

Livingston obtained the relations

$$k_1\pi = \log\left(\frac{p_0 - p + c.p}{p_0 - p}\right) \text{ and}$$

$$k_2\sigma = \frac{(p_0 - p)(p_0 - p + c.p)}{c.p.p_0} \qquad (6) \text{ and } (7)$$

(where $k_1 = V\Sigma/RTv_m$, $k_2 = Nv_m/V\Sigma$, V is the molar gas volume, and Σ is the specific surface of the adsorbent). He then calculated the conditions under which the values of $k_1\pi$ and $k_2\sigma$, for any given value of c, could be expressed as a linear relation equivalent to equation (2):

$$k_1\pi = b' - mk_2\sigma. \qquad (8)$$

It follows from his reasoning that if the $k_1\pi - k_2\sigma$ relation is linear, then the pressure–volume adsorption isotherm may be expressed accurately by either the Brunauer – Emmett – Teller or Harkins – Jura equations.

Equations (6) and (7) are only valid for the limiting condition when $n = \infty$, being based on equation (5). In practice, it has been found that when $n > 5$, equation (5) represents the data fairly closely. However, with highly porous solids n is frequently less than 3, and equation (5) is no longer applicable. We have found, in adsorption experiments on highly porous amorphous carbons, that when $n < 3$, the Harkins – Jura plots of log p against $1/v^2$ are invariably curved. Similar results have been obtained by Joyner, Weinberger, and Montgomery[2]. The treatment of Livingston has, therefore, been extended to include equations (3) and (4).

From equation (3) we obtain:

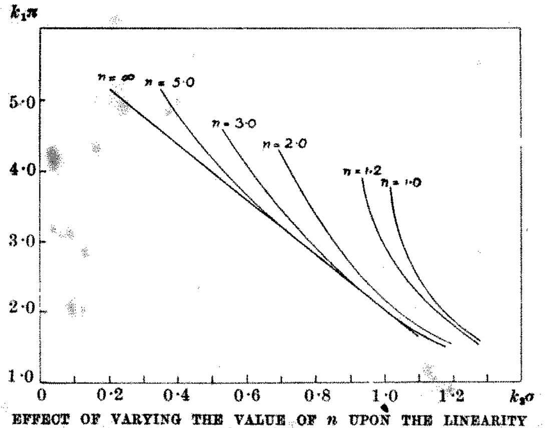
$$k_1\pi = \int_0^p \frac{c}{p_0 - p} \cdot \frac{p_0^{n+1} - p_0 . p^n (n+1) + np^{n+1}}{p_0^{n+1} + p . p_0^n (c-1) - cp^{n+1}} \, dp, \qquad (9)$$

$$k_2\sigma = \frac{p_0 - p}{cp} \cdot \frac{p_0^{n+1} + p_0^n . p . (c-1) - cp^{n+1}}{p_0^{n+1} - p_0 . p^n (n+1) + np^{n+1}}; \qquad (10)$$

From equation (4):

$$n = 1;\ k_1\pi = \log\left(\frac{p_0 + cp}{p_0}\right);\ k_2\sigma = \frac{p_0 + cp}{cp}. \qquad (11) \text{ and } (12)$$

The most general conditions are represented by equations (9) and (10). In order to discover the effect of low values of n, these equations were used to calculate the values of $k_1\pi$ and $k_2\sigma$ when $c = 50$, $p_0 = 800$, and $n = 1$, $1 \cdot 2$, 2, 3 and 5. Equation (9) was solved by graphic integration. The value of 50 was chosen for c, as Livingston showed that a longer linear portion on the $k_1\pi - k_2\sigma$ plot is obtained for this value of c than for any other value, when $n = \infty$. The results are shown in the accompanying graph. When $n < 5$, the $k_1\pi - k_2\sigma$ relation is no longer linear. The tendency to curve away from the $k_1\pi - k_2\sigma$ linear relation (when $n = \infty$) progressively increases as the value of n decreases. It appears that if $n < 5$, the conditions represented by equation (2) are no longer satisfied, and we should expect the plot of $\log p$ against $1/v^2$ to be curved. This is precisely what occurs.



EFFECT OF VARYING THE VALUE OF n UPON THE LINEARITY OF THE $k_1\pi - k_2\sigma$ RELATION

The physical significance of n is not known, but has been taken to depend mainly on the sizes of the pores. If this interpretation is correct, the above preliminary calculations indicate that when the average diameter of the pores becomes less than a certain critical value, the Harkins – Jura equation cannot be applied to the adsorption data.

T. D. SMITH
R. BELL

Northern Coke Research Laboratory,
Physical Chemistry Department,
King's College,
Newcastle-upon-Tyne 2.

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[1] Livingston, H. K., *J. Chem. Phys.*, 15, 617 (1947).

[2] Joyner, L. G., Weinberger, E. B., and Montgomery, C. W., *J. Amer. Chem. Soc.*, 67, 2182 (1945).

A Suggested Explanation of Sangster's Rotations and Schmidt's "Wandering Vortices" in Geomagnetism

A CURIOUS and hitherto unexplained phenomenc was discovered many years ago by Sangster[1] froı a study of Greenwich magnetograms for periods magnetic disturbance. He showed that the horizont component of the disturbance vector at Greenwic rotates for considerable periods in the same directio so that its end describes a sequence of loops, whic vary greatly in size and shape but are all describe in the same sense, when viewed, say, from abov From 10h. to 24h. almost all the rotations are ant clockwise, while from 0h. to 10h. they are mostl clockwise.

The results of some calculations, made by Mr. Ashour and myself, of the currents induced in *non-uniform* ionospheric shell by a varying extern magnetic field, suggest a simple explanation of tl above phenomenon.

We find that the induced currents form vorte systems the centres of which tend to move co tinually towards the point of highest conductivit which we take to be the sub-solar point, B say. F example, a sudden increase in an inducing fie parallel to the earth's axis produces a system currents initially along circles of latitude, so that tl corresponding vortex centres are initially at the nor and south poles; these vortex centres do not rema stationary, but move rapidly along the noon meridia towards B. A *fluctuating* field leads to a sequence vortices of alternate polarities all moving towards two vortices of opposite polarities corresponding each complete alternation of the field. In tl actual ionosphere, the resulting system of curre vortices will doubtless be much more complex ar irregular than that found from our calculation but there will be the same tendency for the vortices to move away from the point of lowe conductivity and towards the point of highe conductivity.

It is this tendency which seems to me to expla Sangster's clockwise and anti-clockwise rotatio For, during the afternoon and up to midnight, tl point of highest conductivity of the ionosphe would lie in the south-west of Greenwich, and th of lowest conductivity to the south-east. Now it easily seen that a current vortex in the ionosphe moving southwards approximately along a meridia to the west of Greenwich would cause the disturban vector at Greenwich to rotate in an anti-clockwi direction through one half-revolution. If this vort were succeeded by another of opposite polarity, tl vector would rotate in the same direction throug the remaining half-revolution. Hence a successi of such vortices of alternate polarities would accou for the continued rotation of the disturbance vect in the anti-clockwise direction, which is found Greenwich from 10h. to 24h. At midnight, the conditions would be reversed, and the vector wou afterwards rotate in the clockwise direction observed. The theory indicates a change back to tl anti-clockwise direction at noon; Sangster's analys of the observations makes this change occur at 10 It is tempting to suggest that this earlier epoch ma be due to earth-currents induced in the great stret of sea to the west of Greenwich, but it is, of cours desirable to investigate the Sangster rotations other stations before attempting to develop tl theory further.

The actual existence of moving current vortices, milar to those assumed in the above explanation, as deduced by Schmidt[2] from an examination of the isturbing force at ten European stations during a eriod of disturbance at about 18h. on February 28, 396. The figure given by him (and reproduced in Geomagnetism", p. 313) shows a current vortex oving southwards along a line to the west of the ations, *followed by another of opposite polarity.* It ow appears that these "wandering vortices", as hmidt called them, may be due merely to self-duction in a *non-uniform* ionosphere. It is perhaps orth emphasizing that, in order to explain the otion of these vortices, it is unnecessary to assume ther (1) that there is any mass-motion of the conucting material, or (2) that the currents are prouced by some moving primary source of electrootive force. Once the currents are produced (by ectromagnetic induction or otherwise) the nonniform distribution of conductivity in the ionosphere ill necessarily cause the current vortices to move in e manner described above.

A. T. PRICE

mperial College of Science and Technology,
London, S.W.7.
March 23.

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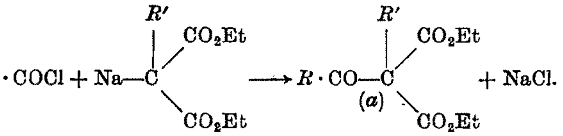
roc. *Roy. Soc.*, A, 84, 85 (1910).

et. *Z.*, 16, 385 (1899); see also Chapman and Bartels, "Geomagnetism", 311.

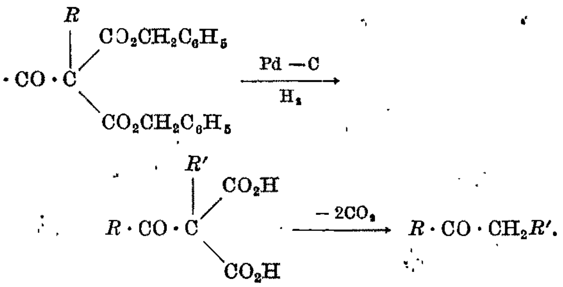
A New Ketone Synthesis

THE reaction between substituted malonic esters d acid chlorides has been investigated on a number occasions in the past[1], and has been found to give e corresponding acylmalonic esters in high yield cording to the following reaction :



Previous workers[2] have realized the potentialities such a reaction for the synthesis of ketones of the eneral formula $R.CO.CH_2R'$, but have failed, except the case where $R' = H$[3,4], to effect the ketonic drolysis of this type of keto-ester without simtaneous rupture of the bond (*a*).

It has now been found that the benzyl esters of ylmalonic acids readily undergo hydrogenolysis at om temperature in the presence of palladized charal with the formation of the parent keto-acids. ese acids on gentle warming (50–70° C.) lose two olecules of carbon dioxide and furnish the correonding ketones in excellent yield.



The method is applicable, for example, by suitably modifying the functional groups, to the synthesis of a wide variety of ketones, diketones, keto-acids and other carbonyl compounds. Typical cases in which it has so far been applied are the preparation of heptadecan-8-one (91 per cent yield from *n*-octoyl chloride and dibenzyl *n*-octyl-malonate), 2-methylpentadecan-5-one (80 per cent yield from undecoyl chloride and dibenzyl *iso*butyl-malonate), octacosane-10 : 19-dione (78 per cent yield from sebacyl chloride (1 mol.) and dibenzyl *n*-octyl-malonate (2 mol.)), tridecan-3-one-1-carboxylic acid (more than 66 per cent yield from undecoyl chloride and tribenzyl ethane-1 : 1 : 2-tricarboxylate) and heptadecan-9-one-1-carboxylic acid (81 per cent yield from 8-carbethoxy-*n*-octane-1-carbonyl chloride and dibenzyl *n*-heptyl-malonate, prepared by Mr. R. G. Mason).

The many possibilities opened up by this reaction will be the subject of further investigations, the results of which will be published elsewhere in due course.

R. E. BOWMAN

Birkbeck College,
London, E.C.4.
April 1.

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[1] Lang, *Ber.*, 20, 1326. Michael, *Amer. Chem. J.*, 14, 510.

[2] Robinson and Robinson, *J. Chem. Soc.*, 127, 175 (1925).

[3] Walker and Hauser, *J. Amer. Chem. Soc.*, 68, 1386 (1946).

[4] Bowman, unpublished results.

Extinction of Petrol Fires by Methyl Iodide

IN a recent communication on this subject[1], O. C. de C. Ellis makes a number of statements which should not go unchallenged. First, it is stated that carbon tetrachloride will not extinguish petrol fires. For many years carbon tetrachloride has had world-wide use for the extinction of petrol fires, particularly those associated with internal combustion engines, and its reputation rests to a large extent on its success for this very purpose. Secondly, it does not decompose stoichiometrically to yield twice its vapour volume of chlorine ; the amount of chlorine evolved in a fire is, in most cases, negligible[2].

More serious, however, is that several important factors should have been overlooked in the tests and interpretation of results. Carbon tetrachloride and similar materials can extinguish flame only by achieving a sufficiently high concentration in the atmosphere ; clearly, then, volatility is of considerable importance. Methyl iodide (b.pt. 42·3°) will vaporize more readily than carbon tetrachloride (b.pt. 76·7°) ; consequently, there can be apparent differences in the properties of these two substances when they are applied to fires, although modification of technique will achieve the desired result in each case, namely, extinction of the fire. In using carbon tetrachloride it is necessary to provide sufficient heat transfer and, among other ways, this can be simply done by directing the liquid on to a warm surface, when sufficient vaporization takes place to put the fire out. To apply carbon tetrachloride directly into the middle of an inflammable liquid burning in an open tank may, quite likely, not extinguish the fire due to the fact that the carbon tetrachloride penetrates to the cold region underlying the burning surface and so does not vaporize. In any event, large fires of this type should be dealt with by carbon dioxide when the vapours are reasonably confined (as, for example, in a paint tank), or foam when they cannot be so confined.

It is not true that carbon tetrachloride is only one-fifth as effective as methyl iodide; this claim is explained by the fact that the importance of vaporization was ignored and the carbon tetrachloride was used incorrectly. Work carried out some time ago in the laboratories of this Company, to determine the minimum concentration of various substances required to extinguish a standard heptane flame, indicated, indeed, that the descending order of merit is, in general, bromide, iodide, chloride; but the following results show that there is no disproportionate superiority of methyl iodide over carbon tetrachloride.

Compound	Minimum extinguishing concentration (gm. compound/litre of air at N.T.P.)
Methyl bromide	0·19
Methyl iodide	0·28
Carbon tetrachloride	0·33
Methylene iodide	too involatile

The suggestion that pump type extinguishers should be filled with methyl iodide is impracticable. The mechanical problems presented by the use of a volatile liquid like carbon tetrachloride in equipment of this kind have been considerable in the past. If methyl iodide were used these problems would be greatly magnified and, indeed, would be insuperable unless the extinguisher were always kept at a cool and constant temperature. The alternative, therefore, would be the use of a pressurized bottle. Such extinguishers already exist for applications where they are particularly suited, and are filled with carbon tetrachloride or methyl bromide or a mixture of these two.

Judged, therefore, on its usefulness as a fire extinguishing agent, methyl iodide falls between two stools. It is too volatile to be used in a pump type of extinguisher and it would be pointless to consider its use in pressurized bottles on the grounds of improved combustion inhibition, since such appliances already use methyl bromide which is superior in this respect. In fairness it should be said, however, that methyl iodide may have one advantage over methyl bromide in that it may be less toxic.

Concerning the toxicity of methyl iodide, little published information can be found. Garland and Camps[3] report a fatal case of poisoning by methyl iodide in which the symptoms were similar to those of methyl chloride and methyl bromide. Henderson and Haggard[4] say that its toxicity is greater than that of methyl chloride, but less than that of methyl bromide. The same authors rate the toxicities of the latter two substances, relative to carbon tetrachloride, under acute conditions of exposure, as follows: methyl chloride 0·29, carbon tetrachloride 1·00, methyl bromide 2·20. Methyl iodide, therefore, would appear to be of the same order of toxicity as carbon tetrachloride, and it would be rash to assume that it is safer in use without sufficient confirmatory evidence.

A. NICHOLSON

The Pyrene Co., Ltd.,
Brentford,
Middlesex.

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[1] Ellis, O. C. de C., *Nature*, **161**, 402 (1948).

[2] Fieldner and Katz, *J. Franklin Inst.*, **190**, 543 (1920).

[3] Garland, A., and Camps, F. E., *Brit. J. Ind. Med.*, **2**, 209 (1945).

[4] Henderson and Haggard, "Noxious Gases and the Principles of Respiration Influencing their Action" (Reinhold Pub. Corp., New York, 1943).

Influence of Some Anti-Shrink Treatmen on the Friction between Wool Fibres

A NEW apparatus has been built for the measur ment of the friction between two fibres. The princip is that two fibres are twisted a few turns, and t four fibre ends loaded with equal forces, P_1. T load at one of the ends is increased until slippi occurs. If the necessary force is P_2 and the (sma angle between the fibre ends, β, the coefficient friction is given by the formula

$$\mu = \frac{\ln P_2/P_1}{\beta\pi n},$$

where n is the number of turns. The apparatus w be described in detail elsewhere[1].

Some measurements were carried out on fibr treated with sodium hypochlorite at pH 1, and fibres treated with alcoholic potassium hydroxi The measurements were made on the treated fibr in distilled water, after washing with water or neutralizing agent. The apparatus is built symmetri ally, so that it allows measurements of both wit scale and anti-scale friction on the same fibres. I consecutive measurements the variation in fricti with the number of slippings, due to abrasion, cou be determined. The same pair of fibres has been us for several series of measurements after differe times of treatment. For each series fresh parts of t fibres were introduced in the twist, thus avoidi abraded areas. For untreated fibres, up to 2,5 slippings can be made under the same conditions the apparatus without any noticeable change in t friction.

Figs. 1 and 2 give the values of the frictional c efficients at different times of treatment and differe numbers of slippings. The smaller dots indica values obtained at consecutive slippings after t given time of treatment.

There is a marked difference in the effects of t two treatments, which are both used for obtaini non-felting wool. Both cause an increase of t frictional coefficients. The chlorination diminis the difference between the anti-scale and the wi scale friction; but this difference is maintained af the alcoholic potash treatment. A very remarka difference is the behaviour of the friction after t treatments. The friction of the chlorinated wool

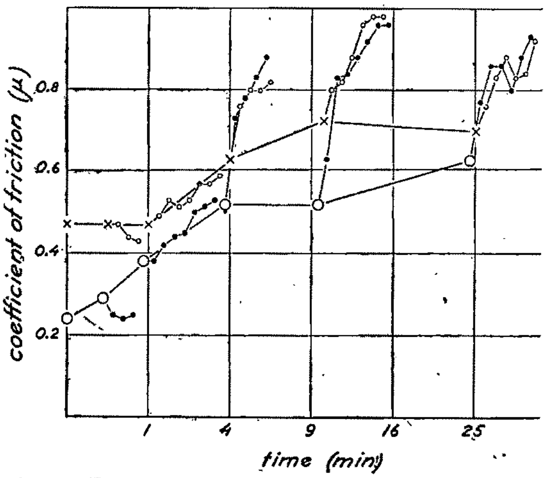

Fig. 1. FRICTIONAL COEFFICIENTS OF WOOL (○, WITH-SCALE ×, ANTI-SCALE) AFTER TREATMENT WITH HYPOCHLORITE (0·0 PER CENT AVAILABLE CHLORINE) IN 0·1 N SULPHURIC ACID

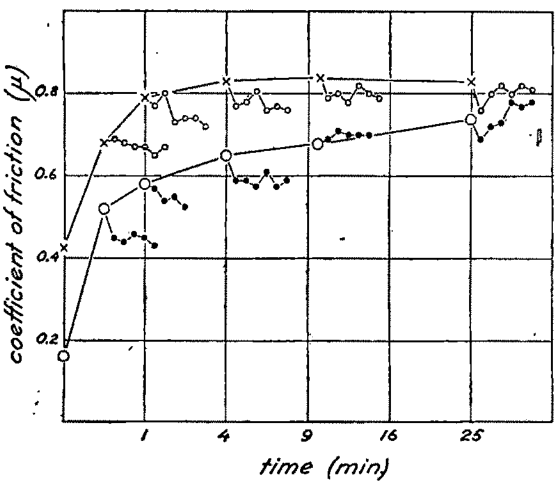

Fig. 2. FRICTIONAL COEFFICIENTS OF WOOL (○, WITH-SCALE; ×, ANTI-SCALE) AFTER TREATMENT WITH 2 PER CENT POTASSIUM HYDROXIDE IN 95 PER CENT ALCOHOL

onsiderably increased by only a few slippings in the pparatus, and the rubbings of the fibres during measurement eliminate the difference between the nti-scale and the with-scale friction. There is no orresponding effect for the potash-treated wool, where rubbings of the fibres do not noticeably hange the friction. All the measurements recorded in the graphs were made in distilled water. Measurements on chlorine-treated wool in soap solutions show a considerable decrease in the frictional coefficients μ about 0·15); but there is still no difference between anti-scale and with-scale friction. For the potash-reated fibres, the friction in soap solutions is somewhat lower than in distilled water, but there is still difference between the two coefficients.

It is assumed that the non-felting is caused by he elimination of the difference between anti-scale nd with-scale friction. An increase of both coefficients, as with potassium hydroxide treatment, auses a decrease in felting, but not complete elimination[2].

We hope to get more information about the chemical reaction between wool and various non-felting eagents by further studies of the frictional properties.

JOEL LINDBERG
NILS GRALÉN

Swedish Institute for Textile Research,
Gothenburg.
March 31.

Lindberg, J., and Gralén, N., [*Medd. Svenska Textilforskningsinst. Göteborg*, No. 6 (1948)].

Harris, M., and Frishman, D., *Amer. Dyestuff Reporter*, **37**, P52 (1948).

Pharmacology of Some *bis*-Trimethyl Ammonium Compounds

THE curare-like action of a series of *bis*-quaternary mmonium polymethylenes has recently been described by Barlow and Ing[1] and by Paton and Zaimis[1], and we can confirm that the C_3 compound curarizes, but is relatively inactive compared with *d*-tubourarine chloride on the rat diaphragm (1 per cent). ts action was completely reversed by prostigmine. Tetramethyl ammonium chloride showed about ·5 per cent of the activity of *d*-tubocurarine chloride on the rat diaphragm.) The C_5 compound had no action on the rat diaphragm. The C_3 compound has marked cholinergic action—salivation, lachrymation, bradycardia in decerebrated guinea pig—together with relaxation of decerebrate rigidity at a dose of 1·0 mgm. per kgm. It produced a response of the rabbit's ileum similar to that of acetyl choline (potency about 0·1 per cent that of acetyl choline). It has slight activity as an anticholinesterase (rat brain). It has no action on pseudo-cholinesterase (horse serum). Its cholinergic activity, apart from its low curarizing activity, would clearly render it unsuitable as a clinical substitute for *d*-tubocurarine. The C_5 compound has about the same anticholinesterase activity as the C_3.

The overlapping of 'muscarine', 'nicotine', and anticholinesterase activities is a very striking phenomenon which constantly recurs in complex quaternary ammonium compounds. If the chain includes phenyl groups the effect of increasing the distance between the $\overset{+}{N}$ atoms is not to increase the curarizing activity, but to develop anticholinesterase activity. $\overset{+}{N}(CH_3)_3.C_6H_4.CH_2.C_6H_4.\overset{+}{N}(CH_3)_3.2I$, in which the distance between the quaternary nitrogens is a little less than that of the C_7 *bis*alkyl ammonium, is about 6 per cent of the activity of *d*-tubocurarine on the rat diaphragm, and shows 'muscarine' effects but is not an anticholinesterase. If four more CH_2 groups are inserted into the chain, the curarizing activity drops to 2 per cent, but the compound is a very active anticholinesterase—of the same order of activity as eserine. Clearly the nature of the chain, as well as the distance apart of the $\overset{+}{N}$ atoms, affects considerably the activity of the compound.

We have attempted to determine the distance between the nitrogen atoms in Fisher – Hirschfelder models of the tubocurarine ion. Unfortunately, at least seven possible configurations can be constructed, any one of which might represent *d*- or *l*-tubocurarine, or *d*- or *l*-curine, and no one of which is convertible into another without breaking one bond or another. The distance apart of the nitrogen atoms varies for different models from that corresponding to C_3 to that corresponding to C_8 straight chains.

With regard to the species variation, remarked on by Barlow and Ing, and Paton and Zaimis, we showed in July 1947, at the Pharmacological Society, some results with two closely related compounds—*d*-tubocurarine and its dimethyl ether.

The ratio of the potency of the dimethyl ether to *d*-tubocurarine is:

	Intact animal	Diaphragm
Rabbit	9	3
Rat	3	3
Guinea pig	2	1
Albino mouse	0·5	0·4

Not only does the ratio vary between different species, but also especially in the rabbit the discrepancy may be larger in the intact animal.

GERTRUDE E. GLOCK
G. A. MOGEY
J. W. TREVAN

Wellcome Physiological Research Laboratories,
Langley Court,
Beckenham, Kent.
May 14.

[1] *Nature*, **161**, 718 (1948).

Incidence of Malaria in Tropical Africa

THE conventional 'parasite-rate' (percentage proportion of children aged 3–10 years in whose blood malaria parasites are detected by a single examination) may be a misleading standard of qualitative measurement giving a distorted idea of the amount of malaria in a locality. But in practice a reduction from 70 to 40 per cent is often claimed to be evidence of effective malaria control, and we are led to believe that a figure of 5 per cent is a splendid achievement indicating a very low malaria incidence.

It has been pointed out that the rate at which infants acquire their first infection offers an exact and quantitative alternative method of measurement. If we can find the number of *infective mosquito bites* received by people in a given time, we have in a single figure not only the malaria-transmitting ability of the mosquitoes but also the actual incidence of the disease itself[1].

Working in Freetown, West Africa, we investigated the blood of infants at monthly intervals, and the examinations of fifty individuals made sequentially for eighteen months showed that twelve infections were received during that time. We could say that mosquitoes were infecting one in six infants each year.

Now if we visualize a situation in which one in every six persons in a city in the British Isles were to be infected with malaria each year, the problem of dealing with some 13,000 cases among a population of 80,000 such as existed in Freetown would indeed be a formidable one! (We are not, however, necessarily inferring that the African may react to infection as severely as the European.) Yet when we came to express the number of examinations of infants in whom malaria parasites were detectable as a percentage of the total examinations made, a parasite-rate of 5 per cent was obtained. On the face of it, that is a very small figure and could have easily misled us into a false assumption that the malaria incidence was very low.

Now while the infants were being investigated, mosquitoes were collected from houses in Freetown by standard methods, and the proportion carrying salivary gland infections was measured. From this data it was possible to calculate the 'parasite-rate' of the infants. The accuracy of these estimates encouraged us to calculate theoretical 'parasite-rates' produced by a wide range of numbers of 'infective mosquito bites' received by the average child in a year (see table). These values were in close agreement with observed data.

Number of infective mosquito bites per child per year	0·01	0·1	0·2	0·4	1·0	2·0	5	10	50
Calculated parasite-rate % in children	0·26	2·6	5·0	10	23	40	73	92·5	99·9

A reduction of the parasite-rate to 40 from 70 per cent then merely represents the difference between the average child receiving two infections of malaria each year and five. A parasite-rate of 2·5 per cent is revealed as the result of infection of one in ten children each year, which is certainly still too high.

Yet after four years of the most intensive mosquito control in Freetown, it appears that the parasite-rate of school children could not be reduced below a figure of 10 per cent (we can stop mosquitoes breedin but not people moving into and out of our contro area). While that is a very low rate for tropica Africa, our investigation suggests that infections ar still received by no less than half the children eac year.

We feel that were it possible to achieve a situatio where one in a thousand persons contract the diseas per year, then we might be entitled to say tha control of malaria could be effected. But over nearl all tropical Africa the average African seems norm ally to receive not less than five and frequently man more than fifty infective mosquito bites each yea

Above a figure of 75 per cent the parasite-rate ha no practical significance, since the average person i receiving superfluous infections. At satisfactor numbers of infective mosquito bites per year, th parasite-rate is less than 1·0 per cent. Consequentl changes in intervening values have also little practic meaning.

If this be the case, most efforts at malaria contr may merely reduce the frequency of receiving in fection at the cost of partial loss of immunity withou necessarily leading to any appreciable reduction the disease.

It all depends upon whether we are concerned i protecting small groups of completely non-immun Europeans, or attempting to protect the otherwis immune or partially immune indigenous populatio If the latter, it may well be that we shall hav to revise our conventional methods of assessin the incidence of malaria, and attempt to discov just how often the *average* African is, in fact, infecte and what exactly are the effects of malaria upon h health and efficiency.

G. A. WALTON
(Colonial Medical Research Servic

Department of Entomology,
London School of Hygiene
and Tropical Medicine,
Keppel Street, W.C.1.
April 7.

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[1] *Ann. Trop. Med. Parasit.*, **41**, 380.

Inhibition of Aerobic Sporing Bacilli by Hæmatin

CERTAIN bacilli will not grow on nutrient ag containing hæmatin at a concentration of 1/20,00 Other bacilli do not appear to be affected b hæmatin. The organisms tested are shown in t following table, the figures in brackets being t number of strains of each species tested.

INHIBITED BY HÆMATIN	NOT INHIBITED BY HÆMATIN
Bacillus brevis (5)	*Bacillus anthracis* (2)
,, *licheniformis* (11)	,, *carotarum* (2)
,, *megatherium* (10)	,, *cereus* (11)
,, *subtilis* (45)	,, *circulans* (7)
	,, *firmus* (11)
	,, *fusiformis* (5)
	,, *laterosporus* (1)
,, *alvei* (1)	,, *alvei* (2)
,, *coagulans* (1)	,, *coagulans* (2)

With the exceptions of *B. alvei* and *B. coagulan* all the tested strains of a given species reacte uniformly towards hæmatin. The growth of *subtilis* was completely inhibited by hæmatin at concentration of 1/125,000, and was partial inhibited by hæmatin at a concentration of 1/500,00

The effect of hæmatin on a wide range of other species of bacteria was tested; but in no case was inhibition observed, with the possible exception of some *Corynebacteria*. At a concentration of 1/16,000 hæmatin appeared partially to inhibit the growth of a few strains of *Corynebacterium diphtheriæ mitis* and *gravis*, *C. hofmanni*, *C. xerosis* and a gelatin-liquefying diphtheroid. On the other hand, it strongly stimulated the growth of two strains of starch-fermenting, gelatin-liquefying *Corynebacteria*.

Hæmatoporphyrin and coproporphyrin III at concentrations of 1/20,000 did not appear to inhibit the growth of *B. anthracis*, *B. brevis*, *B. cereus*, *B. licheniformis*, *B. megatherium* or *B. subtilis*. Mesoporphyrin, 1/20,000, did not inhibit the growth of *B. anthracis*, *B. cereus* or *B. subtilis*, but it appeared partially to inhibit the growth of *B. brevis*, *B. licheniformis* and *B. megatherium*.

None of the organisms referred to above was inhibited by whole or laked red blood cells, with the exception of six of the forty-five strains of *B. subtilis* tested. These six particular strains grew quite readily on nutrient blood agar, but the cultures autolysed within seventeen hours of inoculation; they did not autolyse for at least three days when blood was omitted from the same nutrient agar. With the exception of *B. megatherium*, all the strains of organisms which were inhibited by hæmatin were also inhibited by laked red blood cells plus trypsin; they were not inhibited by whole red blood cells plus trypsin, even when they were able to hæmolyse the red cells.

Prof. C. Rimington (who kindly supplied me with the porphyrin derivatives I have tested) has reminded me that Kämmerer[1] claimed more than thirty years ago that hæmatin (1/2,000) did not inhibit any of the organisms he had tested, including (what was then called) *B. subtilis*, but that mesohæmatin inhibited the growth of a large number of Gram-positive organisms, including *B. anthracis*.

I am indebted to Miss Kathleen Gilliver of this laboratory for supplying cultures of the bacilli which I used, and for advice concerning them.

This work is being continued.

W. E. van Heyningen
Sir William Dunn School of Pathology,
University of Oxford.
April 9.

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[1] Kämmerer, H., *Verhandl. d. deutschen Kongresses f. inn. Med.*, 31, 704 (1914).

Effects of Aeration on Bracken and Heather Grown in Nutrient Solution

It has frequently been noted by ecologists, and is readily observed in the field, that the bracken fern (*Pteridium aquilinum*, Kuhn.) is halted in its advance on encountering water-logged soil. Also, irrigation of a *Pteridietum* rapidly decreases the density and height of the plant. Apparently no experimental investigation of aeration as a factor in the growth of bracken has hitherto been made. Watt has suggested that aeration may be an important factor in the outcome of the struggle between bracken and heather (*Calluna vulgaris*, Salisb.), and therefore the latter has been the subject of similar experiments.

Solitary bracken sporelings bearing a few small fronds and roots were placed in jars containing a variant of Knop's solution. One series of eight jars was aerated continuously for two months. A second series was left unaerated, and nitrogen from a cylinder bubbled through a further eight cultures.

Calluna seedlings were grown under similar conditions except that each series consisted of twelve jars and the medium used was half-strength Crone's solution, periodically adjusted by addition of dilute sulphuric acid to maintain the *p*H of the solution below 6.

Estimations of dissolved oxygen were made by the Winkler method adapted for small samples in a syringe pipette.

The results of these experiments are summarized in the accompanying table.

The roots of the bracken plants in aerated cultures were long with many branches, of a golden-yellow colour, and the tips of the main roots and laterals were noticeably swollen.

In the unaerated series, the roots were short and bunched, and in no case did the roots penetrate more than a centimetre or so beneath the surface of the solution. The roots were dark-brown in colour. No lateral branching occurred and swollen root tips were not found.

The plants treated with nitrogen were older than the others. One might have thought that their greater size would have rendered them more vulnerable to the effects of low oxygen supply. Nevertheless, even after two months of almost continuous passage of nitrogen, the health of the plants was but slightly impaired, as indicated by a wilting of some fronds to a small extent. The mean root-length was somewhat lower than in the unaerated series. The rhizomes of most plants in the series bore many short adventitious roots along their length and, in certain cases, these were developed to such an extent as to produce a network in the damp cotton wool and on the surface of the cork. This may be interpreted as a response whereby the young plants were able to absorb oxygen from the air when grown in solution containing little oxygen.

At harvesting, the aerated heather plants, while apparently healthy, were of smaller stature than the unaerated ones. The root systems tended to be bunched, and, although much branching occurred, the laterals were very short in most cases. Microscopical examination of the aerated roots showed that the mycorrhizal fungus had very few external hyphæ. In the cortical cells, the mycelium was never so dense as to fill the cells completely.

In unaerated solutions, both root- and shoot-growths of heather were luxuriant. Mycorrhizal development was little different from that in the aerated plants.

	Pteridium aquilinum			*Calluna vulgaris*		
	Aerated	Unaerated	Nitrogen	Aerated	Unaerated	Nitrogen
Mean temp. of sol. (deg. C.)	11·3	—	—	15·7	17·4	17·9
Mean dissolved oxygen (c.c./litre at N.T.P.)	7·71	6·293	1·191	7·053	5·153	2·616
Mean lengths of roots (cm.)	22·6	6·7	6·2	8·1	15·3	8·2
Mean dry weight of roots (gm.)	0·0815	0·0595	0·0922	0·0894	0·0960	0·0717
Mean dry weight of fronds (gm.)	0·1475	0·0648	0·1573	0·2586	0·3561	0·2412
Ratio of roots to fronds (mean dry weight)	1 : 1·8	1 : 1·1	1 : 1·7	1 : 3	1 : 3·7	1 : 3·4

With almost continuous treatment with nitrogen, root- and shoot-growths were approximately the same as with air. External hyphæ were more frequent and the mycelium in the root cells was often in an advanced stage of digestion.

Work on the respiration-rates of the roots in relation to oxygen supply, and on the precise oxygen concentrations in various bracken and heather soils, is being carried out.

L. W. Poel

Department of Botany,
Agricultural College,
Glasgow, C.2.
March 10.

Etiology of Grass Disease

In view of the letter in *Nature* of May 22 in which W. S. Ferguson recorded a paralysing action of grass juice on the isolated rabbit intestine, it may be of interest to note that we have succeeded, by ligature of the ileum in experimental ponies, in reproducing the main clinical, biochemical and post-mortem findings of acute grass disease. Although in this disease there is no obvious obstruction to the onward passage of fluid from the greatly distended small intestine to the dehydrated contents of the colon, the close similarity between experimental ileal obstruction and the naturally occurring condition suggests that in the latter there may be some functional upset in this region. As the large majority of cases occur in horses at grass, and as the peak incidence occurs during the active-growth stage of the herbage, it is tempting to suggest that the disturbance may be due to some chemical substance either existing preformed in the grass or produced in the process of digestion. Ferguson's observations would seem to be well worth following up with this possibility in mind.

A. Robertson
D. E. Donald
J. S. S. Inglis
H. Paver

Royal (Dick) Veterinary College,
Edinburgh 9.

Apus and a Rare Cladoceran in Britain

The primitive crustacean known as apus, or *Triops cancriformis* (Bosc), which is of particular interest to zoologists, has only been recorded five times in Britain. It was found in 1738 in Kent[1], at the beginning of last century near Christchurch in Hampshire[2], a little later at Bristol[3], in 1907 in Kirkcudbrightshire[4], and in 1934 near Fordingbridge in Hampshire[5]. Last summer, at the suggestion of Prof. J. Omer-Cooper, one of the discoverers of apus near Fordingbridge, I sought it and got it again from the same pool in which it occurred in 1934[6]. It seems, then, as if apus were a permanent inhabitant of Britain and not merely introduced from time to time through its drought-resistant eggs being carried in mud on birds' feet. I am submitting a full account of my find for publication in the *Proceedings of the Zoological Society*. Apus may not be quite so rare in Britain as the recorded finds suggest, for Ray Lankester, in letters to Dr. W. T. Calman and Dr. R. Gurney, related that he found it on Blackheath and in Worcestershire. I should welcome news of other finds. The habitat in Hampshire is a shallow grass-bottomed pool which is waterless in dry weather.

In 1946, Mr. D. J. Scourfield described a new species of *Daphnia* from Kew Gardens, *D. ambigua*[7]. From the locality in which he found it, Mr. Scourfield suggested that it had been introduced with aquatic plants from abroad. Last summer, and again this summer, I have found *D. ambigua* Scourfield to be abundant in Regent's Park lake. This need not invalidate the hypothesis of a foreign origin, since *D. ambigua* may have been introduced into the lake, in the form of ephippia by birds, from the old Botanic Gardens near by. It was there that the first freshwater medusa was discovered in 1880, in a tank with the water lily *Victoria regia*, coming, therefore, perhaps from South America. Again, I should like to hear of other finds of *D. ambigua*.

H. Munro Fox

Bedford College,
University, London.
June 28.

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[1] Brown, L., *Phil. Trans. Roy. Soc.*, 40, 153 (1738).

[2] Leach, W. E., Supp. to 4th, 5th and 6th editions "Encyclopædia Britannica" (1816).

[3] Clayfield, W., specimens in British Museum (Nat. Hist.).

[4] Balfour-Browne, F., see Gurney, R., *Nature*, 76, 589 (1907).

[5] Hobson, A. D., and Omer-Cooper, J., *Nature*, 135, 792 (1935).

[6] Fox, H. M., *Agenda Sci. Meet. Zool. Soc. Lond.*, No. 2 (1948).

[7] Scourfield, D. J., *J. Quekett Micr. Club*, (4), 2, 127 (1946).

Re-discovery of *Apus cancriformis*

In September 1907 I discovered two shallow grassy pools on the Preston sea merse, near Southwick, Kirkcudbrightshire, in which *Apus* was present. In one of these it was so abundant that when I raised my eleven-inch ring net out of the water it was half full of specimens, mostly full-grown. I searched many other pools in the same area but without finding it and, returning to the same pools a few days later, I found the edges covered with the shells and very few specimens left in the water. The gulls had discovered this mass of food and had destroyed most of the *Apus*. I have visited the area many times during the last forty years but not until this month, working the merse near the mouth of the Southwick burn, have I again seen *Apus*. My son found three specimens in a pool which then yielded us about thirty or more, and several other pools near the first produced small numbers, mostly immature.

Geoffrey Smith[1] remarked upon the erratic way in which the Phyllopods are scattered through the regions they inhabit, and how they may appear in a pond for several seasons and then vanish. While *Apus* occurred in different parts of Britain on each of the few occasions of which we have records, the accepted explanation of its appearance seems to have been that it was brought each time on the feet of geese and other aquatic birds; but when it turns up after forty years within a mile or two of where it was originally found, it is perhaps reasonable to ask, has it been present in the hundreds of pools in the sea merse which extends, with gaps, from Southwick via Ruthwell, Powfoot, etc., and into Cumberland?

Frank Balfour-Browne

Brocklehirst,
Collin,
Dumfries.
June 29.

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[1] "Cambridge Natural History", 4, 34 (Macmillan).

ENGINEERING RESEARCH AT CAMBRIDGE

THE report of the head of the Department of Engineering, University of Cambridge, on the work of his Department for the year 1946–47, was published in the *University Reporter* of April 27.

The report is divided into three sections under the headings teaching, research and workshops. The first section is of interest because it deals with the transition period when some men were reading for he old undivided Mechanical Sciences Tripos, held for the last time in 1947, and others for the new wo-part Tripos which was held for the first time in hat year. The new Part 2 course, in spite of starting under difficult conditions due to heavy numbers and shortage of staff, ran surprisingly smoothly. In all, 765 candidates sat for Tripos examinations in 1947. The report points out that while the number of undergraduates in the Department (658) was 117 less than the average in 1920–21, the corresponding year after the First World War, no less than 574 of hem were reading for honours as compared with 447 in 1920–21. The difference in research activity is even more marked; during 1946–47, in addition to the members of the teaching staff, 23 postgraduate students were engaged in research work as compared with 3 in 1920–21.

In its second section the report deals briefly with ome thirty-five projects being carried out in nine laboratories of the Department. In aeronautics the study has been begun of the behaviour of air as it flows past a solid porous surface through which some of the air is sucked, and theoretical work was coninued on the prediction of aerodynamic reactions on wings when account is taken of the boundary layers which form on their surfaces. Other investigations involving fluid motion, carried out in the Hydraulics Laboratory, included the protection of a pumping main by admitting air through a valve as n alternative to the air-bottle method, the actions of whirlpools, a theoretical investigation giving an pproximate method of dealing with the equations governing the oscillations in a surge tank fitted to a ipe line, and the instability of a fluid surface when accelerated in a direction normal to its plane.

The main effort in the Electrical Laboratory was centred on re-equipment and on setting up a Magnetic Laboratory, but five main projects in electronics were undertaken, namely, the construction of an automatic plotter for trajectories in an axially symmetric electrostatic system, the construction of a new type of mass spectrograph, the investigation of he modulation of an electron beam, and also of hot noise in thermionic valves, and the construction of an experimental electrostatic electron microscope.

In the Heat Engines Laboratory, new methods have been used to examine the scavenging process in two-stroke engine. An investigation, supported by he Motor Industries Research Association, was also mbarked upon to record the movement of a piston ring relative to its groove in an engine running under s own power. Other projects, supported by the Ministry of Supply, concerned gas turbine problems, ncluding the investigation of the flow through ascades of axial-flow compressor blades, and a study of the turbulent boundary layer break-away of air rom the flat boundary surface of diffusers and from he curved surfaces of blades. Work was also begun n the heat-flow characteristics of liquid metals and on the development of a magnetic pump for pumping a liquid metal.

Considerable work was in hand in the Materials Laboratory. Since 1943 a team of workers, supported by the Admiralty, has been investigating the causes of fracture in welded ships. It has been shown that while residual stresses and reaction forces can be high, neither is the chief cause of fractures in welded ships; the trouble can, however, be attributed to a property of mild steel known as 'notch brittleness'. Two other investigations aimed at determining the effects of high rates of strain on mild steel and the effects of low rates on aluminium and other materials. A third was concerned with distribution of stress and strain in real materials having non-Hookean properties.

In the Mechanics Laboratory, the solution has been obtained to the problem of the stresses caused by a suddenly applied load on a beam supported in various ways; a number of direct verifications of the theoretical predictions of stress have been obtained experimentally. An investigation, supported by the London, Midland and Scottish Railway Company, of the motion of a single railway axle and a pair of wheels was completed. A special photo-elastic bench equipped with stroboscopic light sources has been constructed, with the help of a grant from the Institution of Mechanical Engineers, for the determination of the dynamic stresses in gear teeth. An attempt, assisted by the British Iron and Steel Research Association, is being made to determine theoretically and experimentally the relative distribution of useful and frictional work in the wire-drawing process.

A number of problems relating to pressure vessels have been investigated. Methods were devised for the solution of the differential equation governing the stresses and deflexions in drumheads of any rotationally symmetrical form with the aid of a mechanical analogue apparatus; help with this project has been given by the Research Department of Messrs. Babcock and Wilcox. Tests, supported by the British Welding Research Association, have been made on the pipe-bend portions of welded pipe lines, and it has been shown that the greatest surface strain occurring in the cross-section is the transverse strain inside.

With the support of the Nuffield Foundation, a start was made on the problem of tillage by measuring the component soil forces on a simple implement in motion.

In addition to the work on brittle fracture, the Department has been collaborating in other investigations on ships. Full-scale trials were conducted by the Admiralty during the years 1945–47, and the work being carried out in the Department is the reduction of the experimental data to a form suitable for interpretation into practical design recommendations. Work similar in aim though very different in scale has been undertaken on a 14-ft. sailing boat.

Much research into the behaviour of other structures was carried out. An investigation, supported by the British Welding Research Association and the Department of Scientific and Industrial Research, to find the true load-carrying capacity of rigidly jointed steel frame structures was continued. The behaviour up to collapse of a length of continuous stanchion bent in double curvature was investigated experimentally and a theoretical analysis of the same problem was completed. A successful start in developing a method of design taking account of plastic deformations was made by dealing with single-bay rectangular portal frames; the lateral instability of steel beams bent until they had partially yielded was studied, and a considerable programme of tests on battened struts was carried out.

In addition to these investigations under static loading conditions, attention has been given to the fatigue strength of structures. Equipment was developed successfully for carrying out fatigue tests on full-scale structures and structural components by the resonance vibration method.

A comprehensive investigation into the behaviour of light alloy struts was made, and an experimental and theoretical study of the lateral instability of light alloy beams is also being undertaken with the help of the Aluminium Development Association.

RABELAIS ON SYPHILIS

IN a thesis for a doctorate in medicine at the University of Paris, Dr. Mottron has chosen to extract from the books of Gargantua and Pantagruel all the references to syphilis ("Rabelais et la Verole". By J. Mottron. Pp. 127. Tours: Arrault et Cie., 1947). The texts are quoted *in extenso* and the commentary thereon gives a study of syphilis as it was understood in the first half of the sixteenth century.

Rabelais was a contemporary of Fracastorius, but he did not use the term syphilis, which only became popular much later. In the prologue to Gargantua, Rabelais dedicates his writings to "Buveurs tres-illustres, et vous verolez tresprecieux". His references to the disease are all in terms that could be understood by his lay readers.

The epidemic of syphilis in Europe began in 1493, and when Rabelais was writing there was already a good descriptive knowledge of the disease. The chancre was recognized as the primary focus of infection and its characteristic induration had been described. Also known were the short latent period before the start of the secondary stage with its *croustelevés*, or rupial lesions, and all the other manifestations of secondary syphilis on the skin and in the nervous system.

It was fortunate that mercury, the only useful remedy of the times, was used almost at once, and by accident, in the treatment of the new disease and that its good effects were recognized. Mercury was first used by inunction, and there is an allusion to this method of treatment in Rabelais' prologue to the books of Pantagruel. The toxic effects of mercury are also mentioned. When mercury was shown to affect syphilis the dosage was increased to toxic levels, and the ill-effects were confused with the manifestations of the disease itself. This confusion resulted in the change to guaiacum which, for a short period, superseded mercury.

Although mercury was used orally as early as 1533, inunction long continued as the chief mode of application. Sweating baths were often associated with mercury inunctions. Gasparo Torrella (1497) recommends the "best way to treat syphilis is to sweat the patient for fifteen days, fasting, in a steam bath or oven". Jean Fernel (1557) writes of steam baths at high temperature for twenty days or more. Sarsaparilla, a sudorific agent used in conjunction with baths, is also mentioned by Rabelais. The vogue for sweating has continued ever since. Baths in mercury vapour were used by Langston Parker i 1850 and to-day we use more elaborate methods i the hypertherms. Rabelais seems to have intende his works to be read by the suffering *verolez* whil they were sweating. It is doubtful whether eve Rabelais could mitigate the sufferings of the moder sweating cabinet; but it is an idea which ought t be tried.

Dr. Mottron seems to favour the theory tha syphilis existed in Europe in the pre-Columbian er and that the disease was unrecognized before 1493 or confused with leprosy, scabies, etc. He cite Broca's (1876) observation of the discovery o syphilitic lesions in bones from an ancient leprosorium and quotes the monk Theodoric (thirteenth century) Gaddesden (fourteenth century) and Bernard Gordo (1305), on the transmission of 'leprosy' by sexua intercourse.

The evidence of contemporary observers such a Torrella and Ulrich von Hütten is, however, of a new, hitherto unknown disease which alarmed th doctors to the point where they fled from the presenc of the sick. Public health measures were quickl enacted all over Europe. In Paris, in 1497, foreigner with the great pox were warned to leave the cit under pain of the halter for disobedience, and citizen so affected had to stay always indoors. The nex year, 1498, the penalty for the unfortunate syphiliti discovered at large in Paris was to be thrown into th river. In the city of Aberdeen, at the same time, t combat the French disease, it was ordained "that al licht weman be chargit and ordanit to decist fr their vicis and syne of venerie, and all their bothi and housais skalit". All these evidences sugges something absolutely new and terrifying.

In favour of the American origin for syphilis ar many points unspecified by Dr. Mottron. He doe not mention, for example, Ruy Diaz de Isla' "Tractado Contra el Mal Serpentina", in which i described the treatment, at Barcelona, of some o Columbus's men on their return from Haiti. No does he allude to more recent investigations on ancien bones which seem to show that syphilitic osteitis di not occur in Europe or Egypt before the sixteent century. This controversy is, however, interminabl and can be closed for the present with the observatio that Rabelais talks of a case of the *verole* in 1420.

The entity of syphilis is recognized by Rabelais He mentions gonorrhœa only rarely, but it is quit clear that he knew it as a separate disease. Syphili was also distinguished from leprosy in Rabelais day. Vibert speaks of lepers fearing contaminatio from syphilitics. Rabelais knew syphilis to be contagious and venereal disease; but he does no seek, like some of his contemporaries, for causes i planetary disturbances, poisoned water, cannibalism etc.

Dr. Mottron ascribes to Rabelais the trac "Triomphe de Très Haute et Puissante Dam Vérole". In this is cited, perhaps for the first tim a cause for venereal disease which is still occasionall suggested by patients:

> "Et notre fiffre a uriné
> Contre un mur dont mal lui en print".

Dr. Mottron is to be congratulated on his scholar development of a very interesting theme. My onl criticism is of his rather one-sided treatment of t theory of the American origin of syphilis; but Rabelais is on his side I shall say no more.

JAMES MARSHALL

STRESS ANALYSIS AND THE DESIGNER

A DISCUSSION on "Stress Analysis and the Designer" was opened by Sir Donald Bailey the Birmingham Conference on April 13 of the Stress nalysis Group of the Institute of Physics. Sir onald outlined his attitude to stress analysis as engineering designer. He needed answers to articular problems which could not be obtained by athematical methods either because of the comexity of the mathematical solutions or because of sign assumptions, unknown boundary conditions other practical uncertainties. He specified his quirements as the need to measure stresses up to –85 tons per sq. in. in steel or 25–30 tons per sq. in. light alloys, occurring at frequencies from 0 to 25 cles per second in structural work and up to cycles per second in mechanical work. This quired recording apparatus that would respond to least 1,000 cycles per second. The stresses obtained ould be correct to within 2½–5 per cent for all resses from 4 tons per sq. in. upwards.

Sir Donald outlined the field conditions under hich he required his apparatus to operate. On ructural work he found that he had very often to rry out tests in bad weather and on remote sites void of a power supply. The structures under vestigation were often large and the readings had be available at a central recording station several undred feet away from the structure. Experts on rain gauge methods were not usually available, and e equipment used had therefore to be sufficiently liable to be operated by the practising engineer, ho was not generally competent to carry out pairs to electronic equipment if this went t of commission at the crucial moment during a st.

The shortcomings of a number of methods of expermental stress analysis were then discussed. Mechanical d optical strain gauges are generally unsuitable for e in the field because they are incapable of recording alized and dynamic stresses and cannot be adapted central recording of the readings from a large mber of gauges. Sir Donald has found acoustic uges to be unsatisfactory and too large and heavy his purposes. Brittle lacquer techniques and oto-elastic methods were mentioned in passing, t neither of these are field methods. The rigid mperature control required for the brittle lacquer thods rules these out for use in the field; photostic methods are extremely useful, but necessarily ited to laboratory investigations on small-scale dels.

The electric resistance strain gauge is the most dely used method, but Sir Donald Bailey felt that ch more development work is needed here; the cking of the gauges to the structure needs much ill and experience in order to give consistent results. e waterproofing of gauges in the open air has been nd difficult. Temperature control and the correct cing of large numbers of gauges have been found kward and time-consuming, and the equipment ed in the recording of dynamic stresses has not, in neral, been found very reliable.

During the discussion which followed, the use of e acoustic strain gauges, particularly those of the ihak type, was defended; and a number of akers felt that by virtue of their robustness and edom from troubles due to changes of temperature, these gauges were eminently suitable for use in static tests of large structures.

A number of speakers felt that the difficulties of mounting electric resistance strain gauges have been exaggerated, but there was general agreement that the waterproofing of gauges in exposed positions is of paramount importance. The general feeling of the meeting was that there is no alternative to soldering the leads to electric resistance strain gauges; plugs and sockets invariably lead to erratic results. Where immediate results are required in the field, the use of pen-and-ink recorders was advocated; a representative of Messrs. Kodak pointed out that immediate results are obtainable from ordinary film and that processing in special solutions in a mobile unit need only take 40 seconds.

There was very general support for Sir Donald Bailey's contention that the manufacturers of electronic devices might pay more attention to the reliability of their products. The point was made that the engineer engaged on stress analysis work should be able to feel the same confidence in his oscillographs, amplifiers and other electrical recording equipment as the average householder has in his domestic wireless set. The view was put forward very strongly that the manufacturers tend to think of their customers too often as experts in electronics, who use the equipment in laboratories where minor repairs can easily be carried out, and do not cater for the engineer who wants to use his electronic gear merely as a tool and who knows no more about the construction of the instruments than is necessary for their efficient use. One industrial research unit was quoted as an example of the waste of effort involved in the present position; in this unit no less than nine members of the staff out of a total of thirty are engaged in the instrument section dealing mostly with breakdowns and troubles caused by insufficient screening of electrical recording instruments. It was made very clear by the discussion that the manufacturers have a long way to go before they achieve a standard of reliability and robustness in their products which will satisfy their customers in the growing field of experimental stress analysis.

E. K. Frankl

INTERNATIONAL INSTITUTE OF WELDING

WELDING has just achieved organisation on an international scale by the formation of the International Institute of Welding, at a meeting in Brussels during June 8–11, attended by the representatives of fourteen countries.

At the meeting of the Governing Council on June 11, M. P. Goldschmidt, administrative director of the Belgian Institute of Welding, was elected the first president of the International Institute, and the Council elected as vice-presidents Prof. H. E. Jaeger, lecturer in naval architecture at the University of Delft, and Prof. A. Portevin, president of the French Institute of Welding. One other vice-president is to be nominated by the American Welding Society. Mr. Walter Edström, vice-president of the Swedish Welding Committee, was elected treasurer. A special responsibility has fallen to the British welding community through the election as the first secretary-general of the international body of Mr. G. Parsloe, secretary of the British Institute of Welding.

The primary business of the meeting was to establish the International Institute and to set up a number of special commissions on various technical subjects. The following subjects have been included, the names of the respective chairmen being given in brackets: gas welding (M. C. G. Keel, director of the Swiss Acetylene Society); electric arc welding (Prof. H. E. Jaeger); resistance welding (chairman to be nominated by the U.S. National Resistance Welding Association); documentation (M. A. Leroy, director of the French Institute of Welding); testing and measurement (M. P. Goldschmidt); preparation of a welding dictionary (chairman to be nominated by the Belgian Institute of Welding); hygiene and safety (Mr. A. Härlin, secretary of the Swedish Welding Committee); weldability (Prof. Jaeger); residual stresses (Dr. F. A. Fox, assistant director of the British Welding Research Association); mechanical stress relieving (Prof. W. Soete, technical adviser to the Belgian Institute of Welding and lecturer at the University of Ghent); brittle fracture (Mr. Scheil, of the A. O. Smith Corporation, Milwaukee)

On June 8 and 9, two sessions were devoted to the reading of technical papers, and works visits were arranged on the following day.

It is intended to hold a similar expanded meeting of the Governing Council annually, and an invitation from the Netherlands to meet there in 1949 has been accepted. An invitation from the British delegation to hold the first World Welding Congress in Great Britain in the British Festival year, 1951, was also accepted.

TOXICITY OF D.D.T.

THE insecticide most in the public mind to-day is that known as D.D.T., concerning the efficacy of which rather extravagant claims have been put forward. Nevertheless, its discovery has already proved an event of major importance in view of its cheapness, adaptability and wide range of application. There remain, however, many aspects needing detailed study. One of these is the toxicity of D.D.T. to man and animals, both in the tropics and in temperate regions.

This subject has been investigated by Surgeon-Lieut. F. M. G. Stammers and Lieut.-Commander F. G. Sarel Whitfield, senior entomologist to the Medical Director General of the Navy. A brief summary of the investigations appeared in *Nature*, 157, 658 (1946); the full account has been published in the *Bulletin of Entomological Research* (38, 1; 1947). In the course of the investigations fifteen men, attached to the Royal Naval School of Tropical Hygiene in Colombo, were adopted as subjects for inquiry. They had been exposed for many months to heavy and continuous daily contact with a 5 per cent solution of D.D.T. in kerosene. Their work consisted of spraying ships and shore establishments against infestation by various insects. Of the men employed, one was a Tamil and the remainder Cinghalese. The results of a detailed medical investigation of these men, together with their general demeanour and labour output, indicated that they had received no ill-effects. In England the toxicity of a continuous-phase aerosol of D.D.T. to man and animals was investigated by means of trials at the Royal Naval Hospital, Plymouth, and at the Chemical Defence Experimental Station, Porton.

In so far as human beings were concerned th results were entirely negative. Also, there were n symptoms of D.D.T. poisoning in rats and rabbi as the result of 28-days exposure to continuou D.D.T. aerosol. Messrs. Stammers and Whitfiel devote most of their paper to a critical review the literature on the subject under investigation. A the result of this study and of their own investig tions, it seems that D.D.T. is harmless to man ar animals when used as an insecticide. It is, neverth less, possible by unskilled formulation, by the use unsuitable solvents and by misapplication to inc risk of life. The chance of cumulative effects fro the storage of D.D.T. in the milk and tissues sheep and cattle needs further investigation.

INSTITUTE OF PHYSICS

ANNUAL REPORT

AT the annual general meeting of the Institute Physics held on May 20, the following we elected to take office on October 1: *President,* D F. C. Toy; *Vice-President,* Dr. E. T. Allibon *Honorary Treasurer,* Mr. E. R. Davies; *Honora Secretary,* Dr. B. P. Dudding; *New Ordinary Me bers of the Board,* Mr. J. H. Awbery and Mr. E. W. Selwyn. Dr. G. B. B. M. Sutherland has be appointed by the Faraday Society as its new re resentative on the Board.

The twenty-eighth annual report of the Boa covering the work of 1947 was presented to the mee ing. The report shows that the membership, no at about 3,250, continues to grow at the rate of little more than ten per cent per annum. The Ins tute has seven branches, five in Britain and o each in Australia and India, and six subject grou comprising electronics, industrial radiology, X-r analysis, industrial spectroscopy, electron micr scopy, and stress analysis. The last was formed March 1947. All the branches and groups have ea held several meetings during the year, and the repo lists these in detail. In July, the Institute co-operat with the H. H. Wills Physical Laboratory of t University of Bristol in conducting a summer scho at which the attendance was 133, on "Cohesi Forces in Metals and the Mechanical Properties Solids"; and, in September, with the Physical Socie and in collaboration with the Institution of Electri Engineers, it organised celebrations, including special exhibition at the Science Museum, to ma the jubilee of the discovery of the electron.

The report shows that the Board has been acti in matters concerning the education and traini of physicists. The preparation of a report on develo ments in technological education has been undertak (and has since been published); and to help in pu licizing the newly established National Certifica in Applied Physics, the Institute has produced illustrated booklet entitled "Experimental Science A Career for the Practical Boy or Girl". T Australian branch, also, has in preparation a rep on "Physics in Australia" and a booklet on "Phys as a Career". In addition to individual inquir from members concerning professional matters, t Institute has, either through the Joint Council Professional Scientists and other bodies on which t Institute is represented, or directly, dealt with di culties in connexion with the re-organisation of t Scientific Civil Service, the collection of up-to-d ata on salaries paid to physicists and on available cientific man-power.

In April 1946, the statement that "the Board was n full agreement with the views expressed by the resident of the Royal Society regarding atomic nergy and secrecy" was circulated to members of he Institute. The Board has since seen fit to amplify his statement, and has declared that it "strongly elieves that atomic energy should only be used for eaceful and not warlike purposes". This, in its pinion, requires international agreement, and thus olitical action, which the Board feels is a matter est left to individual men of science. The Board grees to promote the free exchange of scientific nformation between scientific workers of all countries; ut it also realizes that it has been the practice for ome to accept a measure of secrecy as a condition f their employment or service. In this connexion he Board is prepared to give advice to individual members.

The report mentions that during the year a scheme as discussed with the Physical Society for the stablishment of an applied physics journal. It was ecided, however, that it was not practicable, at resent, to launch such a journal, and an alternative uggestion of the Council of the Physical Society that he Institute's publication, the *Journal of Scientific nstruments*, should be enlarged and a special section, f about forty per cent of its space, be devoted to non-instrument' articles, was adopted. Since anuary 1948 the *Journal* has appeared in this modified form under the new title of *Journal of cientific Instruments and of Physics in Industry.* A second edition of the "Handbook of Industrial Radiology" was called for during the year, and among he new publications the Institute has in hand are book of "Laboratory and Workshop Notes" selected rom the Institute's *Journal*, and, in book form, the apers read at the 1946 Manchester Conference on he measurement of stress and strain.

Repairs and improvements to the Institute's House t 47 Belgrave Square, London, are proceeding teadily but very slowly, the report states, but already onsiderable benefit has been derived from the increased accommodation and facilities, which include members' reading room, and a lecture room with a apacity of a hundred. It is anticipated that the ssential work will be completed within two years.

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND

AN indication of the nation's indebtedness to the Council for the Preservation of Rural England nay be obtained from a perusal of the Society's annual report for 1947–48, obtainable from 4 Hobart Place, London, S.W.1. Foremost among the issues ith which it has had to deal has been the vast roblem of the post-war use of land for training the armed forces. The Council has been charged by the Ministry of Town and Country Planning with the duty f presenting evidence in writing, and if necessary erbally, on amenity and scientific grounds, in all ases where it is considered desirable that such vidence should be presented. On his afforestation olicy the Minister of Agriculture has been advised on landscape planting and types of trees, while the ouncil's officers have also played their part in causing the cost-limit for the building of new houses to be raised in order that local stone might be used for facing in those districts where stone-built houses are traditional.

In conjunction with the Caravan Club and the Town and Country Planning Association, the Council for the Preservation of Rural England has set up regional sub-committees to eliminate (in the words of the Scott Report on Land Utilization in Rural Areas) "the nameless messes, the assemblage of caravans and converted buses and encampments which have littered and spoilt many a once charming stretch of coastline, lakeside and riverside, and a hundred other attractive scenes".

The submission of the Scott Committee that the introduction of carefully regulated suitable industries into the countryside would be beneficial has been endorsed by the Council and particular cases have been investigated, while the Council has also advised the Minister of Town and Country Planning on the location and design of wireless installations for the police and the B.B.C. Representations to the Postmaster General on the colour of telephone call boxes has enabled substantial agreement to be reached for those districts where objection is raised to the standard red of the 'Jubilee Kiosk'.

Opencast coal working has caused the Council much concern, and clear recommendations have been made to the Minister of Fuel on methods of regaining soil fertility and the restoration of land drainage after settlement as well as the general amenities. The reports of the Committee on National Parks were warmly supported by the Council; but dissatisfaction was registered with the Government's tardiness in implementing the main recommendations.

Other subjects dealt with by the Council during a year of considerable activity were the control of outdoor advertisements, the distribution and design of electricity installations, the siting and landscape treatment of road works and the preservation of buildings of historic and architectural interest.

CROPS OF THE CARIBBEAN

THE Governments of the United States and the United Kingdom (1942), and later of France and the Netherlands (1945), united to establish a Caribbean Commission to encourage and strengthen social and economic co-operation between their various possessions and bases in the area known geographically and politically as the Caribbean. In order to survey needs, to determine what research has been done, to facilitate research on a co-operative basis, and to arrange for the prompt dissemination of the results of research, the Caribbean Research Council was set up in 1943. One of its research committees, dealing with agriculture, nutrition, fisheries and forestry, has instituted a series of crop inquiries in all territories, and the results of two such investigations have recently been published (Crop Inquiry Series No. 4, "Root Crops and Legumes", 1947, and No. 5, "Vegetables". Caribbean Commission, 1736 Vermont Ave., N.W. Washington, D.C., or Kent House, Port of Spain, Trinidad, B.W.I. 0.50 dollar per copy).

Agriculture in the Caribbean has traditionally emphasized production for export, on the theory that it is more advantageous to produce locally a high-priced crop (sugar) and buy low-priced foods in the world market. This has resulted in neglect of home-produced foodstuffs, and as the conclusions are similar for both publications under review, it is convenient to treat them together. Production of root crops, legumes and vegetables is unorganised, being mainly in the hands of peasants who cultivate small kitchen gardens about one-eighth of an acre in extent, as an adjunct to small-scale agriculture. Seed is generally imported, and is often of low viability owing to lack of cool storage. Pests and diseases are common, and there are only limited facilities for preservation of the produce. Yields are low; but it would appear that very considerable expansion of vegetable production is possible without disturbing the acreage devoted to sugar, which is the main crop. Two encouraging trends are a pre-war export of vegetables on a small scale from some of the territories, and some attempt at co-operative harvesting and marketing.

Details of all aspects of vegetable culture in each territory are set forth in the bulletins, which have been edited by Dr. H. W. Marston, with assistance (for Bulletin No. 5) from Dr. Gustave Burmeister, both of the United States Department of Agriculture.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, July 19—Friday, July 23

CONGRESS OF UNIVERSITIES OF THE COMMONWEALTH (in the Examination Schools, High Street, Oxford).

Tuesday, July 20

At 10 a.m.—Discussion: "Relations of the State and the Universities".

Wednesday, July 21

At 10 a.m.—Discussion: "Inter-University Relations".

Thursday, July 22

At 10 a.m.—Discussion: "A critical review, from the points of view of an historian, a philosopher and a sociologist, of the structural and moral changes produced in modern society by scientific and technological advance".

Friday, July 23

At 10 a.m.—Discussions: "General Plans for Colonial Higher Education" and "The Extension of the University Secondment Scheme".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1).—Conference on "Civil Engineering Problems in the Colonies".

Wednesday, July 21

BRITISH STANDARDS INSTITUTION (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 3 p.m.—Annual General Meeting.

Thursday, July 22—Friday, July 30

COMMONWEALTH INSTITUTE OF ENTOMOLOGY (in the Large Chemical Lecture Theatre, Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7).—Fifth Commonwealth Entomological Conference.

Friday, July 23

At 10.30 a.m. and 2.30 p.m.—Discussions on Insecticides.*

Monday, July 26

At 2.30 p.m.—Discussions: "Biological Control" and "Estimation of Insect Populations in the Field".*

Tuesday, July 27

At 10.30 a.m.—Discussions: "Recent Developments in the Control of Stored Products Insects" and "Tsetse Research and Control".*

At 2.30 p.m.—Discussion: "The Need for Plant Quarantine on a Continental Basis, with Special Reference to Africa".*

Thursday, July 29

At 2.30 p.m.—Discussion: "Locusts and Grasshoppers".*

Friday, July 23—Saturday, July 24

BIOCHEMICAL SOCIETY (in the Biochemistry Department, The University, Glasgow, W.2), at 11.15 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT KEEPER to be responsible for the Zoological Collections in the Manchester Museum—The Registrar, The University, Manchester 13 (July 24).

EXPERIMENTAL OFFICERS AT THE MICROBIOLOGICAL RESEARC DEPARTMENT, Ministry of Supply, Porton, Wilts, for work in connexio with a pilot plant producing antibiotics—The Secretary, Civil Servic Commission, Scientific Branch, 27 Grosvenor Square, London, W. quoting No. 2198 (July 24).

LECTURER (Grade II) IN THE DEPARTMENT OF PHYSICS—Th Registrar, The University, Liverpool (July 24).

SENIOR ASSISTANT ENGINEER and a GENERAL ASSISTANT ENGINEE for Power Engineering Section, and a GENERAL ASSISTANT ENGINEE for Light-current Engineering Section, in the Authority's Laborato at Leatherhead—The Director of Establishments, British Electricit Authority, British Electricity House, Great Portland Street, Londo W.1 (July 26).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, The Univers ity, Reading (July 30).

GLASS DELEGACY RESEARCH FELLOWSHIP in the Department o Glass Technology—The Registrar, The University, Sheffield 10 (July 31

LECTURER IN PHARMACOLOGY—The Secretary, Welsh Nationa School of Medicine, 10 The Parade, Cardiff (July 31).

OFFICER-IN-CHARGE OF SOIL MICROBIOLOGY SECTION, an OFFICER IN-CHARGE OF SOIL ECOLOGY SECTION, and an OFFICER-IN-CHARG OF BIOLOGICAL ASSAY SECTION, for the Soil Biotics Division, a ORGANIC CHEMIST for Soil Chemistry Division and SOIL PHYSICIST (2) for Soil Physics Division, in the Soil Bureau of the Departmen of Scientific and Industrial Research, Wellington—Office of the Hig Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 31

PHYSICISTS (2) FOR RADIO SECTION, a SENIOR PHYSICIST (Office in-Charge) FOR RADAR SECTION, a SENIOR PHYSICIST or ENGINEE (Officer-in-Charge) FOR ELECTRONICS AND ACOUSTICS LABORATORY and PHYSICISTS (3) FOR THE GENERAL PHYSICS LABORATORY, at th Department of Scientific and Industrial Research, New Zealand-Office of the High Commissioner for New Zealand, 415 Strand London, W.C.2 (July 31).

SENIOR LECTURER IN PLANT BIOCHEMISTRY at the University o Melbourne—The Secretary, Universities Bureau of the British Empir 8 Park Street, London, W.1 (July 31).

LECTURER IN MATHEMATICS (Pure Mathematics)—The Principa Royal Holloway College, Englefield Green, Surrey (July 31).

DEPUTY CHIEF SCIENTIFIC OFFICER in the Directorate of Engin Research and Development, Ministry of Supply, London—The Secre tary, Civil Service Commission, Scientific Branch, 27 Grosvenc Square, London, W.1, quoting No. 2191 (August 5).

HISTOLOGIST (Senior Research Officer or Research Officer) FOR TH DIVISION OF FOOD PRESERVATION AND TRANSPORT of the Counc for Scientific and Industrial Research, Brisbane—The Chief Scientifi Liaison Officer, Australian Scientific Research Liaison Office, Afric House, Kingsway, London, W.C.2, quoting No. 1772 (August 7).

RESEARCH OFFICER FOR THE DIVISION OF INDUSTRIAL CHEMISTR of the Council for Scientific and Industrial Research, Melbourne-The Chief Scientific Liaison Officer, Australian Scientific Researc Liaison Office, Africa House, Kingsway, London, W.C.2, quotin No. 1538 (August 7).

SENIOR PRINCIPAL SCIENTIFIC OFFICER IN THE INFESTATION CONTRC DIVISION of the Ministry of Agriculture and Fisheries—The Secretar Civil Service Commission, Scientific Branch, 27 Grosvenor Squar London, W.1, quoting No. 2193 (August 9).

DIRECTOR FOR THE CENTRAL GLASS AND CERAMIC RESEARC INSTITUTE, Calcutta—The Secretary, Council of Scientific ar Industrial Research, 'P' Block, Raisina Road, New Delhi, Ind (August 10).

TEMPORARY SENIOR LECTURESHIP IN MATHEMATICS at Aucklan University College, Auckland, New Zealand—The Secretary, Univer ities Bureau of the British Empire, 8 Park Street, London, W (August 15).

PHYSICISTS or ENGINEERS FOR METROLOGY AND ACOUSTICS LA ORATORIES in the National Research Laboratories, Ottawa—Tl Scientific Liaison Officer, Canada House, Trafalgar Square, Londo S.W.1 (August 16).

PROFESSORSHIP OF ECONOMIC AND MINING GEOLOGY at the Univer ity of Adelaide—The Secretary, Universities Bureau of the Briti Empire, 8 Park Street, London, W.1 (August 31).

ENTOMOLOGIST FOR THE RESEARCH DIVISION of the Departme of Agriculture and Forests, Sudan—Sudan Agent in London, Wellin ton House, Buckingham Gate, London, S.W.1, marking envelo 'Entomologist, Agriculture'.

GOVERNMENT CHEMIST in the Medical Department of the Go Coast—The Director of Recruitment, Colonial Office, 15 Victor Street, London, S.W.1.

LECTURER IN CIVIL ENGINEERING, a LECTURER IN MECHANICA ENGINEERING, and a LECTURER IN MATHEMATICS—The Clerk to tl Governing Body, Battersea Polytechnic, London, S.W.11.

LECTURER IN VETERINARY SCIENCE, a LECTURER IN GENETICS, LECTURER IN HORTICULTURE, a LECTURER IN STATISTICS AND EXPER MENTAL METHOD, a LECTURER IN POULTRY HUSBANDRY and LECTURER IN ENTOMOLOGY, for the Canterbury Agricultural Colleg Lincoln, New Zealand—The Secretary, Universities Bureau of t British Empire, 8 Park Street, London, W.1.

READERSHIP IN BIOCHEMISTRY tenable at the Royal Cancer Hospit —The Academic Registrar, University of London, Senate Hous London, W.C.1.

RESEARCH WORKER IN CHEMOTHERAPY AND TROPICAL MEDICI at the National Institute for Medical Research, London, N.W.3-The Secretary, Medical Research Council, 38 Old Queen Stree London, S.W.1.

SENIOR SCIENTIFIC OFFICER to take charge of Biology and Che istry Section (G.224/48A), a SENIOR SCIENTIFIC OFFICER to ta charge of Physics and Electronics Section (A.185/48A), a SCIENTIF OFFICER for investigation of deterioration of materials and equipme exposed under tropical conditions (F.429/48A), a SENIOR EXPER MENTAL OFFICER to lead a team working on Electronics (A.186/48A and EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTA OFFICERS for work in Chemistry (F.430/48A), Biology (G.225/48A Physics and Electronics (A.187/48A), General Engineering (C.415/48A for Ministry of Supply Tropical Testing Establishment, Port Harcou Nigeria—Technical and Scientific Register (K), York House, King way, London, W.C.2, quoting relevant reference number.

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EXAMINATIONS AND SELECTION BOARDS

THE remarks which Sir Percival Waterfield, the First Commissioner of the Civil Service, made at Oxford in March regarding the low standard in personality and intelligence shown by applicants for entry into the Civil Service have aroused a considerable discussion and formed the subject of a debate on the Civil Service initiated by Viscount Mersey in the House of Lords on May 26. Sir Percival's statement that, of three thousand graduates interviewed, 40 per cent of those who wanted to go into the administrative service and 50 per cent of applicants for the foreign service scored marks for personality and intelligence which represented complete failure, is one of which industry and the universities as well as the Civil Service are bound to take careful note. His further statement that about five per cent of applicants for the administrative service and eight per cent for the foreign service were below even the lowest category may well be discounted, as was suggested in the debate, by war-time conditions and the absence of the screening which was practised by the universities with candidates for the written examinations; but the feature that, among those who failed, 60 per cent had university or college scholarships and 20 per cent were those who had State scholarships, should cause at least as much disquiet to the educationist and industrialist as to the Civil Service Commissioners.

The three fundamental questions which arise here were well indicated by Viscount Mersey in opening the debate: the training or education which the candidates have received; the tests or examinations to be applied to them when they desire to enter the Civil Service; and the qualities which are judged necessary for the Civil Service. This part of Lord Mersey's speech suggests that he was aware of the discussion on selection for management at the British Association meeting in Dundee last year. Neither he nor any other participant in the House of Lords debate, however, recognized that in selecting men for the Civil Service, or for any other walk in life, the chief requirement is, as Mr. A. Rodger pointed out at Dundee, a reasonably clear notion of what we are trying to assess. The first question to be answered is: "What are we looking for in our candidates?" Unless we can give a reasonably clear answer to that question, neither the written examination nor the selection board is likely to give us the men or women we require.

It might well be argued, therefore, that some of the criticisms of the selection—and rejection—of candidates for the Civil Service are due to the simple fact that, with the growth of the Civil Service and the increasing range and complexity of its duties, we have become less sure of the qualities we desire in our Civil servants, and less able to formulate precisely the relative weight we attach to initiative, integrity and other aspects of personal character for which no method of assessment yet exists, if, indeed, it could be found. We cannot expect to devise the appropriate methods of selecting and testing candidates while we are uncertain in our own minds about the precise requirements those methods are to meet. Even if that uncertainty and indecision were removed, we have still a long time to wait before we can be satisfied of the validity of the new methods, as was, indeed, repeatedly asserted in the debate by the strongest supporters of the new tests.

There are, in fact, sound reasons why we should not discard the intellectual tests, however imperfectly such written examinations may disclose the boldness, quickness, clarity and candour which, with self-discipline, marked the habit of Greek thought in its greatest days, as Prof. F. A. Adcock noted in his presidential address to the Classical Association earlier this year. Indeed, Lord Lindsay very pertinently remarked that people who showed themselves capable of passing searching written examinations with distinction could not be altogether devoid of ability. He himself thought that while the interview by the Civil Service Selection Board was much better in many ways than the half-hour interview, the right course was to restore the solid evidence of achievement in the written examination and supplement the examination with the interview.

Whatever the ultimate decision, it seems clear that, as Lord Moran suggested, we are only at the very beginning of a method of assessing accurately the suitability of men and women for the Civil Service or for any other sphere. The task should be approached in humility, and it is of the first importance that we should arrange for the records of candidates to be followed up to see whether they meet the criteria of success for the various branches of the Civil Service. These criteria are not really known with any certainty; but the time and expense of validation should not be allowed to constitute obstacles in a matter of such general importance.

Lord Simon of Wythenshawe as well as Lord Piercy were confident that the new methods had proved their worth by helping the Final Selection Board to make fewer mistakes and a better selection. Nevertheless, we are only at the beginning, and it may be possible to devise an entirely fresh system. Lord Elton, for example, in urging once more that since character as well as intelligence is indispensable to all high achievement, character as well as intelligence should be the concern of the scholarship examination, directed attention to the Rhodes Scholarship system, which for forty years has been trying to do exactly what the Civil Service Selection Board is now attempting by the new methods. Lord Elton believes that the traditional tests were over-narrow in that they confined themselves to selecting persons likely to absorb readily and reproduce lucidly the ideas of other people. He emphasized that the Rhodes selection committees have been able to rely greatly on the school and academic record of the applicant, and that on none of these sixty or seventy selection committees was there a psychologist.

Lord Pakenham, who concluded the debate for the Government, had little difficulty in showing that Lord Elton had gone too far in implying that the Civil Service Selection Board should likewise dispense with the services of the psychologist. He indicated that particular importance is attached to studying the previous records of the candidates, and he promised that some sort of White Paper on the subject would be prepared. His speech itself gave an admirable account of the working of the methods at present used; and he submitted that the Government is taking the wisest course in trying out both systems and seeking to judge which system appears to select Civil servants who will maintain and enhance the great traditions of the public service of Great Britain.

Lord Pakenham's speech dealt mainly with this question of selection boards; but he made several specific statements of considerable interest. First, he said that the Departments of State were emphatic that they were getting very good material; but that the standard for the Home Service, and to a lesser extent for the Foreign Service, appeared to have been pitched too high. Accordingly, in the Home Service it had been decided to lower the pass mark slightly. The Foreign Service authorities, who had decided to rely on the selection board method for their recruits during the next few years, had not yet decided how to fill their much smaller gap. Lord Pakenham agreed with Lord Lindsay that in the post-war period many people had entered for the examination who would not have entered before the War; but he also said that a later and larger sample of candidates than that cited by Sir Percival Waterfield gave figures of 26·6 per cent and 30·7 per cent, respectively, of candidates for the Home and Foreign Services who passed the original qualifying test but who were finally graded as out of the running.

Nevertheless, although this is a slightly more encouraging picture than that given by Sir Percival Waterfield, the Government is proposing to review the national State scholarship system, and the Minister of Education has appointed a 'working party' to consider, in consultation with local education authorities and others, the various problems concerned with university awards. It is to be hoped that the 'working party' will grapple with the question of character which Lord Lindsay emphasized in this connexion for it grows more important as the proportion increases of candidates coming from schools where there are fewer opportunities for the training of character than in the public schools, where it is traditional Something must be done, as Lord Lindsay suggested, to secure that the State scholarships do not go to those who take no part in the ordinary activities of the school. Nor is the problem solely one for tackling at the secondary school level; Mr J. W. C. Adams, warden of Crewe Hall, Sheffield points out in the *Universities Quarterly* of May, tha many of the universities could do more to encourag participation in the corporate life of the university both by making halls of residence a more prominen feature of the civic universities and in other ways.

The debate in the House of Lords accordingly confirmed the value of the experiments in selection now proceeding; but it also underlined their experimental character and emphasized that the experiments must be so conducted as to permit judgment after a year or two of their reliability. Equally, it vindicated the very high standard of the universit man at the present day: there was no evidence that he universities are selecting the wrong people or raining them wrongly, and the whole trend of the debate was against premature or excessive specialization, in science, the arts or any other field. Lord Cherwell in particular commended Sir Percival Waterfield's suggestion that no arts student should be without some knowledge of science, and no science student without some knowledge of the humane tudies.

The increasing demands of the Civil Service on the trained man-power and woman-power of Britain raise the same problems of education and training. ust as the validity of the selection board's methods or the Civil Service is a matter of deep concern to ndustry, so the educational quality and attainments f the graduates from which both industry and the Civil Service are recruiting men and women are of much concern to them both. Nor indeed could the niversities themselves be indifferent to the views of either industry or the State service in this matter, r attempt any considerable changes without having egard to both points of view.

The situation is already serious. It is clearly ndesirable that an excessive proportion of the outstanding ability to be found each year among those eaving the universities of Britain should be drawn nto any one section of life. It has already been uggested that the Civil Service is obtaining more than its fair share of the first-rate ability at present vailable. The nation is best served by a reasonable istribution over all those spheres of life which call or such gifts. Statements by Sir Lawrence Bragg nd others have indicated some reluctance on the part of the ablest science students to enter industry. If such a tendency became too marked, the effect on ndustry would be serious. It would be equally nfortunate if industry itself attracted too large a proportion of our most gifted investigators and left the universities depleted in this respect.

Before the schemes of university expansion proceed o far, we should therefore reconsider the whole uestion of the aims and content of university ducation. Something more should be done along he lines that Dr. Percy Dunsheath attempts in his ecent book "The Graduate in Industry"*. The raduate needs to be informed about the openings that exist in industry and the real conditions of work hich obtain there; equally the industrialist does not always appreciate the contribution which the ained mind, when matured by experience, can make to industrial efficiency. Dr. Dunsheath has ndicated many ways in which the university appointments boards could make invaluable contributions to he more effective use of trained man-power. From hem, too, may well be expected some of the quantitive data by which we should revise our estimates r the rate and direction of university expansion, rticularly if, as seems likely, difficulties arise in meeting the requirements for graduates in applied cience suggested in the recommendations of the arlow Committee on scientific man-power in 1946. eyond this there is a wide field for research into the demands which various occupations make upon, and the scope they afford to, the various attributes of human personality.

The House of Lords debate is to be welcomed for putting the whole problem in its true perspective. It is not simply a question of the methods by which industry and the State can best select their recruits. Nor is it solely a question of the conditions which will enable the universities, industry and the State to attract to their service a fitting proportion of the ablest minds available from those graduating each year, or even of the way in which those men and women are to be trained and nurtured before they enter the universities, during their residence there, and in their subsequent careers. What stands out above all is that an unparalleled opportunity for experiment is in front of us, of which selection methods are only one facet. The problem of the development and wise use of the trained man-power and woman-power of Britain calls for the closest co-operation between industry, the State and the universities, as well as those institutions like the British Institute of Management and the National Staff Administrative College which are seeking to explore new methods and raise the whole standard of administration. Further, it should be remembered that, both in industry and in the Civil Service, the wise and full use of our ability involves increasing attention to its use and training after recruitment, so as to ensure that the keenness of young and able minds selected with so much care is not blunted by failure to use their talents to advantage, and in ways that afford satisfaction to their ideals as well as to their intellect and personality.

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* The Graduate in Industry. By Dr. Percy Dunsheath. Pp. x+276. ondon: Hutchinson's Scientific and Technical Publications, n.d.) s. 6d. net.

WHAT IS PHYSICAL CHEMISTRY?

(1) Rational Approach to Chemical Principles

By Dr. John A. Cranston. Pp. xii+211. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1947.) 8*s.* 6*d.* net.

(2) The Elements of Physical Chemistry

By Prof. Samuel Glasstone. Third printing. Pp. vii+695. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 25*s.* net.

(3) Physical Chemistry

By A. J. Mee. Third edition. Pp. xix+782. (London: William Heinemann, Ltd., 1947.) 20*s.*

(4) Physical Chemistry

By Dr. E. D. Eastman and Prof. G. K. Rollefson. (International Chemical Series.) Pp. viii+504. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 22*s.* 6*d.*

PHYSICAL chemistry emerged as a separate subject at a time when physics and chemistry were separated by a fairly wide *terra incognita*, and the application of physical and mathematical methods to chemical reactions and equilibria offered an attractive field which was catered for by neither of the parent sciences. It soon developed a homogeneous subject-matter of its own, which has remained the backbone of physical chemistry courses ever since. It is natural that most of the new methods and fundamental conceptions of the behaviour of matter, which have contributed to the fuller understanding of chemical reactions and modes of combination, should have come from the experimental and mathematical branches of physics, and the role of the physical chemist has been to ensure the immediate and effective application of these methods and conceptions to chemical studies.

Now that the frontier between physics and chemistry has disappeared, the task of the physical chemist is by no means so clear. On one hand, the mathematical description of chemical combination has become a highly specialized branch of higher mathematics; on the other, the physicists have provided an armoury of weapons, such as X-rays, spectroscopes, mass spectrographs, electron microscopes, isotope techniques, etc., which are so demanding that their users tend to remain experts in their particular fields. In these circumstances, what should be taught to students as physical chemistry? Should it be those parts of physics which are most useful to the chemists? Or should it be the borderline region which concerns itself with the nature of chemical combination and the mechanism of chemical reaction —perhaps leaving the more mathematical aspects to the chemical physicist?

Faced with this vast and confusing extension, it is not surprising that teachers of physical chemistry have been much concerned with what to put into their courses and what they can safely leave out. That the times seem to many teachers to call for a re-orientation of physico-chemical studies is shown by the large number of recent text-books in which new interpretations have been offered of the subject.

The four books under review all reflect this tendency. Dr. Cranston's little book offers a new approach to physical chemistry in the school. He states his objective as follows: "It appears to the author that no more promising step . . . could be taken than ruthlessly cutting out the historical approach to the subject. The study then becomes a rational one. The physicist's atom is taken as the starting point and a reasonably detailed picture of its structure is drawn. The fundamental laws of chemistry . . . then tumble out of the picture in a perfectly rational way." The reviewer thinks that Dr. Cranston has justified his claim except in one respect. The introduction of the atom first has led him to describe the quantum numbers of the atoms in the periodic scheme on p. 21, while it is not until p. 80 that we are introduced to the conservation of energy or even the units of energy. Surely it is asking a little too much of the intuition of even "the average school boy, who, in an age of wireless, is already familiar with many aspects of electricity", to expect him to make any sense of the distinction between magnetic and spin quantum numbers, at the very beginning of his studies. A very simple picture of the atom would be adequate for everything which follows.

How to deal with atomic structure, in fact, presents a difficulty to all these authors. It obviously comes within the category of "those parts of physics which are most useful to the chemist", forming, as it does, the whole basis of his conception of matter; but it does not fit in very well with the more usual curriculum of physical chemistry which follows. Both Glasstone and Mee tackle this question at or near the beginning, but Eastman and Rollefson, for some reason, interpolate it between the liquid state and solutions. The reviewer would suggest leaving it out of text-books of physical chemistry entirely, an letting it be studied, empirically treated as it is under *inorganic* chemistry. Those students who wan to delve deeper should be encouraged to get help an inspiration from their physics departments.

Prof. Glasstone's book, a new addition to his serie of text-books, is in a style familiar to his man readers, and provides, at a more elementary leve than his "Text-book of Physical Chemistry", a clea and straightforward account of the subject. It references for further reading are entirely to article in the *Journal of Chemical Education*—a fact which makes it less suitable as a text in Great Britain tha across the Atlantic. A further feature is the larg number of revision questions, which enable the studen to test his knowledge and perhaps anticipate hi examiner's choice.

Mr. A. J. Mee's is a new edition of a well-know book, which will require no recommendation to user of the previous editions. The text of Profs. E. D Eastman and G. K. Rollefson is perhaps the mos comprehensive of the four books under review, a may be judged from such entries as the radial dis tribution of atoms in silica glass, infra-red frequencie of chemical bonds, and tracer studies with radioactiv atoms. Readers can decide for themselves whethe the book covers adequately the seven objectives o physical chemistry which are listed in the firs chapter. Space does not permit quoting these in full but how widely the authors interpret the subjec can be judged from their seventh objective: to describe, interpret or predict . . . "the molecular atomic and subatomic structure of the constituen particles"!

The last three books might well have given mor space to the rapidly expanding applications o physical chemistry in the biological field. Out o about 700 pages, Glasstone devotes 24 to the colloida state and Mee about 29, while Eastman and Rollefson do not mention it (they have a brief chapter on sur face phenomena). This is inadequate at a time whe chemistry is becoming increasingly concerned with larger molecules, both of living and of non-livin origin.

The most striking feature of these and of othe recent text-books of physical chemistry is the fac that they adhere so closely to the traditional curriculum. Writers of introductory texts are naturally concerned mainly with the past, and are wise not to concentrate too much on ephemeral 'recent advances' Perhaps it is asking too much to expect them t distinguish the trend of the present day and s anticipate the future needs of the present generatio of students.

J. A. V. BUTLER

APPLIED ELECTRONICS

Electronic Circuits and Tubes

By the Electronics Training Staff of the Cruft Laboratory, Harvard University. Pp. xxiv + 94 (New York and London: McGraw-Hill Book Co Inc., 1947.) 45*s*.

THIS book sets down, in nearly 1,000 pages, th greater part of the war-time course given t U.S. officers at the Cruft Laboratory, Harvar University. The range of material included i necessarily very great and, as Prof. Chaffee ha frankly stated in his foreword, ". . . the scope an the method of presentation of the material in this olume are not on a graduate level. . . .” Indeed, this could not possibly be so in a single volume which ncludes: A.C. vector theory; bridge and other measurements; transient analysis; network theory; wave-filters; thermionic emission; electron dynamics; transmitter and receiver circuits; gas-ischarge tubes; modulation theory; timing, ectification and control circuits. The treatment is ssentially technological and, in many places, merely escriptive.

The recent flood of books on the more technological spects of electrical communications makes one earch any new publication for positive contributions o the art; in this respect, this book is saved by ertain novel treatments. In particular, attention may be directed to the use of surface models in onnexion with coupled circuits, and to the simple pproach to the problem of transients and signal istortion.

Against these favourable points must be weighed the very condensed and sketchy treatment of certain opics. Thus, magnetrons are dealt with in one page, hile klystron and other micro-wave tubes are mitted (in spite of the title). Transmission line theory has been included in a companion volume ealing also with wave-guides and antennæ, and this as necessitated treating wave-filters from the eginning as finite structures, which, though the more practical condition, results in an unwieldy resentation likely to be confusing to the beginner.

To two appendixes are relegated the elements of he relevant mathematics, electricity and magnetism: ppendix (*a*) opens with the definition of powers of a umber and meaning of logarithms, and Appendix) with the inverse square law. If it be assumed that the reader needs to start at such elementary levels, it s unlikely that he will learn much from such intense ramming. It would have been preferable to have sed this space for expanding the main text, giving eferences to good elementary text-books which might supply the foundations.

The urgency of the War required the rapid training of great numbers of people, with varying backgrounds, n the application of electronic techniques. But the alue of such a course is doubtful now. Nevertheless, here must be many scientific people, possessing suitable grounding in mathematics, electricity and magnetism, who may be interested in applying such echniques to their particular branch of science. or them, this volume may serve as a reference book nd as a guide to the literature. There are a few, but elect, references and a clear index; the diagrams re good, and the style is consistent in spite of the oint authorship.

E. C. CHERRY

METABOLISM OF DRUGS

Detoxication Mechanisms

The Metabolism of Drugs and Allied Organic Com-ounds. By Dr. R. Tecwyn Williams. Pp. viii + 288. (London: Chapman and Hall, Ltd., 1947.) 25*s*. net.

THIS is the first monograph to be published in English describing the chemical changes which rugs or other substances foreign to the body undergo hen administered to animals. It is undoubtedly a seful compendium of the work which has been arried out in this field. Dr. R. T. Williams excuses his title on the grounds that the subject has been treated under such a heading in text-books of biochemistry. The title is, however, too narrow for the subject. Many of the reactions considered are certainly not detoxication processes. Thus the conversion of the azo dye prontosil into sulphanilamide appears to be an activation, and the metabolism of some substances such as picric acid and trinitrotoluene leads to more toxic products. The functions of the biochemical changes are unknown in most cases. “Detoxication Mechanisms” is rather a teleological expression, and the reviewer would like to suggest that another title or even the present sub-title be used for future editions. Even if it has become customary to use this term, there is no need to continue using a term which Dr. Williams admits if “Taken in its literal sense . . . becomes in many cases a misnomer”.

The metabolic processes which are described include oxidation and reduction and synthetic reactions such as the formation of thiocyanate from cyanide of acetyl and methyl derivatives of amines, and conjugation with glucuronic acid, sulphate, glycine, acetyl cysteine, ornithine and glutamine. The changes are considered particularly in reference to different groups of compounds, according to whether they are aliphatic or aromatic and the nature of their substituent groups.

The changes which most normal body constituents undergo, such as phosphorylation or oxidation, are often the same in all species, from bacteria to the higher mammals. The changes undergone by drugs and purines, however, show remarkable differences. Thus phenylacetic acid is conjugated with glycine by most mammals but with glutamine by men and chimpanzees and with ornithine by fowls. Aromatic amines are acetylated by most animals and birds, but not by dogs. The metabolism of β-naphthylamine shows interesting differences. When given to dogs, in which species it induces cancer of the bladder, it is excreted as 1-hydroxy, 2-amino derivatives; but in rats, rabbits and monkeys, in which bladder cancer has never been induced with this compound, 6-hydroxy, 2-acetylamino-naphthalene is produced.

The biochemical changes which synthetic substances undergo in the body give an indication of capabilities which would otherwise pass unrecognized. Thus the acetylation of amines is most easily demonstrated with foreign substances such as the sulphonamides. The study of the metabolism of phenyl-substituted fatty acids gives indications of the metabolism of fatty acids in the body. In this case the phenyl group acts as a tracer. Dr. Williams considers that there is no satisfactory unitary theory for the processes considered. Substances foreign to the body are probably changed chemically because they resemble natural body constituents sufficiently closely for them to become substrates of existing enzymes. A fresh drug may stimulate the body to produce a fresh enzyme by adaptation, but in many cases animals metabolize foreign compounds as soon as they are administered.

Dr. Williams has produced a useful compendium of the facts of the subject which will be of value to many biologists with interests in pharmacology and chemotherapy. When more facts are known, it might be possible to generalize and introduce satisfactory hypotheses for the innumerable chemical processes which the animal body can carry out.

E. BOYLAND

Modern Rubber Chemistry

By Dr. Harry Barron. Second edition. Pp. viii + 502. (London: Hutchinson's Scientific and Technical Publications, 1947.) 36*s*. net.

The Water-Soluble Gums

By Dr. C. L. Mantell. Pp. v + 279. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 36*s*. net.

IN "Modern Rubber Chemistry" Dr. Barron covers an immense field, stretching his title to include such topics as fabric construction, mould design and physical testing. The author's intention of being understood will be largely achieved, but there are some repetitions and examples of careless writing. A more selective account of early work would permit a clearer treatment of the scientific principles underlying, for example, the structure of rubber and the theory of vulcanization. The work of Farmer and his co-workers on this latter topic is surprisingly omitted. The useful analogy of likening the process of polymerization to the joining of hands is weakened by an unnecessary reference to chain formation through secondary valencies. The work as a whole can, however, be recommended as a valuable text-book on the technology of rubber.

Accompanying an increased insight into the structure and properties of synthetic polymers, our knowledge of many naturally occurring substances has been greatly enriched in recent years; indeed, many significant advances in high polymer science have resulted from studies on cellulose and natural rubber. It is of interest to note that while Dr. Barron turns to current high polymer theory to clarify some of the obscurities of rubber behaviour, this approach is not evident in Dr. Mantell's work.

"The Water-Soluble Gums" is a comprehensive account of the sources, collection, manufacturing processes and applications of a class of substances obtained mainly from plants. Gums are here described loosely as hydrophilic colloids, and it seems possible that the scope of the subject might be better defined by the phrase "Water-Soluble High Polymers". This definition would necessarily include polyvinyl alcohol, which is rapidly assuming importance, particularly in the United States, as a 'synthetic gum'. In general, the treatment of the subject is somewhat uncritical, and recent work on chemical constitution is not adequately described.

Volumetric Analysis

By Prof. I. M. Kolthoff and V. A. Stenger. Second revised edition. Vol. 2: Titration Methods; Acid-Base, Precipitation, and Complex-Formation Reactions. Pp. xiii + 374. (New York and London: Interscience Publishers, Inc., 1947.) 36*s*.

THE issue of the second revised edition of this standard work on volumetric analysis will be welcomed by a wide circle of analytical chemists. The book under review, the second of a set of three volumes, confirms the favourable reception accorded to the first edition.

This volume is divided broadly into three parts: (*a*) apparatus and general principles describing equipment and technique needed to achieve the best results with volumetric methods; (*b*) acid-base reactions, which include standard titrations and reactions involving displacement, hydrolytic precipitation and complex formation; and (*c*) quantitative precipitation and complex formation reactions in which titrations with silver nitrate, potassium ferr cyanide and many other reagents are described.

Within the scope of this book, which does n include oxidation-reduction methods, the treatment very comprehensive and contains a wealth of practic detail and shrewd comment. Many references a notes are included, but, as the authors point out, t lack of information during the war years has pr vented a full description of work published outsi the United States since 1940.

This book is recommended with confidence not on to analytical chemists but also to workers in oth branches of chemistry.

Chemistry in the Service of Man

By Prof. Alexander Findlay. Seventh editio Pp. xx + 390. (London, New York and Toront Longmans, Green and Co., Ltd., 1947.) 12*s*. 6*d*. ne

THE appearance of a seventh edition of th widely read book is timely and welcome. It h long been recognized as a valuable general accou of the way in which the science of chemistry helps meet the needs of mankind. Advances, both scienti and technical, have been so rapid of late that it essential for the subject to be reviewed at freque intervals, all the more so because of the effect of w

Prof. Findlay has carried out such a review adm ably in this latest edition. He handles his vast the with authority and skill. A wise selection of mater has been made, and the subject-matter has been ke up to date without a loss in the general balance.

As in previous editions, sound scientific treatme is happily married with a most agreeable ease style.

Honey and Your Health

A Nutrimental, Medicinal and Historical Comme tary. By Dr. B. F. Beck and Dorée Smedley. P 231 + 21 plates. (London: Museum Press, Lt 1947.) 12*s*. 6*d*. net.

THIS book is really a companion volume to the la Dr. Beck's earlier work "Bee Venom Therapy Although it is difficult to accept some of the autho views with regard to the nutritional advantages honey over other mixtures of sugars, it is alm impossible not to become infected by his enthusia and to enjoy reading the folk-lore about honey whi he has collected together from so many parts of t world. His history of the uses to which honey w put in bygone times makes fascinating reading a will, I feel sure, give pleasure to many people besi those who keep bees. Incidentally, this book conta some excellent recipes in which honey plays a ma part.

COLIN G. BUTLER

Sociology of Religion

By Joachim Wach. (International Library of So ology and Social Reconstruction.) Pp. xii + 4 (London: Kegan Paul and Co., Ltd., 1947.) 30*s*. n

THE author summarizes and reviews the literatu dealing with the forms, social expressions a general social relations of religion in all its vari manifestations. It is a work of immense erudit The index occupies 29 pages and the number footnote references is (roughly estimated) 5,000. a work of reference it is undoubtedly useful and w worth publishing. It is very doubtful, thoug whether anyone will have a better understanding religion after reading the book than he had before, even a better understanding of sociology.

A. D. R.

THE INDIAN FOREST SERVICE

By PROF. E. P. STEBBING
University of Edinburgh

THE passing of the British forest officer from India, where a succession of young men possessing that British intuitive love of an open-air life, with a ouch of the adventurous in it, has built up a magnificent forestry property for India, merits a record. t has been a work which has had a minimum of publicity, due perhaps to the failure of the forest officer (until comparatively recently) to write for the public.

The history and work of the British forest officer in the teak forests of Burma was reviewed in *Nature* of December 13, 1947 (160, 818). Earlier, in *Nature* of September 8, 1945 (156, 286), an article on "Post-War Forest Policy in India" was published. When the memorandum discussed in the latter article was written by the Inspector of Forests to the Government of India, the decision as to the future political division and status of the country had not been settled, and it was considered likely, in fact probable, that many British forest officers in the different rovinces would continue to serve out their time under whatever Indian government or governments were set up. This, in the event, has not proved generally to be the case.

The history of the forests of India from the practical point of view commences with the introduction of British administration into the country after the defeat of the French; as distinct from the earlier days of the East India Company, which only maintained trading posts at Bombay, Madras and Bengal. It was after the defeat of Tippoo Sahib in 1799 at Seringapatan in the south that British administration spread throughout a large part of Madras, and was ccelerated in portions of Bombay and lower Bengal. he administration extended almost in spite of ourselves, the forward progress being necessitated if the areas already under British rule were to be safeuarded; it was not premeditated.

The gradual extension of British rule soon began to have its effect on accessible forests. The partition of the provinces into divisions and districts necessitated the erection of headquarters buildings in each, the construction calling for large amounts of timber. he military authorities required timber for many purposes, while the Admiralty at home and the smaller dockyards around the coast of Britain and at Bombay ere soon taking increasing amounts of teak timber om the forests in the south, Malabar, Travancore and southern parts of the Central Provinces and Hyderabad, etc. The population of India, now living under settled conditions, rapidly increased in numbers, and in their old-time demands on the forest for fuel, grazing and small timber. In the south, teak was the only timber in use. It was the difficulties in meeting the requirements of the Naval dockyard in Bombay that resulted in the appointment of Dr. Gibson as *ad interim* conservator of forests in Bombay in 1844, with an assistant conservator and small office establishment; these were the first appointments of the nd in India. Gibson was confirmed conservator of forests in 1847. In Madras it was not only the overnment's and Army's annual teak supplies which were causing the gravest concern, but also the scarcity of firewood for Madras city and the hill station at Ootacamund which eventually led to the appointment of Dr. Cleghorn as conservator of forests in 1856. He was given three assistants. Shifting cultivation was rife in both presidencies when the British took them over. It was due to their efforts that this wasteful utilization and destruction of the forests had been, to a great extent, eliminated by Government order by 1860.

In the northern half of the country on the eastern section, sal (*Shorea robusta*) was the only timber in common use, and Government departments, in the absence of teak, would only take this type, while in the north, Punjab, etc., the chief timber in common use was the deodar (*Cedrus deodara*) brought down from the outer Himalaya. The partial disappearance of the accessible teak forests in Malabar, on the west coast of Madras, was the first intimation that forests were not inexhaustible, and from the middle thirties of last century, the recognition that some form of control would be necessary was gradually forced upon the Government of India, not only in connexion with the large annual Government requirements in the three timbers mentioned (the deodar after the capture of the Punjab in 1850), but also to safeguard the requirements of the population itself throughout much of the country.

Many attempted panaceas in short-term measures, to tide over sudden emergencies, were made before the position was faced squarely by the Secretary of State for India at home and the Governor General in India. The Indian Mutiny had come and gone; with, as a main first step, the commencement of the building of the Indian railways, for which large amounts of timber would be required, threatening, if left in the hands of timber contractors, to result in the extinction of large areas of timber forest. Correspondence between the Governor General and the Secretary of State, Sir Charles Wood, in 1862–63, resulted in the formation of the Indian Forest Service, and the appointment of Sir Dietrich Brandis as the first inspector general of forests. But it was one thing to create a forest service on paper and another to fill its ranks and to lay down the powers and duties of the new Service in connexion with the districts in which forests were situated, hithertofore entirely under the charge of the Civil district officer. From the first it was laid down that a conservator of forests should be appointed to each province (save where already in existence), his duties to be administrative and advisory to the lieutenant governor in charge of the province; and that the provinces should be divided up into a number of forest divisions, each under the executive control of an assistant conservator of forests. In the first instance, the new Service was filled by young men volunteering from the Army, the newly disbanded Indian Navy, and other sources. Many of those so appointed had some experience of the forests gained on private shooting expeditions. This served as a start; but Brandis soon realized that the fully trained forest officer would be required to introduce and maintain an effective organisation in the country. In the late sixties, with the consent of the Secretary of State for India, he commenced choosing yearly a few young men with sufficient acquaintance with scientific subjects—botany, zoology and so forth—who received their forestry training in France or Germany. In 1885 home training was started at the Royal Indian Engineering College, Coopers Hill, where it remained until 1905, after which probationers were trained at the University of Oxford, and eventually also at Cambridge and

Edinburgh. This training of British probationers for the Indian Forest Service persisted until about 1933; some Indian probationers were also trained in Britain, and eventually entered the Service up to 1939. Up to the outbreak of the First World War, the India Office advertised the number of probationers required annually, and the annual quota was selected before the specialized training commenced. It was this consistent policy, maintained throughout so long a period, that produced a fine body of men who have, through the years, built up and brought to its present position the magnificent forest estate in existence. For now it can be readily recognized that it was the action of the Secretary of State and the Governor General in the early sixties of last century which saved the forests of India from extinction in all accessible (to the timber market) regions, while the smaller areas in the vicinity of villages and small towns would quickly have disappeared.

Perhaps the four most important steps taken in the pre-Forest Service period were the formation of the very successful Nilumbur teak plantations, initiated by Conolly, Collector of Malabar in 1843; the public recognition by Cleghorn, a few years after his appointment as conservator, that sylviculture must be introduced into the management of the Indian forest; and the recognition of the damage done to the forests by the shifting cultivator, and the virtual suppression of the practice throughout the greater part of Madras and Bombay. Lastly, the growing realization and conviction of the Government of India between about 1840 and 1860 that the forests of India at the time accessible to exploitation of all types, including the provision of fuel and grazing required by the rapidly rising population, which was primarily agricultural, were not inexhaustible.

After its inauguration, the Indian Forest Service made considerable headway during its first decade. Apart from the constant support and driving force of successive Secretaries of State for India at home, there can be little doubt that the rapidity with which it got fairly settled in the saddle was due to the policy of railway construction adopted at the period. Buildings were required and wood fuel for the engines; also the sleepers for the tracks had at this time to come from the forests in the regions concerned, teak, sal and deodar. The unchecked exploitation of the forest by the timber merchant had been stopped. The brunt of the organisation for this enormous quantity of timber required fell on the young Department, and its energetic chief, Brandis. It is an Odyssey in itself, both the work and the names of the men mainly associated with it.

Some of the work during the first thirty years has already been dealt with in the article in *Nature* on "Post-War Forest Policy in India" referred to above. The main work of the Department, apart from exploitation and providing for the requirements of the people, lay in selecting and, after sanction, demarcating the forest reserves and protected forests in different parts of the country (including Burma), in laying down and cutting a network of fire traces for their protection, and in the division of the forest blocks by lines or rides into the unit of working and supervision termed the 'compartment'. This was a gigantic task which in the main was completed by the end of the century. To enable forest reservation to be legal, a special Indian Forest Act VII of 1865—amended by Act VII of 1878—was enacted. Separate Acts were passed for Madras, Bombay and Burma. The fire protection policy, the first attempted in a tropical country, was based on a first successful attempt to protect the Bor teak forests in the Central Provinces from fire durin the hot weather season. At the period, fires ra unchecked across the countryside in India during th hot weather, and the consensus of opinion held tha it would be impossible to protect the forests fron their customary baptism of fire. Forest officers o those decades can tell of the hardships of fire-fightin during the hot weather months. But great result were achieved.

During the latter part of this period in the mor advanced forests of the country it was possible to giv up departmental exploitation and introduce th method of marking standing trees in the forest fo sale, their felling and removal being undertaken b the purchaser, thus enabling the forest officer to tur to a study of the sylviculture of his forests, and othe professional duties. It was in this way that a beginning in the preparation of working plans took plac in India. From the appointment of Brandis in 186 as inspector general of forests, to the end of th century, three men occupied the post, himself an two other Germans, W. Schlich, and B. Ribbentro who had been recruited as fully trained young Germa forest assistants, and sent out to India in Januar 1870. Schlich held the post only for a couple of year 1883–85, when he accepted the appointment a professor of forestry at the newly organised forestr school at the Royal Indian Engineering College a Coopers Hill. Ribbentrop held the post with distin tion up to 1900.

The next great departure, and one which o considering the history and order of the progre would have been misplaced had it occurred earlie that is, before the reservation of the bulk of the fores contemplated had been achieved, was the formatio of the Imperial Forest Research Institute by Lor Curzon in 1906. By now the officers in charge of th forest divisions throughout the country had muc more time to give to purely forestry problems, an moreover, in the more advanced forestry areas the had the advantage of ranger executive officers wh had been trained at the (N.C.O.) ranger's class at th Dehra Dun Ranger's College, instituted in 188 Many of the divisional forest officers had problen which urgently needed study by the research office Sir Sainthill Eardley Wilmot was the inspector gener of forests at the time, and to him and the Vicero belongs the credit of taking a step which was to hav widespread ramifications, although it is impossible t go into the matter in detail. When Curzon asked th Inspector General where he was going to get h research officers from he replied, to the Viceroy expressed amazement, "from the Forest Department' The Agricultural Research Institute for India ha been inaugurated a few years before, also under th ægis of Curzon; but its officers had all to be recruite from home. One outcome was the new researc building, built at Dehra Dun and opened in 191 which quickly made its value apparent during th First World War—so much so that at the close that war a new building on a far larger scale, outsi Dehra town itself, was projected and sanctioned b the Government of India at a cost of one millio pounds. This has been functioning for many yea and once again, during the Second World War, w its value to India and the fighting forces fully show The introduction of research as a part of the work the Forest Department necessitated some form publications of the investigations achieved. The are now well known. During the previous centu ere were no official publications of the Department. he *Indian Forester*, a monthly magazine, started in 885 and still issued, was a private departmental ublication.

As research work progressed, it gradually became bvious that some decentralization would be neces-ary ; for example, one or more provinces might have major sylvicultural problem requiring study by the ylvicultural research officer. Even with the assis-ance provided at the Institute, it was not possible to nswer all calls. The selection and appointment of cal research officers in the provinces which required em was sanctioned, and thus came into being the cal research, sylvicultural, forest entomologist, and tilization officers, and, as important as any, the rovincial conservator of working plans. These fficers kept in close touch with Dehra Dun.

Reference was made in the article in *Nature* on the ak forests of Burma to the great progress made in orking the forests under carefully prepared working lans. In India, by the opening of the Second World Var, a network of plans for the forest reserves was in rce, and many of these had been revised more than nce. Since their early and tentative introduction, reat advances had been made in the scope and ntensity of management of many of these plans. he one *sine qua non* of the working plan, if properly repared, is that all over-felling is permanently hecked. Briefly, only the annual yield, that is, the nnual increment put on the trees, is cut. In the emorandum on "Post-War Policy in India, 1944", ne Inspector General of Forests was able to write on he subject of excess war fellings in the Government eserve forests in India : "Little is required to restore ne departure from normal, that is the excess War ellings ; a 40–50 per cent reduction in pre-War ields for a period of five to ten years, may in some ases be necessary. The true position can be determ-ned by the revision of the Working Plans which ust, therefore, be accelerated after the War." This forestry management brought to a high standard f efficiency.

Lastly, since the financial aspect of this great ndertaking by Government forms one of its aspects, e following figures speak for themselves :

evenue in 1868–69 = Rs. 40,38,800 and Surplus Rs. 12,65,467.
evenue in 1936–37 = Rs. 4,38,07,019 and Surplus
ast year before Rs. 1,53,58,194.
eparation of Burma)

In addition, forest produce to the value of s. 84,14,946 was given away free or at reduced rates uring 1936–37.

This article has no concern with political questions. t is merely a parting—a farewell to the Indian Forest ervice. But in the light of the long experience I have een fortunate to have had in following the progress f the management of the forests of India, and in the tudy I have been able to make of the history of those rests, it may not be out of place to put out a word f warning. In the case of forests in which the manage-ent has been brought along the road to efficiency in orking, as understood by the forester using these ords, there can be no standing still, no relaxation of upervision, either by the gazetted officer in charge r his chief ranger executive officer, and no delegation f important sylvicultural operations—the constant nspection, for example, of young crops of regeneration ntil they have passed out of the danger period, the arking of thinnings upon which the whole future of the timber crop depends, and so forth—and equally and all-important, no over-felling, even in an emergency, without a full recognition by the higher authority of its necessity. These are fundamentals. That they have not only been introduced but also maintained in the Government forest estate in India, the Second World War has effectually proved.

I would say this to India and Pakhistan. The British forest officer has built up not only a great legacy which he now makes over to the owner, but he has also brought it to a pitch not, I believe, existent in any comparable area of forest in the world. If it is a proud legacy to leave behind, it is an equally proud one to take over. In the hands of the India and Pakhistan forest officers, the world will watch with interest the further great progress to be achieved, a progress which will afford lessons in tropical forest management for both the executive forester and the research officer, wherever he may be working.

THE WORK OF THE NATIONAL PHYSICAL LABORATORY

THIS year, 'open days' at the National Physical Laboratory were held on June 21 and 22. On the first day representatives of industry, including many from organisations having no previous contact with the Laboratory, took this opportunity of seeing the large variety of research and investigational work that is undertaken. On June 22, the occasion of the annual inspection by the Laboratory's General Board, of which the president of the Royal Society is chairman, the visitors included members of the scientific staffs of universities and Government departments.

During the last twelve months the work of the Laboratory has been concentrated so far as possible on those short-term projects of the greatest immediate benefit to industry, although much has also been done during the year on the maintenance of the various national standards and on programmes of fundamental research. No outstanding new developments were on show, but the two hundred and seventy-two scientific exhibits well illustrated the work of the Laboratory's ten divisions, and mention will be made of a few of the more interesting items.

The aerodynamical work on the design of the proposed Severn Suspension Bridge, one of the most interesting exhibits in 1947, has now been transferred to an outstation where scale models are undergoing test in a large wind tunnel. The work of the Aerodynamics Division is largely concerned with problems of high-speed flight, and exhibits in the various tunnels demonstrated the work being done to improve flying performance by the use of specially designed low-drag wings and boundary-layer control by suction or blowing. Researches into problems of stability, control and flutter, increasingly important at high speeds of flight, are being carried on and a model 'xylonite' elastic wing, incorporating the major structural characteristics of a typical aeroplane wing, is used in the study of the twist of a wing caused by a change in distribution of the air loads and its effect on the response of the aeroplane to movement of the ailerons.

The Metrology Division has just completed for the first time since 1932 a comparison of the national copies of the Imperial Standard Yard and the International Metre with their respective principal copies.

Using specially devised equipment, a new high standard of precision has been attained. Interesting experiments carried out in the United States have established that when gold is irradiated with neutrons in an atomic pile, an isotope of mercury is produced which yields almost ideal monochromatic radiations when electrically excited. It will be possible in due course to propose replacement of the existing material standards of length by definitions in terms of the wave-length of this particular radiation.

Among the new machines made and designed by this Division was shown a floating-micrometer for measuring the diameter and rate of taper of tapered plug screw gauges.

An interesting new development in the Engineering Division is the setting up of a photo-elastic laboratory. The equipment on show included a photo-electric photometer for accurate measurements of the photo-elastic patterns. Work on heat transfer in pipes using mercury as the working fluid, started in 1938 but dropped during the war period, has recently been resumed, using an all-steel double-flow heat exchanger.

A strain-operated electronic trigger device designed in the Division was in operation on one of the special machines installed in the Lubrication Laboratory. This device will stop the machine should an increase in frictional force above a critical level indicate that seizure of the bearing under test is imminent. Small variations in strain of a weighbar are converted to voltage changes by an electrical resistance strain-gauge circuit, and when the strain exceeds a certain predetermined magnitude an electronic trigger is tripped which stops the machine before serious damage occurs. The principles underlying the operation of this device are thought to be applicable to a wide range of machines where the imminence of an unsafe condition may be accompanied by increase of linear strain in one element of the machine.

In the Physics Division the work of the radiology section on the protection of operatives against ionizing radiations and on the measurement of radioactivity is growing in importance with the increased availability of radioactive substances, and a comprehensive range of measuring and standardizing equipment was on show.

During the past year, further progress has been made with the extension of the section dealing with the fundamental work on acoustical standards of measurement. Among other developments which were on view was a room which has been provided for the standardization of microphones and other acoustical instruments. The walls of this room are lined with wedge-shaped absorbent constructions of the type now recognized to be exceptionally effective in suppressing reflected sound, thereby permitting field measurements of the highest accuracy.

A new quartz spectrograph has been installed in the Metallurgy Division, and together with a microphotometer and a precision comparator forms the main equipment of the Spectroscopic Laboratory. One of the interesting activities of this Division is the preparation of new materials and the study of their properties, and attention is now being given to the preparation of the metals vanadium and titanium in a state of high purity. Little is known, so far, of their physical properties and metallurgical behaviour, and this investigation will yield useful fundamental data.

Another notable exhibit was a projection microscope adapted to phase-contrast illumination. In this form high parts of the structure under examination
are revealed as bright areas; the low parts da
Light reflected by the specimen is split into
parts, one being advanced in phase a quarter o
wave-length relative to the other by means o
'phase-ring' in the objective lens. The two be
are re-combined and the interference between th
produces the typical phase-contrast effect. The sa
factory working of the method calls for the repl
ment of the ordinary disk aperture by one of
ring type. The images are similar to those given
the electron microscope and so help towards appr
ating the difference between electron microscope
normal optical microscope images. The phase-contr
microscope is capable of being sensitive to steps
surface-level of about 50 A.

The Electricity Division had on show equipm
for extending the range of quartz-controlled os
lations to centimetric wave-lengths. A number
stages of frequency multiplication, mixing
amplification are used to obtain sources of oscillat
of a power of about 3 watts having frequenc
controlled by the primary standard, of the follow
values: 33·6–36·8 Mc./s. in steps of 0·4 Mc.
67·2–73·6 Mc./s. in steps of 0·8 Mc./s. and 201
220·8 Mc./s. in steps of 2·4 Mc./s. By using th
oscillations and their harmonics up to the order
controlled frequencies are obtained throughout
range 350–8,000 Mc./s. at intervals of 1 per cent.
variable frequency oscillator, monitored by
standard, enables values between the control
frequencies to be obtained without appreciable l
in accuracy. Two further stages to be added
extend the range to 50,000 Mc./s.

The most obvious application of the equipmen
the rapid and precise calibration of wavemeters,
the sources at their fundamental frequencies will
serve for the testing of cables and dielectrics.
application of more fundamental importance may
the study of the radio-frequency spectra of at
and molecules. The spectra of a number of ga
have been examined both in Great Britain and
United States during the last three years, and t
of the ammonia molecule, for example, has lines
the neighbourhood of 23,000 Mc./s. the frequen
of which have been measured to a precision of 1 p
in 10^6. Such lines can be used as standards of
quency, and the possibility of obtaining molec
standards of this kind is exciting consider
scientific interest.

In the High Voltage Laboratory, measurement
the time variation of the light from sparks are b
made by means of a photo-multiplier, amplifier
cathode ray oscillograph. The immediate purpos
to provide a spark suitable for shadow photogra
in the Aerodynamics Division. The effects of electr
material and spark current are being studied
observations are being made on a gas disch
tube suitable for light pulses of 1 micro-sec
duration.

The Radio Division has developed a cathode
direction finder for the location of thunderstorm
long ranges. The apparatus exhibited is simila
that used by the Meteorological Office and is of g
value in problems such as the routing of aircraft
the Atlantic. A symmetrical arrangement of ort
gonal loop aerials is connected to a twin-cha
superheterodyne receiver which is tunable over
frequency range 10–30 kc./s., the normal operat
frequency being 12·5 kc./s. At this frequenc
minimum field-strength of 100 μV./m. (approximat
is required to give a full-scale trace on the cath

tube ; but for normal operation on atmospherics Britain, the balanced attenuators incorporated in equipment are adjusted so that a full-scale trace given by a field-strength of about 5 mV./m. Visual servation of the bearing on the cathode ray tube generally employed, but the equipment can easily adapted for photographic recording.

The Mathematics Division exhibited the compre- nsive range of machinery that it has available for nputational work ; one room was devoted to an position of relaxation methods, which have a ler application than is generally supposed. The vision is also able to offer advice on the application statistical methods to various research problems.

The work of the Ship Division continues to be ected mainly to satisfying the immediate require- nts of the shipbuilding industry for the large ume of new construction both for British and eign owners. Vibration of ships' hulls is a subject which much full-scale research has been con- ued, especially on vessels with long superstructures h as passenger liners, and a vibrograph and elerometer were shown, together with typical ords taken at sea.

Research on the design of ships' propellers is ried on principally in the Lithgow water tunnel, ich can be operated at reduced pressures to enable itation phenomena to be studied. The tunnel is o equipped with apparatus for the measurement the thrust delivered by the propeller and the shaft rse-power absorbed.

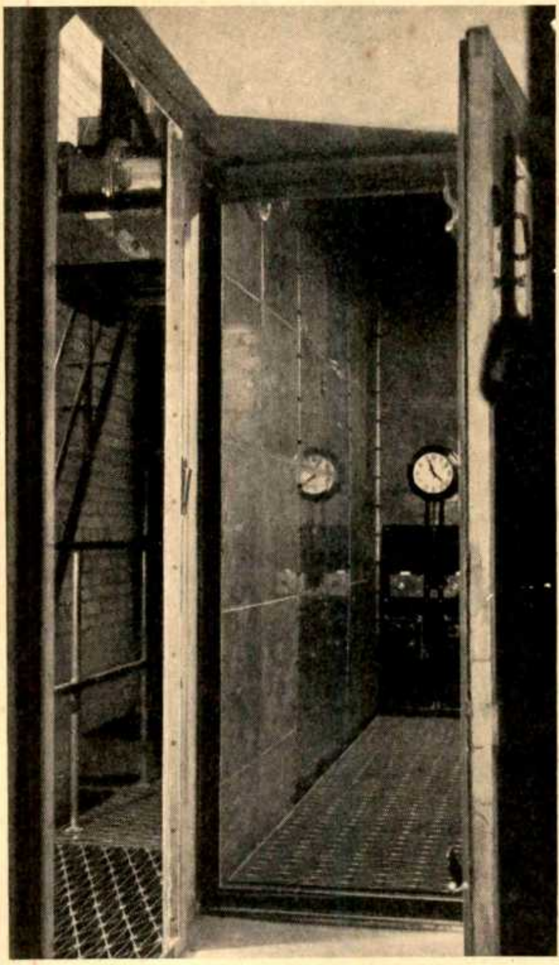
The Light Division displayed an interferometer able of comparing the flatness of two surfaces up 12 in. in diameter. The surfaces need not be in ual contact, although their separation should ferably be small. The observer is able to view, at rmal incidence, the interference fringes formed ween the surfaces, and means are also provided recording the fringe system photographically. amination of the record enables departures from tness of the order of 0·01 microns to be measured.

Among the exhibits in the Photometry Section of s Division was apparatus for studying the spectral ponse curves of the various mechanisms in the man retina. The principle is to measure the allest perceptible intensity of a monochromatic t stimulus applied at a particular point of the ina when the latter is brought into various states adaptation by exposure to a coloured light-field, ich may or may not be of the same wave-length the test spot.

CALORIMETER BUILDING FOR OMESTIC HEATING RESEARCH AT THE FUEL RESEARCH STATION, GREENWICH

By DR. A. C. MONKHOUSE

ONSIDERABLE attention has been paid in recent years to the more efficient use of fuel for nestic purposes, and to the development of better pliances for space heating, cooking and water ting. The amount of coal used directly for nestic purposes is about one-quarter of the total l consumption in Great Britain. If the indirect as gas, coke and electricity be included, the ount is one-third, or about 60 million tons a year. Improvements in the domestic use of fuel are of vital importance, therefore, in the economic and social life of the community.



ENTRANCE TO ONE OF THE CALORIMETER ROOMS

The Fuel Research Station of the Department of Scientific and Industrial Research has in the post-war years, in conjunction with other Government departments, research associations and industry, devised and undertaken tests to determine the performance of the various types of domestic appliances, particularly those using solid fuels. These tests involve the measurement of fuel consumption, the amount of heat emitted as radiation and convection, the heat imparted to the water, the loss of potential and sensible heat in the products of combustion, and the quantity of smoke produced. Some measurements, such as those of convection, are with many appliances difficult to determine directly and are usually assessed by a difference figure in the heat balance. To obtain more accurate data of the distribution of heat from an appliance, a special laboratory building has recently been erected at the Fuel Research Station at Greenwich ; it was opened for inspection by Sir Edward Appleton on June 30.

The building is a four-story structure occupying a ground area of about 3,000 sq. ft. On the first floor are four rooms or cabinets, 12 ft. square and 9 ft. high, each mounted centrally in a constant temperature chamber 20 ft. square and 26 ft. 6 in. high. In these rooms, which are, in effect, calorimeters, the appliances to be tested are installed. The rooms are made of ¼-in. plywood, birch or gaboon, covered on the inside and outside with copper sheets 2 ft. by 1 ft. 6 in. Plywood has been chosen because of its low heat capacity, consistent with suitable thermal conductivity and mechanical strength. Each copper sheet is electrically insulated from its neighbour. Differential thermocouples are embedded at the mid-points of the copper sheets directly opposite each other on the inside and outside of the plywood, so that the difference between the internal and external temperature of the walls can be recorded. By suitable wiring the temperature difference can be measured through any individual panel, or the average through a group of panels such as a complete wall, floor or ceiling, and the heat-flow calculated. In practice, the calorimeter rooms are calibrated by a series of measurements when known amounts of heat are supplied from an electric heater operated at constant voltage.

An appliance to be investigated is mounted on a grating floor in the room, and the flue outlet connected through an opening in the ceiling to the chimney. The rooms are designed to be air-tight; but the pressures inside and outside are automatically balanced by control of the flow of the inlet air, so that risk of leakage is reduced to a minimum. Air enters the room by a duct and its flow is measured by an orifice plate and is automatically recorded. The arrangement is novel as the appliance can be operated under natural draught conditions, while by use of the balanced pressure system the air flow can be accurately recorded. In addition, an auxiliary fan with a flow meter is mounted above the cabinet and can be used to extract ventilating air if required. The temperatures of the air entering and the products of combustion leaving the room are recorded, and, where required, measurements of the water heated by the appliance. Radiation from the appliance is measured in the room by thermopiles arranged on a travelling arc covering the hemisphere in which the appliance is placed centrally.

Constant-temperature conditions on the outside of the testing cabinets are obtained by controlled air circulation, and a refrigeration plant is also provided to give cool air, when atmospheric temperatures are high or when appliances with a high output of heat are being examined.

The flues taking the products of combustion from the room are lined with stainless steel to enable the soot deposited to be removed without contamination for weighing and analysis. The flues terminate below the roof of the building, and constant conditions are maintained at the exit by a cowl and an injector fan. The smoke content of the gases is measured by projecting a beam of light across the flue on to a photoelectric cell. Two separate light paths are used, one directly across the flue for dense smoke, and the other with an oblique path for the lighter smokes. Electrical supplies to the light projectors and the photo-cell amplifiers are specially stabilized so that the record is unaffected by variation of mains voltage or frequency. The double windows through which the beams of light pass are electrically heated to avoid deposition from the products of combustion. The photo-cell equipment is calibrated by direct determination of the concentration of smoke in the chimney gases.

The control room for the four testing rooms is on the first floor and is 52 ft. long by 10 ft. wide; it is connected by air locks to each of the four rooms. All instrument readings are automatically recorded i the control room, each calorimeter room having it separate panel. The instruments include six-lin recording potentiometers and controllers for the constant temperature chamber. Air-flow recorders ar mounted underneath the inlet ducts in the contr room. Equipment is also provided for the accurat control and measurement of the water supply fo measuring the boiler output of appliances.

Laboratory and office accommodation, and fu storage, are arranged in the building, which forms complete unit.

The construction and design comprise many nov features, and the calorimeter building should provid more detailed and accurate information of the hea output of domestic appliances and thus point th way to improvements in methods of heating.

OBITUARIES

Prof. Jacques de Lapparent

PROF. JACQUES DE LAPPARENT, the eminent Frenc lithologist, *Correspondant* of the Paris Academy Sciences, died on May 18 at the age of sixty-five.

Jacques de Lapparent was educated in Paris. Th enthusiastic interest which he displayed for minera during his youth grew with time. The man thoroughl realized the vocation of the boy and, moreover, became a true scientific creator, a scholar backed b an artist.

As a university professor, J. de Lapparent wa appointed to Lille in 1913, to Strasbourg in 1919, t Paris (Sorbonne) at the beginning of 1947. Sinc 1942, he also gave a regular course of geology an mineralogy at the École Centrale des Arts et Manufactures of Paris. His lectures were none the less i the classical style, and his original views and styl brought together a select group of advance students, chiefly in his later years.

Though he was a keen mineralogist and geologis de Lapparent devoted the greatest part of his care to petrography and lithology. As a naturalist h gathered a great deal of information by travellin through many countries: Great Britain, Finlan Yugoslavia, Greece, French North Africa, Frenc West Africa, and, of course, throughout France.

J. de Lapparent published about a hundred an twenty studies, including his authoritative an inimitable "Leçons de Petrographie", which established his world-wide reputation. Part of his reputation was due to some thirty published studies concerning bauxites and clays. He endeavoured to clea up the mineralogical composition and conditions deposit of these rocks and earths. He was the firs to show that three types of bauxite exist, each them characteristic of geological phenomena at th age of formation: gibbsite bauxites formed abov water-level, boehmite bauxites at water-level, an diaspore bauxites below water-level. Studying clay in a similar broad manner, he showed at the outs that fuller's earths are either kaolinite–halloysi earths, or attapulgite earths, or montmorilloni earths. These two last constituents, both aluminou and magnesian, are of different architectural type Prof. de Lapparent endeavoured to elaborate an unequivocal classification with the aid of X-ray studie which specify 7 A., 10 A., 14 A. as the structur spacings for phyllites. At the same time, wit his usual well-balanced scientific sense of researc he explained the geological origin of some montmorillonite clays.

Indeed, Prof. de Lapparent was able to combine the keenest observation of the naturalist, either in the field or in the laboratory, by eye or with the aid of a microscope, with the ability to call upon modern physico-chemical techniques, to contribute to lithological problems. In this respect, it must be emphasized that, though he considered himself a naturalist, he was fully conversant with many physico-chemical methods, procedures and tests, X-ray crystallography being among the most helpful. He was able to grasp very easily the structural work coming from Sir Lawrence Bragg and his school and from Prof. L. Pauling. His aptitude for understanding in quite a short time the geometrical and physical aspects of atomic structures was really amazing. His efforts to introduce into petrography the results of structural X-ray crystallography, made with a pioneer's confidence, began to receive full appreciation in recent years.

J. de Lapparent wrote with a modern style—rather unusual, at least in French scientific papers—which sometimes gave a wrong impression to the reader more accustomed to a bald style supposed to be more fitted to scientific truth. The epigraph introducing one of his books was the famous quotation: "To everyone his own truth"; one of his works bears for title: "Defense de l'attapulgite".

Actually, J. de Lapparent strived to report with a vivid style changes in the earth's crust, because he was himself a living representation of these phenomena. Further, the reader cannot but be impressed by the longing for truth which inspires J. de Lapparent's works and to appreciate the essential synthesis which appears in them in various guises. Up to the end of his life, Jacques de Lapparent maintained his high standards and his enthusiasm. His loyalty to friends, his charming attitude to all his acquaintances without reference to their position, made him a most attractive personality.

R. J. Hocart

WE regret to announce the following deaths:

Mr. T. R. D. Bell, C.I.E., chief conservator of forests, Bombay Presidency, during 1909–20, on June 24, aged eighty-five.

Mr. Harry Brearley, Bessemer medallist of the Iron and Steel Institute in 1920, known for his work on stainless steel, on July 14, aged seventy-seven.

NEWS and VIEWS

Zoology at Belfast: Prof. T. T. Flynn, M.B.E.

PROF. T. T. FLYNN is to retire at the end of the present session from the chair of zoology at the Queen's University, Belfast, which he has held since 1931. Born in Australia in 1883 and trained at Sydney under W. A. Haswell and J. P. Hill, he developed a natural interest in the anatomy and embryology and reproductive phenomena in marsupials. He maintained this interest throughout his university career, making valuable additions to knowledge in this subject. So recently as 1941, in collaboration with J. P. Hill, fundamental agreement in the mode of formation of the primary germ layers in monotremes and marsupials was demonstrated, while in 1947 strong support was given for the view of a similar mode of formation in birds and an incentive predicated for the re-examination of germ-layer formation in reptiles in the light of the work portrayed. Along with his interest in marsupials and their nearer allies, Flynn contributed work on the Pycnogonida of South Africa, describing ten new species; on corals of the Barrier Reef; on the invertebrate fauna of Tasmania; on rare and fossil Cetacea; and he demonstrated his interest in marine biology as leader of the Australian Antarctic Summer Expedition 1912, and as sole Royal Commissioner for the Tasmanian Fisheries in 1915. In his retirement to Jamaica he hopes to utilize this latter experience in taking a serious interest in the marine biology and fisheries of the Caribbean area, as well as in meeting the demands of the British Museum for local biological material.

On graduating at the University of Sydney, Prof. Flynn was awarded the University Medal and John Coutts Research Scholarship; and later he received the University Medal for his D.Sc. thesis. He was Macleay Fellow of the Linnean Society of New South Wales in 1911, and Rockefeller Fellow during 1930–31; he was elected a member of the Royal Irish Academy in 1934. In the Second World War he was Chief Casualty Officer (Civil Defence), Belfast, and received the M.B.E. for his services. His many friends wish him a happy and fruitful retirement.

Baron Roland von Eötvös (1848–1919)

ON July 27 the centenary occurs of the birth of the distinguished Hungarian physicist Baron Roland von Eötvös, who in 1891 founded the Hungarian Mathematical and Physical Society and was long the president of the Hungarian Academy of Science. Both his grandfather and great-grandfather had held high office under the Austrian crown, and his father Baron Josef von Eötvös (1813–71) was at one time Minister of Public Instruction. Born at Budapest, the younger Eötvös was educated at the University there, but studied later under Kirchhoff, Helmholtz and Bunsen at Heidelberg, and under Franz Neumann at Königsberg. He became a *Dozent* in physics at Budapest, and in 1872, at the age of twenty-four, was appointed to the chair of theoretical physics, and later was transferred to the chair of experimental physics. Known widely for his invention of the torsion balance for the investigation of gravitational anomalies, he was recently referred to by Prof. A. O. Rankine as "the father of geophysical prospecting for oil, even if a hesitant one". He died at Budapest on April 8, 1919, at the age of seventy.

European Meteorological Telecommunications Panel

AN international conference was held in London during July 5–10 to consider the problems which confront European meteorologists in the exchange of weather information. The meeting took place under the auspices of the International Meteorological Organisation, which recently decided to establish a meteorological telecommunications panel under each of its six regional commissions. This was the first meeting of the panel for the European region, and it was attended by meteorologists and telecommunications experts from Belgium, Eire, France, Great

Britain, Italy, Netherlands, Norway (also representing Sweden), Poland and the Occupied Zones of Germany. Observers from the United States Weather Bureau and the International Civil Aviation Organisation were also present. Unhappily, the Danish delegate and his secretary were killed in an air collision over Northolt on the day before the conference opened.

In an address of welcome to the delegates the Secretary of State for Air referred to the growing importance of meteorology to economic problems, and he directed attention to the accuracy of modern weather forecasts—a fact which is frequently forgotten by the public, who tend to stress the occasional failures. Rapid dissemination of weather reports is vital to forecasting. Hitherto the international exchange of reports has been made primarily by wireless telegraphy, but in recent years high-speed teleprinters have been introduced to link several of the countries in western Europe. The conference discussed measures for increasing the efficiency of this international meteorological teleprinter network and for extending it to the countries of central and eastern Europe. For exchanging weather information between Europe and North America, high-speed radio teleprinters are to be used, although it will be necessary to retain a trans-Atlantic cable link as a standby for use when radio fade-outs render the radio-teleprinter channel inoperative. The conference recommended that Great Britain should provide the European terminal for these trans-Atlantic exchanges and should also be responsible for disseminating the American reports throughout Europe by wireless telegraphy and by the European land-line teleprinter network. Great Britain already transmits in high-power broadcasts from Rugby a 'European collective' message, which gives a selection of European weather reports and can be heard throughout the northern hemisphere.

Evolution of the Gene

PROF. A. H. STURTEVANT discusses one of the most pressing problems of biology in a recent issue of the *American Scientist* (**34**, 225; 1948). It has been a mystery how new heritable material for the production of new characters originates. When Harland, as the result of his work on cotton, concluded that homology of parts in related species is not correlated with the homology of genes which produce them, another reason was given for disbelief in the value of homology for biological analysis. Sturtevant challenges this view and points out that the polyploid nature of cotton permits the differentiation of two sets of genes in the amphidiploids after their creation. Hence, in one species, one set of genes may control some characters, leaving the other free for differentiation. In a different species the reverse takes place. Sturtevant compares the characters in different species of *Drosophila* and suggests that two organs are homologous if they are conditioned by homologous genes. This implies degrees of homology, since genes may vary from being identical (being allelomorphic mutants), partly homologous to non-homologous. Homology therefore becomes relational and amenable to mathematical treatment rather than absolute.

Sturtevant points out that in a diploid organism all the genes are functional in that the characters they affect are subject to selection. An alteration in any one of them will give rise to a new phenotype. Therefore these genes cannot be spared for other purposes. If, on the other hand, some genes are carried on duplications, these will be surplus to the requirement of the organism and could vary to wide limits without an immediate effect on the individual or even its progeny. He therefore sees a source for new hereditary material in the duplications which constantly occur in most, if not all, living organisms.

Hæmophilia in Dogs

F. B. Hutt, C. G. Rickard and R. A. Field (*J. Hered.*, **39**, 3; 1948) describe the discovery of a sex-linked hæmophilia in dogs. This shows as a lameness and by swellings in various parts of the body when the puppy is six weeks old. Examination showed that the lameness was due to hæmorrhage at the joints. Of seventeen puppies which have been recognized as hæmophilics, not one has been raised to maturity. Several tests for hæmophilia in man were applied to these dogs and were found to give positive results. The breeding histories of the parents of the puppies were known; as a result, it was easily seen that the condition was due to a sex-linked recessive gene called *h*. The importance of the discovery lies in the fact that the comparative physiology of dog and man is well known, and the condition will be of value in research. It is noteworthy that this case in dogs is one of the few sex-linked genes in mammals other than man where seven or eight sex-linked characters are known. The pig has an inherited hæmophilia; but this is controlled by a recessive gene on an autosome. It is probable that paralytic or lame puppies which were destroyed in the past were in reality sometimes hæmophilic. It would be desirable to discover whether any hæmophilic puppies survive to maturity; on the different genetic backgrounds of different breeds, the recessive gene may not always have a lethal effect.

Uganda Forestry Department Report

THE report for the year ended December 31, 1946, of the Uganda Forestry Department has recently been issued (Govt. Printer, Entebbe. 1*s.* 6*d.*). The following quotation from a report on forestry in Uganda, by the late Prof. R. S. Troup in 1922, is given in an opening paragraph. "The percentage of timber forest in Uganda is very small compared with that of most timber-producing countries. . . . There does not, however, appear to be any real cause for alarm, provided the existing forest area is strictly maintained, and all accessible forests are brought under systematic management. . . . The preparation of forest Working Plans should be pushed on in all forests which are accessible to regular working. . . . Without Working Plans systematized work is impossible, and there is a strong risk of the forests being overworked and eventually rendered valueless." Uganda is one of the few departments in the Colonial Forest Services which has printed, published and circulated outside the Protectorate a working plan, with several others in hand. This plan is for the Budongo Forest and it undoubtedly saved that forest during the War. It has now been accurately revised for the second period of ten years, 1945–54. The Buganda Forests were exploited heavily during the War in the absence of a working plan, as in so many other parts of the British Empire and elsewhere in the world. The yield is now carefully controlled. The forest policy for Uganda is also being implemented by the systematic reservation of all main watersheds. This annual report shows that forestry and its requirements are thoroughly understood in Uganda.

Sugar Industry of the Caribbean

SUGAR still occupies the first place in Caribbean economy, despite the severe and growing competition in other parts of the world. The factors concerned with this economy are considered at length in "The Sugar Industry of the Caribbean", compiled by the Caribbean Research Council (Washington, D.C., 1947. Crop Inquiry Series No. 6). Some Caribbean territories have been unable to withstand competition and have given up sugar cultivation, whereas in others there has been an ncrease; but increase is most noted in production, not acreage. This has been greatly helped by research work on new varieties more resistant to disease, and he study of pests. Cane breeding is now active in Barbadoes, British Guiana and Puerto Rico. Experimental work with various fertilizers has had useful results, and there has been a great increase in the import of fertilizers. Sulphate of ammonia is the hief fertilizer. The estates without manure now form a minority. Another change in the industry of cane-growing is the increase in mechanization, especially in United States territories. Weeding and harvesting are still done largely by hand. Generally peaking, there is great scope for the use of more machinery as well as for the centralization of production.

Development of British Somaliland

THE report on the General Survey of British Somaliland, 1946, conducted under Approved Scheme 484, Economic Survey and Reconnaissance, under the Colonial Development and Welfare Act, records that the 1946 rainfall was higher than average and well distributed (British Military Administration, Burao, Somaliland. Pp. 20+12 pl. 6*s*.). Tribes ended to move more to south-west than south-east nd not so far afield from the Protectorate as in the revious two years. This was due to better rainfall in and near the Protectorate, and resulted also in a drawing in of Somali tribes towards British Somaliland. Rainfall and tribal migration maps are appended to the report. Development of water upplies and some minerals should be possible in 1947–48, and if the survey is continued until the end of 1950, a more balanced report, based on the records of a seven-year cycle, should be possible and facilitate the making of definite proposals for developing the ountry.

Medical Progress in Chile

THE Medical Faculty of Valparaiso, formed after a meeting of Chilean medical men convened in March 912, by Dr. Frederico Engelbach, has, since its ormation, planned the publication of an official cientific journal; but for various reasons this has ot been possible until this year. Now the first number of this vigorous Faculty's journal, *Revista Medica de Valparaiso*, has appeared. Well printed and tastefully produced, it will appear in February, ay, August and November each year and will publish only scientific papers. As the Faculty's president, r. R. Gajardo Tobar, says in his editorial, its pages re dedicated to those who have studied phenomena with objective criticism and express their results with the greatest possible precision. The new journal will ecord the more important themes presented to the aculty, summaries of the Faculty's meetings and rticles by individuals invited to contribute. This st number contains articles on hypertension of ephritic origin, streptomycin and tuberculous meningitis, the therapeutic action of urethane in leukæmia, and varicose veins and their treatment. Medical men in both the Old and the New Worlds will welcome this new record of the work being done in Chile.

British Agricultural Bulletin

British Agricultural Bulletin is a new, illustrated quarterly journal published by the British Council. It is intended for overseas circulation, particularly with a view to the needs of agricultural administrators, university and agricultural college teachers, research workers and large-scale farmers, none of whom have time to digest the vast specialist literature of to-day. In the words of Prof. J. A. Scott Watson's editorial note, its aim is "to put British knowledge and experience at the disposal of the farmers and citizens of other countries" and thus to help them in their efforts to increase the world's food supply. The articles in the first number (Spring 1948) cover a wide field and are written by specialists on the subject in each case. General principles of animal improvement, war-time farming in Cheshire, the resting break in farming systems and new ideas in grain storage are discussed in some detail, while of more general interest is the account given of the aims and organisation of the National Agricultural Advisory Service set up in Britain in 1946. Reviews and advertisements of books form a prominent feature, and a special article in this number is devoted to modern English books on agriculture. In future issues, it is hoped to give some account of such new technical developments or scientific discoveries as seem ready for application to farm practice, and to discuss matters of agricultural finance, economics and education in terms intelligible to the layman. The price for four numbers will be 15*s*. (including postage), payable to the British Council, 3 Hanover Street, London, W.1.

Irish Chemical Association Summer School

A SUMMER School organised by the Irish Chemical Association and held in Dublin during July 5–9 attracted 130 participants, of whom some thirty came from universities, hospitals and industrial concerns in Great Britain. The courses covered recent advances in various branches of chemistry. Dr. V. C. Barry, research fellow of the Medical Research Council of Ireland, dealt with the subject of chemotherapy with particular reference to tuberculosis. During his lectures he discussed some of the results obtained by the active school in Dublin of which he is the head (see *Nature*, 160, 800; 1947). Lectures were given on recent advances in the technique of organic chemistry by Prof. W. Cocker, professor of chemistry, Trinity College, Dublin. The last lecture of this particular series was delivered by Mr. E. R. Stuart, Trinity College, Dublin, who surveyed the methods of application of infra-red and ultra-violet radiation to the determination of the structure of organic compounds. Prof. E. J. Conway, professor of biochemistry and pharmacology, University College, Dublin, who has recently returned from a lecture tour in the United States, discussed biological oxidation and reduction, the nature of the cell membrane and the chemical interpretation of the action of hormones and vitamins, and concluded his course with a lecture on the biochemical approach to carcinogenesis. Prof. T. S. Wheeler, professor of chemistry, University College, Dublin, in a course of five lectures, gave a simplified account of the mathematical background of wave mechanics and described the application of the wave theory to problems in inorganic and organic chemistry. The School was opened by Mr. Michael Tierney, president of University College, Dublin, who referred to the responsibility of the man of science for the uses, good and bad, made of his discoveries.

Physiology and Pathology of Animal Reproduction

At the final meeting on June 30 of the first International Congress of the Physiology and Pathology of Animal Reproduction and Artificial Insemination, which was held in Milan under the auspices of the University and of the Spallanzani Institute, a permanent-committee was set up to organise within three years from now another congress on the subject. This committee is constituted as follows: J. Anderson (Kenya), Prof. T. Bonadonna (Italy), Prof. E. Garcia Mata (Argentina), Prof. R. M. C. Gunn (Australia), Dr. J. Hammond (Great Britain), Prof. N. Lagerlof (Sweden), Prof. G. Lesbouyries (France), Prof. B. B. Morgan (United States), Prof. E. Sorensen (Denmark). Prof. N. Lagerlof has been elected president and Dr. Hammond and Prof. Sorensen vice-presidents. Prof. T. Bonadonna, of Milan, secretary general of the first Congress, has been appointed secretary of the committee.

Revue Générale du Caoutchouc

"Rubber Developments" reports that arrangements have been made whereby the old-established monthly journal, *Revue Générale du Caoutchouc*, can be more readily obtained in Great Britain. Recently, the journal has been improved in make-up, and a welcome feature now is the inclusion of summaries in English of the more important articles. Specimen copies of the journal, subscription forms and further information can be obtained from the Secretary, British Rubber Development Board, Market Buildings, Mark Lane, London, E.C.3.

Earthquakes during March and April, 1948

There were at least nineteen strong earthquakes in the world during March, and at least seven during April. The strongest shock during March was probably that of March 3 from an epicentre near lat. 18° N., long. 119° E. off the north-west coast of Luzon, Philippine Islands. It gave ground amplitudes of 160 μ at Kew. The second strongest was on March 1, from an epicentre near lat. 3° S., long. 130·5° E., off the west coast of New Guinea. This gave ground amplitudes of 80 μ at Kew. The deepest shock during March occurred on March 23 from an epicentre near lat. 51° N., long. 155° E., off the southern coast of Kamchatka. The depth of focus was between 200 and 250 km. The only great shock on land was on March 27, when a severe earthquake shook the city of Sucre in Bolivia, causing considerable damage to property, including the cathedral, plunging the city into darkness and cutting off communications with the rest of Bolivia; only three casualties have been reported. An earth tremor on March 16 was felt at Lourdes, Argeles and Bagnères; but no damage is reported. There were no great earthquakes on land during April. The greatest earthquake during April was that on April 21 from an epicentre near lat. 19° N., long. 69·5° W., off the north-east coast of the Dominican Republic, and the deepest (200 km.) was on April 12 from an epicentre near lat. 14° N., long. 90·5° W., off the coast of Guatemala. Reports for these months have been received from the International Bureau at Strasbourg, the Jesuit Seismological Association, the U.S. Coast and Geodeti Survey and the following individual observatories Cleveland (Ohio), Beograd, De Bilt, Durham, Kew Stuttgart, Toledo, Uccle, Zurich and the Swis stations.

Colonial Services: Appointments

The following appointments in the Colonial Ser vices have been announced: R. Wilcox, inspector o mines, Malaya; L. St. Clair Bartholomew, fisherie officer, Uganda; Miss E. B. Cheek, biochemist Institute of Medical Research, Malaya; D. H Constable, soil survey officer, Trinidad; J. Fleming inspector of plants and produce, Nigeria; Miss R. M Lowe, fisheries research officer, Uganda; L. J. S Littlejohn (botanist and plant pathologist, Cyprus) soil conservation officer, Cyprus; P. O. Wiehe (plan pathologist, Mauritius), plant pathologist, Nyasa land; J. A. N. Burra (assistant conservator o forests, Palestine), assistant conservator of forests St. Lucia, Windward Islands; A. B. Walton (senio assistant conservator of forests, Federation o Malaya), conservator of forests, Federation o Malaya; R. J. S. Waddington (inspector of mines Tanganyika), senior inspector of mines, Tanganyika J. W. Loxton (superintendent of surveys, Palestine) staff surveyor, Kenya; R. W. Crowther (veterinar officer, Nigeria), veterinary officer, Cyprus; C. M Anderson (livestock officer, Tanganyika), senio livestock officer, Tanganyika; C. J. Buckley (live stock officer, Tanganyika), senior livestock office Tanganyika; J. W. T. Holloway (livestock office Tanganyika), senior livestock officer, Tanganyika.

The appointment of J. I. Moggridge (*Nature*, Apr 24, p. 637) should read "director, Tsetse Contr Department, Uganda".

Announcements

The Lister Medal for 1948 has been awarded t Prof. Geoffrey Jefferson, professor of neuro-surger in the University of Manchester, in recognition his contributions to "knowledge of the functions an structure of the nervous system, made as a Phil sophical Biologist, practising Neuro-surgery". Pr Jefferson will deliver the Lister Memorial Lecture i London in June 1949, under the auspices of the Roy College of Surgeons of England. This is the nint occasion of the award, which is made by a committ representative of the Royal Society, the Royal Colle of Surgeons of England, the Royal College of Surgeon in Ireland, the University of Edinburgh and t University of Glasgow.

Dr. J. T. Edwards, who was invited in 1946 b the Egyptian Government to advise on veterina education in that country, has been awarded th Order of the Nile (Third Class). Not only was D Edwards able to give valuable service to the veterina schools, but also he devised measures for combati an outbreak of cattle plague which threatened become a national disaster.

Prof. W. Sierpinski, of the University of Warsa and Prof. F. Riesz, of the University of Szeged, ha been elected *Correspondants* for the Section Geometry of the Paris Academy of Sciences.

We have received from Messrs. Johnson, Matth and Co., 73–83 Hatton Garden, London, E.C.1, catalogue of chemical compounds of the precio and other metals. This contains the names of ma compounds of rare metals as well as those of com moner elements, and standard metals of high puri for spectrographic work.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Unit Cell Measurements of Wet and Dry Crystalline Turnip Yellow Mosaic Virus

CRYSTALS of turnip yellow mosaic virus, kindly sent to us by Dr. Kenneth Smith and Dr. Roy Markham (see *Nature*, July 17, p. 88), were examined both optically and by X-ray diffraction in this Laboratory. The crystals were small, isotropic, less than 0·1 mm. in size and ill-formed, but just sufficiently developed to indicate that they were octahedral bipyramids. The smaller crystals, first observed by Smith and Markham under a 1/12 oil immersion lens[1], are better formed and display a better development of this form. Following Federov's law on the relation between lattice development and crystal form, these crystals should possess a face-centred lattice.

Powder photographs were taken of the wet crystals, in sealed thin-walled borosilicate tubes containing mother-liquor, with copper $K\alpha$ rays obtained by crystal reflexion from pentaerythritol. From photographs taken at specimen-film distances of 30, 35 and 40 cm., the following spacings were recorded : 407 A., 250 A., 211 A., 175 A., 147 A. and 83 A. The spacings observed fit a face-centred cubic lattice with side equal to 706 ± 11 A., and the following reflexions are accounted for : 111, 220, 311, 400, 422 and 660, with a notable absence of the 222 reflexion, suggesting, therefore, that the virus particles are arranged in a diamond type lattice. There must be eight molecules per cell in such a lattice, giving an interparticle distance of 306 A. or 30·6 mμ.

The powder photographs of virus, dried over phosphorus pentoxide and taken at 30-cm. specimen-film distance, have not yielded the same number of reflexions ; there being present a strong reflexion at 190 A. and indications of a weak one at about 310 A. In the case of the wet crystals the 220 is the strongest reflexion, and if we assume that this is the same for the dried crystal this gives us a face-centred lattice of side 528 A.

Markham[2] has also sent us crystals that are nucleic acid-free and non-infective, which were obtained from the top layers of centrifuged solutions of the virus. The crystals in this case were smaller in size, but showed the same morphological development and optical properties. A noticeable feature here was the longer exposure time needed (144 hours as compared with 96 hours for the virus crystals) to give even an indication that a low-angle diffraction pattern could be obtained. The low-angle diffraction pattern, although weak, was found to be nearly identical in the measurement of spacings with that of the virus crystals containing nucleic acid. The high proportion of nucleic acid in the virus crystals must contribute effectively to the observed reflexions for the virus crystals, and so it is open to question at this stage whether the intensities of the corresponding reflexions in the two types of wet crystals are the same. This can only be settled with examination of bigger crystal specimens. The measurements, however, from the observed spacings for the wet and dry nucleic acid-free crystals gave cell sides of 725 ± 25 A. and 550 A. respectively. The reliability of these measurements is not as high as that for the virus crystals; but as they stand, the measurements would seem to indicate a slightly larger nucleic acid-free molecule than that containing nucleic acid. For practical purposes, however, one might at this stage assume the same size of hydrated molecule in both the infective and non-infective crystals.

This naturally raises the question of the location of the nucleic acid in the infective crystals. The X-ray evidence by itself at this stage is far too meagre to make any statement about it. It may be situated within the molecule or possibly on those surfaces of the molecule not exerting attractions between the tetrahedrally distributed neighbours. If the differences in cell-size measurement are significant, it might be possible that the nucleic acid in some manner holds the molecule in a tighter mass with the same attractive surfaces remaining unaffected. These questions can only be answered when it becomes possible to compare the wide-angle diffraction patterns of the two types of crystal.

It is most probable that in both types of macroscopic crystal the diamond-type lattice is retained on drying. On observation under the microscope, the virus crystals (those containing nucleic acid) have been observed to shrink homogeneously by about 15 per cent ; the earlier part of this shrinkage being reversible. If the diamond lattice is retained, the interparticle distance would be 228 A. (or 22·8 mμ) for the dried virus crystals, and 238 A. (or 23·8 mμ) for the dried nucleic acid-free crystals. Cosslett and Markham, in studying both types of virus aggregated on the electron microscope, support an open packing corresponding to the projection of a diamond lattice on the (110) planes with an interparticle distance of 19·3 mμ for the virus crystals[4].

On the basis of this evidence, it would appear that the interparticle distance of both types of protein can alter on drying by as much as 76–78 A. The nucleic acid apparently has no effect on the forces holding the particles together in either the wet or the dry crystals. A shrinkage of this extent has been found already in the case of tobacco mosaic virus, where at the isoelectric point the interparticle distances change[3] on drying from 175 to 152 A. There is, however, a fundamental difference between these two cases : the tobacco mosaic virus is one of close-packed long rods, whereas in the turnip yellow it must consist of iso-dimensional molecules. Now the change between the wet and dry state of the tobacco mosaic virus is not accompanied by any noticeable alteration of the internal structure of the virus particle. If we make the same assumption for the turnip yellow virus—and this would also be in accord with all recent work on protein structure, particularly that of Perutz—this would imply that in the crystal in its wet state the molecules are separated by a distance of 78 A. of water. The indication is that the individual molecule has a markedly differentiated surface of tetrahedral symmetry, having four faces with a greater affinity for similar faces in other molecules than has the rest of the surface.

Perutz[4] believes that, in the case of hæmoglobin there is a layer of 'bound' water attached to the surface of the molecule. Let us make the assumption for simplicity that the virus particle is spherical in shape and that in the wet crystal it is surrounded by a layer of water. Markham has observed that the partial specific volume of the particle is 0·685 and the density of the wet crystal is 1·33 (in sodium thiosulphate)[5]. A simple calculation from these figures, using the X-ray data as well, shows that the unhydrated particle must have a diameter of 206 A.; meaning, therefore, that there is a layer of water some 11 A. thick surrounding the particle in the wet crystal. This thickness compares rather favourably with the difference in interparticle distances as measured directly by X-rays and by the electron microscope: 228 A. by X-rays, 193 A. electron microscope[6]. The volume of the cell not occupied by the hydrated molecules in the wet crystal is therefore about 86 per cent, which is somewhat greater than the 76 per cent found by Markham for crystals in ammonium sulphate solution; but as we do not know the exact shape of the virus particles the discrepancy between these figures would imply that the particles are not likely to be spherical in shape. A tetrahedrally desegmented sphere, for example, with the same interparticle distance would give a larger volume.

Similar calculations have been carried out for the nucleic acid-free particles. Here Markham has found that the partial specific volume is 0·75 and the density of the wet crystal is 1·305 (in sodium thiosulphate)[5]. If we assume for the moment that the interparticle distance as measured from the dry crystal is the same as that for the dried virus crystals, then the calculations show this time that the nucleic acid-free particle is surrounded by a layer of water some 3 A. thick. In other words, the unhydrated nucleic acid-free particle has a bigger volume than the unhydrated virus particle. We have been informed by Cosslett (unpublished data) that measurements on electron micrographs of the nucleic acid-free material indicate, within experimental error, a particle that is larger than that observed by them for the virus. This seems to be borne out also by the X-ray measurements on the dried nucleic acid-free crystals, but as mentioned previously, we cannot claim sufficient accuracy for this last measurement.

It would be rash at this stage to speculate too freely on the question as to the location of the nucleic acid in the virus molecule from the few observations that have been made to date; but the evidence, scanty as it is, seems to point to the fact that the nucleic acid-free particle has a larger volume than that containing the nucleic acid. This appears to be a paradox—that something containing additional material should occupy a lesser volume than the same thing without the material! The paradox might be resolved by the suggestion that the nucleic acid draws the protein material of the non-infective particles into a smaller volume. Such a suggestion would not be out of keeping with the findings of many workers that it is extremely difficult, in most cases, to separate completely the nucleic acid from the plant viruses, as, for example, in the case of tomato bushy stunt virus.

We still cannot say anything about the shape of these particles. Whatever their shape, however, the force of attraction holding them together must be acting over relatively large areas of the particle which must come into near contact when the crystal dries, and these surfaces can be separated by 78 A. thickness of water containing ions and yet give the structure considerable rigidity. Similar layers of water have been observed in protein crystals; but the largest recorded thickness is 11 A. in hæmoglobin[3]. The importance of these observations is that they demonstrate at the same time a definite external complexity of virus protein and the possibility of maintaining equilibria at long distances in aqueous solution for bodies other than a plate or rod-like shape where it has been previously observed.

J. D. BERNAL
C. H. CARLISLE

Birkbeck College Research Laboratory,
21–22 Torrington Square,
London, W.C.1. July 9.

[1] Markham, R., and Smith, K. M., *Nature*, 157, 300 (1946).
[2] Markham, R., Matthews, R. E. F., and Smith, K. M., *Nature*, 162, 88 (1948).
[3] Bernal, J. D., and Fankuchen, I., *J. Gen. Physiol.*, 25, 111 (1941).
[4] Boyes-Watson, J., Davidson, E., and Perutz, M. F., *Proc. Roy. Soc.*, A., 191, 83 (1947).
[5] Unpublished data.
[6] Cosslett, V. E., and Markham, R., *Nature*, 161, 250 (1948).

An Optical Analogue of X-Ray and Electron Diffraction Patterns

The bubble model developed by Bragg and Nye[1] gives a pictorial representation corresponding, with a high degree of probability, to the arrangement of atomic sites within a crystalline material. In order, however, to make further progress with the help of this model, it is desirable to produce an experimental technique which will enable some correspondence between the bubble model and the actual degree of order in the crystal to be established.

Perhaps the most convenient method of exploring the regularity of a crystal lattice is by means of X-ray or electron diffraction. With this in mind, some preliminary experiments were performed with bubble rafts made with the help of the Physical Metallurgy Section of this laboratory.

The rafts were photographed on to 35 mm. film at such a reduction that individual bubble images were about 0·2 mm. in diameter. Illumination was by means of two 'Photoflood' lamps symmetrically arranged. The (negative) image of each bubble thus consisted of a thin dark ring enclosing an almost transparent disk which had two dark points (the direct images, by reflexion) of the lamps superimposed on it.

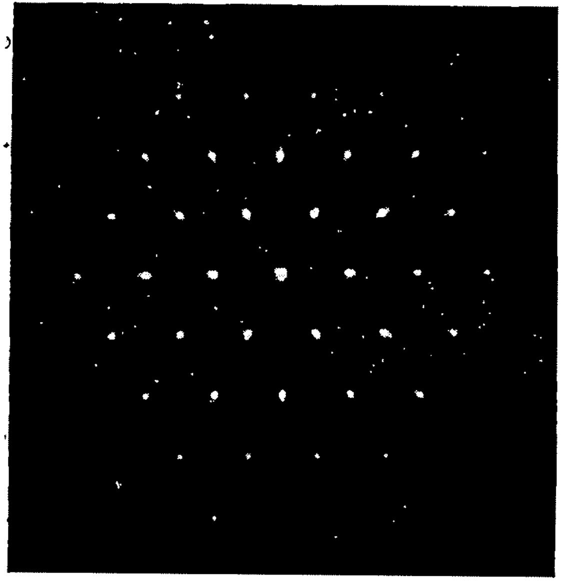


Fig. 1. DIFFRACTION PATTERN FROM PERFECT LATTICE

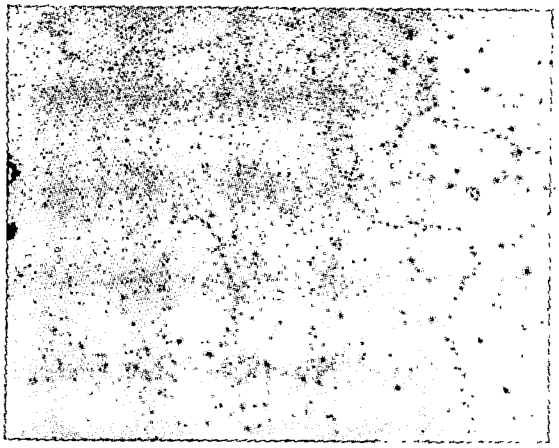


Fig. 2*a*. POLYCRYSTALLINE BUBBLE RAFT

The individual bubbles are not well shown, due to interference with the half-tone dots. Boundaries of crystal grains may be seen; also most of the dislocations may just be perceived as short dark lines

The developed film was then placed in an optical system which was, in effect, a spectroscope. Light from a pinhole approximately 0·10 mm. in diameter was rendered parallel by a collimating lens of about 35 cm. focal length; it then passed through the film and was observed in a telescope. The light source used was a B.T.H. 250-watt mercury vapour lamp with an Ilford 'Mercury Green' filter.

Each bubble image acts as a scattering centre and diffracts light with a polar diagram depending on its geometry and contrast. Interference between wavelets diffracted from the whole array of images gives a Fraunhofer diffraction pattern corresponding to that given by X-rays or electrons diffracted from a single sheet of atoms.

The pattern given by a perfect lattice is shown in Fig. 1. The photograph gives but a poor impression of the beauty of this pattern, which is especially great if the unfiltered light of the mercury lamp is used. In these circumstances each spot, save for the central one, becomes a short spectrum oriented in a radial direction.

Fig. 2*b* shows the pattern due to the polycrystalline raft shown in Fig. 2*a*. This raft was photographed immediately after growth, and consists of a few relatively large crystals with a certain amount of internal strains and dislocations. As might be expected, the pattern consists of 'spotty' rings, each spot being due to an area of almost perfect lattice. In addition, however, a certain amount of continuous background is evident. This is due in part to scattering from the photographic emulsion, but also in part to diffraction from the small amorphous portions around the grain boundaries.

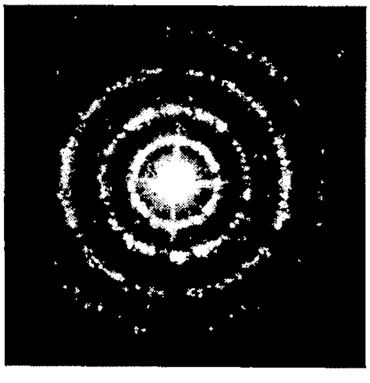


Fig. 2*b*. DIFFRACTION PATTERN FROM RAFT ILLUSTRATED IN FIG. 2*a*

The four white arms at right angles in the centre are due to diffraction from the edges of the rectangular aperture used in forming the diffraction pattern in this case

The patterns derived by this technique are more closely related to those obtained by electron diffraction than by X-rays, as in the former case diffraction is due only to a few atomic layers. Fig. 1 bears a close resemblance to the cross-grating pattern obtained by diffraction of electrons through a very thin sheet of mica.

Further work is being undertaken with the object of improving the resolution and illumination of the diffraction patterns.

J. DYSON

Associated Electrical Industries, Ltd.,
Research Laboratory,
Aldermaston Court,
Aldermaston, Berks.
April 2.

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Discrete Sources of Galactic Radio Frequency Noise

IN a recent communication[1] an outline was given of investigations of the variable galactic noise received from the constellation of Cygnus, first noticed by Hey, Parsons and Phillips[2]. The characteristics of the radiation were described, and evidence was given of its origin in a discrete source. A search has since been made over about one quarter of the celestial sphere for other such sources. The region investigated is roughly enclosed by the co-ordinates:

R.A. 8 hr., Dec. + 40°; R.A. 21 hr., Dec. + 40°;
R.A. 4 hr., Dec. − 40°; R.A. 17 hr., Dec. − 40°.

The frequency used was 100 Mc./s., with an overall sensitivity of 10^{-24} watts $m.^{-2}$ $(c./s.)^{-1}$, and the technique and equipment employed were as previously described[1,3].

So far, six new sources have been found. They are listed in the accompanying table together with the

SOURCES OF GALACTIC RADIO FREQUENCY NOISE KNOWN TO FEBRUARY 1, 1948

Temporary designation	Position		Intensity at 100 Mc./s. (watts $m.^{-2}$ $(c./s.)^{-1}$)	Angular width	Type
	R.A.	Dec.			
Cygnus *A* (1·46)	19h. 59m.	+41° 47′	6×10^{-23}	< 8′	Variable
Taurus *A* (2·47)	5h. 13m.	+28°	10^{-23}	< 30°	Probably long-period variable
Coma Berenices *A* (4·47)	12h. 04m.	+20° 30′	$1·5 \times 10^{-23}$	< 15′	Constant
Hercules *A* (7·48)	16h. 21m.	+15°	2×10^{-24}	< 1°	—
8·48	—	—	2×10^{-24}	—	Constant
5·47	—	—	3×10^{-24}	< 1°	Constant
Centaurus *A* (6·47)	—	—	10^{-23}	< 15′	Probably Cygnus-type variable

source in Cygnus. The positions of three of the sources of northern declination have been computed from the experimental time-elevation curves using the first 20° rise above the horizon. There is an uncertainty of about 1° in the positions given. The source 8·48 rises only shortly before Taurus *A*, and the lobe pattern is then obscured by the stronger source. Similar overlapping of the Centaurus and 5·47 sources has so far prevented their accurate location.

The majority of these sources appear to be in regions of relatively low noise-brightness and star-density. It may be, however, that regions of high noise-brightness are regions of high source-density, not suited to resolution with the present technique. As in the case of Cygnus, the new sources do not appear to be associated with outstanding stellar objects.

The discovery of these discrete sources raises the question of the origin of galactic noise. Henyey and Keenan[4] proposed a mechanism of free-free electron transitions in ionized interstellar matter, with a free space electron temperature of 10^4 ° K. Townes[5] has pointed out divergences between theoretical calculations on this basis and experimental results for the maximum apparent temperatures of the Milky Way, particularly above wave-lengths of two metres. Moxon[6] has shown that the minimum apparent temperature (that is, at the galactic poles) varies as λ^2, whereas the temperature along the Milky Way, after subtraction of the polar residual, depends on λ^3—suggesting a twofold origin. Recent research on solar radiation at metre wave-lengths indicates that radiation from the quiet sun corresponds to a temperature of 10^6 ° K. and is presumed due to thermal emission from the corona. During times of sunspot activity, however, there is evidence that the apparent temperature may exceed 10^{10} ° K. for long periods and be even higher for periods of about a minute.

It is therefore not unreasonable to expect a measurable aggregate of emissions from individual stars in regions of high star-density, despite the large dilution factor. Moreover, it is likely that the free-space electron temperature is greater than 10^4 ° K. in the neighbourhood of *B*- and *O*-class stars.

On the basis of the present observations, it is suggested that the factors contributing to the observed intensity and distribution of galactic noise are threefold.

(1) A 'base-level' due to free-free transitions as proposed by Henyey and Keenan.

(2) An aggregate of emissions from individual stars in regions of high star-density.

(3) A contribution from individual discrete sources, which may be distinct 'radio-types' and for which a place might have to be found in the sequence of stellar evolution. Purely electromagnetic disturbances as an origin of these have been discussed by several writers[2,9,10], and the following additional possibilities are envisaged: (*a*) A pre-main sequence model consisting of a large cool gas sphere, gravitational energy of contraction being radiated in the radio frequency spectrum. (*b*) A post-main sequence model—possibly a development of the planetary nebula consisting of an intensely hot central star, with its radiation in the far ultra-violet, surrounded by a shell of predominantly stripped atoms.

I wish to acknowledge the assistance of Messrs. G. J. Stanley and O. B. Slee in making observations involved in this work, which forms part of the research programme of the Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia.

J. G. Bolton

Division of Radiophysics,
Council for Scientific and Industrial Research,
Australia.
April 6.

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Electric Conductivity of the Ionospheric *D*-Region

Recently, Cowling and Borger[1] have put forward theoretical reasons why the electric conductivity of the ionospheric *D*-region may be considerably less than that of the combined *E*–*F*-regions. On the further postulate that tidal motions increase with height in the ionosphere, they conclude that a recent deduction[2] concerning the origin of the solar and lunar magnetic variations is improbable.

There are two lines of reasoning, both mainly based on experimental evidence, which are difficult to reconcile with Cowling and Borger's conclusion. In the first place, it would appear very doubtful that tidal motions increase with height in the ionosphere. The height gradient of tidal motion depends profoundly on the temperature gradient in the ionosphere, and account must also be taken of the damping due to kinematic viscosity and to conductivity (both thermometric and electric). This damping alone must eventually cause a reduction of motion with increasing height. These considerations are supported by recent experimental evidence[3] that the solar tidal air motion is considerably greater in the *E*-region than in the *F*-region. (The much smaller solar tidal influence on *E*-region ionization is due to the much greater rate of ion production and recombination there.)

Again, recent experimental evidence[4] shows that the phase of the lunar tide in the *E*- and *F*-regions is substantially in opposition to that required to produce the lunar magnetic variations. This suggests strongly that these are produced mainly below the *E*–*F*-regions, and hence that the conductivity there is adequate.

Another argument against Cowling and Borger's conclusion is McNish's experimental evidence[5] that solar flares produce an enhancement, but little change in form, in the solar magnetic variations. It is known that such flares produce negligible changes in ionization in the *E*–*F*-regions, but notable changes in ionization below the *E*-region. Since it is most unlikely that a sporadic disturbance like a solar flare would cause an enhanced air motion identical in form with the regular solar tide, it seems very probable that the main part of the solar magnetic variations is produced below the *E*-region.

Nevertheless, while the weight of experimental evidence strongly suggests that the main part of the magnetic variations is produced below the E-region, it is important to reconcile this conclusion with Cowling and Borger's valuable discussion of the relatively small theoretical conductivity likely to be found there. In this connexion the results of an arlier investigation by Cowling[6] may be important. He showed that the conductivity of an ionized medium an become almost independent of the magnetic field if polarization is set up by the Hall current. n the earth's atmosphere the Hall current is produced by the differential motion of ions and electrons across the earth's magnetic field under the influence of the atmospheric tide. Calculation shows that if polarization adequate to equalize the velocities of ons and electrons is set up, then the effective conductivity of levels below the E-region will be increased by factors of the order 10^2–10^3.

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D. F. MARTYN

Australia House,
London, W.C.2.
April 27.

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WE have recently begun to investigate theoretically how atmospheric tidal motions should vary with height above the E-layer. The work is still in the exploratory stage, and too great reliance cannot be placed on the tentative results which have so far been obtained. These results, however, suggest that tidal motions should increase with height for some considerable way above the E-layer. Considerable phase-changes may also occur above the E-layer. Such results are difficult to incorporate into a general theory of the magnetic variations, and we do not claim to be able to do so: but Dr. Martyn's interpretation of the facts need not be the only possible one.

Dr. Martyn's final suggestion will, unfortunately, not wholly resolve the difficulties to which we directed attention. Polarization counters the magnetic reduction in conductivity fully only if the Hall currents are completely prevented from flowing, and in this case the polarization field must considerably exceed the original field which makes it arise. If, say, the Hall currents in the ionosphere were vertical, the polarization produced by accumulations of charge above and below the conducting layer would be only slowly dissipated, and would be able to build up to a size sufficient to produce the desired effect. But normally the polarization electric field has a horizontal part, which makes the polarization charges leak away as fast as they collect. Hence, while polarization may partially restore the reduction in conductivity due to the magnetic field, it cannot do so more than partially.

T. G. COWLING
R. BORGER

University College,
Bangor.
May 18.

Electromagnetic Level-Shift and Effect of Radiation Field

THE brilliant experiment of Lamb and Retherford[1] has conclusively demonstrated that in the hydrogen atom the $2S$-level is higher than the $2P_{1/2}$-level by about 10 megacycles, a result which reveals a breakdown of the Dirac equation of the electron when applied even to the simplest of the atoms. In a fundamental paper, Bethe[2] has given an explanation of the observed level-shift on the assumption that the transverse self-energy of the electron, in general, depends on the state in which the electron is.

The observed level-shift and Bethe's theory are likely to prove of considerable significance in astrophysics. It is to be observed that the shift in the Balmer lines arising on the above account is comparable to the Einstein solar red-shift. Again, because of the separation between the $2S$- and $2P_{1/2}$-levels the possibility, arising on account of the Stark perturbation, of the (forbidden) transition $2S \rightarrow 1S$, is severely restricted; that is, the $2S$-state would behave as a metastable state, a behaviour which would not have been possible if the levels $2S$ and $2P_{1/2}$ were coincident as demanded by the Dirac equation. The metastable $2S$-state would obviously have an influence on the hydrogen chromosphere. Further, in astrophysical applications, in determining level-shifts, account must be taken of the radiation field surrounding the atom.

It can readily be shown that the transverse self-energy of a free electron is affected by the radiation field, and in the case of temperature equilibrium the increase in the self-energy of the electron is given by

$$\frac{1}{137}\;\frac{\pi}{6}\;\frac{kT}{mc^2}\;kT,$$

where m is the electron rest-mass, k the Boltzmann constant and T the temperature. In the case of atomic levels, the effect of the radiation field becomes complicated (because of the infra-red catastrophe). The details of this investigation will be published elsewhere.

D. S. KOTHARI
F. C. AULUCK

University of Delhi.

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The Proof of Wien's Law

A VITAL step in the proof of Wien's Law, $E(\lambda,T) = T^5\psi(\lambda T)$, for complete radiation, is the adiabatic change in volume of a cavity filled with radiation. In Wien's first proof (1893)[1] and in the more analytical version of it given by O. W. Richardson[2], the cavity is cylindrical in shape and is provided with a movable piston. In order that the distribution in direction may remain random during the expansion, Wien stipulated that the cavity walls should be "perfectly white" (that is, diffuse rather than specular reflectors).

Larmor (1900)[3] pointed out that the proof is simplified if the shape of the cavity is taken to be spherical; the wave-lengths of all components are then altered in the same proportion. It is not, however, obvious that the distribution in direction is maintained during the expansion if the internal spherical surface is perfectly reflecting. Westphal

(1914)[4] makes the walls of his spherical cavity "white", possibly because of Wien's prescription of white walls for the cylindrical cavity.

Though Larmor's proof has been given in extended form in current texts, it appears not to have been demonstrated that, in the case of a spherical reflecting cavity, the change of angle with the normal which ensues on reflexion at the moving surface is compensated by the change of radius between reflexions. If i, θ are angles of incidence and reflexion respectively as the surface moves slowly outwards with speed dr/dt, $\theta - i = (2 \sin \theta /c)dr/dt$. The angle of incidence i' at the succeeding reflexion satisfies the equation $\sin \theta/\sin i' = 1 + dr/r$, where $dr = (2\, r \cos \theta /c)dr/dt$.

Thus $\sin i' - \sin \theta = -(2 \sin \theta \cos \theta /c)dr/dt$, and $i' - \theta = -(2 \sin \theta /c)dr/dt$, giving $i' = i$.

The angle of incidence remains the same at successive reflexions, and we may consider as a distinct group the radiation which is incident at angles between, say, θ and $\theta + d\theta$. If, at some temperature, $u_\theta d\theta$ is the energy density of the group in the immediate neighbourhood of the wall, and u represents the total energy density, it can be shown that $u_\theta = u \sin \theta$, while the pressure due to the group on the wall is $u_\theta \cos^2 \theta\, d\theta$ and the energy of the group in the whole sphere is $U_\theta d\theta = 4\pi r^3 u_\theta \cos^2 \theta\, d\theta$. The energy equation for the group in expansion is then:

$$dU_\theta + 4\pi r^2 u_\theta \cos^2 \theta \,.\, dr = 0,$$

whence

$$r du_\theta + 4u_\theta\, dr = 0.$$

Comparing this with the equation for the whole radiation

$$r du + 4u\, dr = 0,$$

it is seen that the energy of each group is altered in the same proportion during the expansion, and the distribution in direction is maintained.

Wien (1894)[5] showed that this was true for a group at nearly normal incidence ($\theta = 0$); but the general case appears not to have been discussed. Larmor inserted a material particle in his cavity in order to maintain normal distribution in wave-length; but it is not clear from his argument, which is couched in very general terms, that the calculation of the change of wave-length from the Doppler effect is valid when the particle is present. Planck[6] has shown that for a cavity of any shape, the distribution in wave-length remains normal whether the small material particle is present or not; his demonstration of this, like the proof given by Wien for a cylindrical cavity, is valid only if random distribution in direction is maintained. The spherical reflecting cavity, without a material particle, thus provides a satisfactory proof when supplemented by the demonstration above of the maintenance of random direction and by Planck's proof of the maintenance of the distribution in wave-length.

E. O. HERCUS

Department of Physics,
University of Melbourne.

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Photo-electric Star-following Telescopes

EXPERIMENTS have recently been conducted by the Telecommunications Research Establishment at the Royal Observatory, Greenwich, to investigate the automatic guiding of an astronomical telescope on a star. The work was done on the 13-in. astrographic refractor and the degree of success achieved was as follows.

In June 1947, using a very sluggish servo system, that is, one with a natural frequency of the order o 1/10 cycle per min., the steady state error in follow was less than 1″ (corresponding to an image movement of 0·001 in.).

The irregular refraction of the atmosphere causes the apparent direction of a star to vary at frequencies up to at least one cycle per second. Accordingly, a system with a more rapid response was built. In January 1948, using a servo system with a natura frequency of the order of ½ cycle per sec., there was a random steady state error of some few seconds of angle, owing to the larger band-width.

The servo system derives its 'knowledge' of misalignment from an error detection device comprising a graticule in the focal plane of the telescope, and in the form of a disk divided into equal sectors alternately opaque and transparent. The image of the star being followed is made to describe a circle over the face of the disk. Behind the disk is a photo-cell which collects the transmitted light in the form of pulses. When the telescope is aligned on the star, the circle of movement of star image is concentric with the disk and the pulses of transmitted light are of equal duration and separation; but when the circle of image movement is eccentric due to relative movement between star and telescope, the pulses then transmitted are effectively modulated in frequency The amplitude and phase of this modulation give a linear measure to a first order of the telescope misalignment in magnitude and direction. The misalignment signal controls the acceleration of a servo motor which drives the telescope.

Since the astrographic telescope at Greenwich has a fixed plate-holder, guiding is possible only in right ascension; hence only one rectangular component of the misalignment information is required and used

Consideration is now being given to the use of this or a similar system to guide automatically the 100-in. Isaac Newton telescope planned for erection at Herstmonceux.

A. UTTLEY
S. JONES
L. MANNS

Telecommunications Research Establishment,
Great Malvern.
April 8.

Presence of Cobalt in the Anti-Pernicious Anæmia Factor

INDEPENDENT investigation here and in the United States led to the recent isolation of the anti-pernicious anæmia factor as red needle-shaped crystals[1–3]. Examination of its ash has now unexpectedly revealed the presence of cobalt.

In four separate batches of crystals we have detected cobalt by the characteristic cobalt blue borax bead and by the specific red colour reaction with nitroso *R* salt. Colorimetric estimations with α-nitroso-β-naphthol showed the presence of 4·0 per cent of cobalt in crystals dried *in vacuo* at 56° C. If each molecule contains one atom of cobalt, the molecular weight of the compound is about 1,500 ; allowance for 8 per cent loss on drying brings the value to 1,600, in excellent agreement with that of 1,550–1,750 for air-dried material which Dr. Dorothy Crowfoot (private communication) has found by X-ray crystallography. (The uncertainty s due to the amount of available material having been inadequate for accurate determination of density.) The value does not agree with about 3,000, which we found by the diffusion method. The discrepancy may be due to errors inherent in this method or to the use of impure material in the earlier experiments, but it is also possible that association occurs in solution.

So far as we are aware, the presence of cobalt in an isolated compound of natural origin has not been previously reported, although cobalt is recognized as an essential trace element. It has been shown to prevent or cure in ruminants a syndrome involving anæmia and arising from feeding on pastures deficient in cobalt[4].

In discussion with Dr. Randolph T. Major, of Merck and Co., Inc., we have been informed that the Merck workers have also discovered the presence of cobalt in their vitamin B_{12}. Their publication of this inding[5] refers to the presence of phosphorus. Our own analytical figures have already indicated that the molecule contains three atoms of phosphorus.

E. LESTER SMITH

Glaxo Laboratories, Ltd.,
Greenford, Middlesex.
July 1.

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Interrelations of the Serum Protein in the Thymol Turbidity Test

THE mechanism of the thymol flocculation test developed by MacLagan in 1944[1] has in the past four years been the subject of study by several investigators[2–5]. In the course of a detailed study of the circulating proteins of a patient suffering from advanced liver disease, whose plasma was known to give a strongly positive thymol reaction (18 units), opportunity was taken to examine the observation hat normal human albumin would inhibit the thymol reaction[3].

The fraction used for the investigation consisted of the slower-moving components, separated from he descending limb, by the discontinuous electrophoretic technique of Tiselius. Fig. 1 shows the distribution of the components in this fraction. It will be seen that there were two major peaks having mobilities compatible with β- and γ-globulins respectively, and one intermediate peak the mobility of which corresponded to fibrinogen. This fraction was dialysed against 0·15 molar sodium chloride at pH 7·0, and after dialysis gave a well-marked thymol reaction using the technique originally laid down by MacLagan[1].

To the material so obtained varying concentrations were added of (*a*) crystalline normal human serum albumin in 0·15 molar sodium chloride, and (*b*) normal human serum 'albumin' obtained by precipitation of the globulins of normal serum with 26 per cent sodium sulphate at 37° C. and subsequent dialysis against 0·15 molar sodium chloride. Electrophoretic analysis of (*b*) showed that the fraction contained perceptible amounts of α_1-globulin (see Fig. 2).

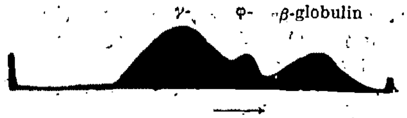

Fig. 1. PHOSPHATE BUFFER, MOLARITY 0·2 ; PROTEIN CONCENTRATION, 112 MGM. NITROGEN/100 ML.

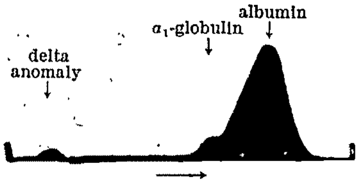

Fig. 2. PHOSPHATE BUFFER, MOLARITY 0·2 ; PROTEIN CONCENTRATION, 160 MGM. NITROGEN/100 ML.

In every instance the concentration of the globulin fraction in the final volume of saline was kept constant. The results are shown in the accompanying table.

(*a*) Crystalline human albumin Ratio of albumin nitrogen to globulin fraction nitrogen	Thymol test
0 to 1	++
0·81 to 1	++
1·62 to 1	++
3·24 to 1	+
4·77 to 1	±
9·55 to 1	–

(*b*) 'Albumin' obtained by precipitation of globulins from normal human serum with 26 per cent Na_2SO_4 at 37° C. Ratio of albumin nitrogen to globulin fraction nitrogen	Thymol test
0 to 1	++
0·28 to 1	–
0·56 to 1	–

The mean ratio of albumin to γ-globulin in eleven sera examined by electrophoretic analysis[6], all giving a well-marked thymol reaction, was 2·6 to 1 (σ = 0·705). This ratio of concentration is lower than that shown in the table as the minimal effective concentration to produce inhibition using normal albumin.

The inhibitory action of pure bovine albumin and of pure horse albumin was studied against the same globulin fraction, and both were found to be effective inhibitors in concentrations of the same order of magnitude as crystalline human albumin.

These results seem to suggest that the inhibitory effect of albumin as such is a function of its concentration in the system under test ; and further, that the interaction is not species specific.

The 'albumin' obtained by sodium sulphate precipitation was inhibitory in much lower concentrations than the crystalline albumins. This 'albumin' was demonstrated to be contaminated by α_1-globulin. This raises the possibility that inhibition may be a function of α_1-globulin closely associated with albumin, as well as albumin itself. An alternative rationalization of the observation is that in the process of crystallization, the specific reactive groupings on the albumin molecule have become modified so as to reduce its potential inhibitory effect when redissolved in normal saline.

I wish especially to express my thanks to Dr. Kekwick and to the Lister Institute for the facilities they placed at my disposal.

NICHOLAS H. MARTIN

St. George's Hospital,
Hyde Park Corner,
London, S.W.1.
April 2.

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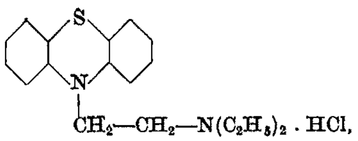
N-Diethylaminoethylphenothiazine: a Specific Inhibitor of Pseudocholinesterase

Mendel and Rudney[1] demonstrated that mammalian tissues may contain two distinct esterases, both capable of hydrolysing acetylcholine *in vitro*: a specific enzyme ('true' cholinesterase) and a non-specific enzyme ('pseudo'cholinesterase). The chemically dissimilar natures of the two enzymes were indicated by their selective behaviour towards particular choline esters[2] and by the selective toxic effects, on the pseudo esterase, of the dimethylcarbamate of (2-hydroxy : 5-phenylbenzyl)-trimethylammonium bromide[3] and of di*iso*propylfluorophosphate[4]. Both these substances exert powerful effects on pseudocholinesterase at concentrations which are relatively ineffective against true cholinesterase.

Experiments recently recorded in these laboratories indicate another organic compound which exerts a similar selective toxic action on pseudocholinesterase. The compound N-diethylaminoethylphenothiazine hydrochloride (also known as 2987 *R.P.*), of the following constitution:



$CH_2—CH_2—N(C_2H_5)_2 . HCl$,

was originally synthesized by Gilman and Shirley[5] and first examined pharmacologically by Bovet *et al.*[6] in connexion with its possible use in the symptomatic treatment of Parkinson's disease. It was tested for anticholinesterase activity, using the technique of Ammon[7]. The source of enzyme was either a rat brain extract, which is believed to contain only true cholinesterase[8], or blood plasma. The brain extract was prepared by grinding a whole rat brain with sand and normal saline, filtering through muslin, and diluting the filtrate with saline to a final volume of 8 ml. per gm. original tissue. Enzyme activities were measured at 37° C., using as substrates acetylcholine, acetyl-β-methylcholine (mecholyl) and benzoylcholine, in presence of various concentrations of 2987 *R.P.*, and measurements of carbon dioxide output in every case were made for a period of 1 hr. after equilibration. Controls without drug and without substrate were also set up. Typical results are shown in the table.

Source of enzyme	Concentration of substrate	Concentration of 2987 *R.P.*	% Inhibition of enzyme
0·5 ml. brain extract	0·007 *M* acetylcholine	$5·1 \times 10^{-4}$ *M*	0
0·5 ml. rat plasma	0·007 *M* mecholyl	$3·0 \times 10^{-4}$ *M*	9·2
0·5 ml. rat plasma	0·006 *M* benzoylcholine	$0·24 \times 10^{-4}$ *M*	74·0
0·3 ml. guinea pig plasma	0·006 *M* benzoylcholine	$0·075 \times 10^{-4}$ *M*	87·3

It will be seen that, while the activity of pseudocholinesterase, indicated by the action of plasma on benzoylcholine, is strongly inhibited by 2987 *R.P.* at concentrations of the order of $0·075 \times 10^{-4}$ *M* an $0·24 \times 10^{-4}$ *M*, the activity of the true cholinesteras indicated by the action of brain extract on acety choline and of plasma on mecholyl, is not affecte appreciably by the drug even at much greater concentrations, of the order of $5·1 \times 10^{-4}$ *M*.

The results are in harmony with the views expressed by Mendel *et al.*[1,2] regarding the chemicall distinct natures of the two types of cholinesteras

J. J. GORDON*

Biological Division,
May and Baker, Ltd.,
Dagenham, Essex.
March 19.

* Present address: Research Department, Bristol Mental Hospita Fishponds, Bristol.

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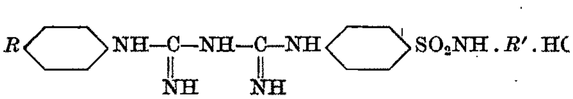
Metachloridine-substituted Aryl Biguanide as Possible Antimalarial Compounds

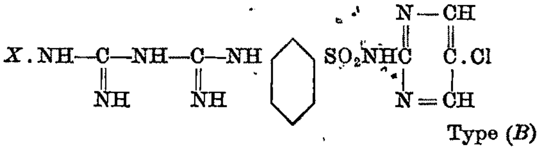
METANILAMIDES are reported to have no antibacterial action[1], and from the parallel nature of th antimalarial and antibacterial properties of sulph anilamides, discouraged research in the field c metanilamides as possible antimalarials. Recently English *et al.*[2] discovered enhanced antimalaria activity in 2-sulphanilamido-5-chloropyrimidine, an their work resulted in the discovery of metachloridine (*SN* 11437) (2-metanilamido-5-chloropyrimidine) which has been found to be effective both in avian and human malarias[4,5,6]. Metachloridine is 5-chloropyrimidine-substituted metanilamide, the action c which is not affected by the presence of *p*-aminobenzoic acid, and is supposed[3] to have a doubl mode of action due to the presence of 5-chloropyrimidine and metanilamide parts in the molecule.

Previously, sulpha-biguanides of type (*A*), som of which have shown encouraging antimalarial activity against avian malaria (*P. gallinaceum*), hav been reported by us[7,8]. The following compound of type (*B*) have also been prepared (see table), wher metachloridine forms the N^5-substituent of N^1-ary biguanides.



Type (*A*

R = H, Cl, Br, NO_2, CH_3, etc.
R' = H, 2-thiazolyl, 2-pyrimidyl, 4 : 6-dimethyl-2 pyrimidyl, 6-methyl-2-pyrimidyl.



Type (*B*)

X = substituted aryls.

N^1-Aryl-N^5-metachloridino-biguanides

X	M.p. of the hydrochloride (° C.)	M.p. of the free base (° C.)
1. Phenyl	232	234
2. *p*-Chlorophenyl	235	239
3. 2 : 4-Dichlorophenyl	256	234
4. *p*-Bromophenyl	227	243
5. *p*-Iodophenyl	208 (decomp.)	239
6. *p*-Methylphenyl	237	233
7. 3 : 4-Dimethylphenyl	246	232–234
8. *p*-Methoxyphenyl	202	236
9. *p*-Nitrophenyl	252	237

The hydrochlorides of these compounds have been prepared by the reaction of the appropriate aryl-cyanoguanidines with metachloridine hydrochloride in solvents like aqueous dioxan or 90 per cent ethanol. The free bases and the hydrochlorides are white crystalline powders.

During the preparation of the copper chelates of the substituted biguanides of types (*A*) and (*B*) by Andreasch's[9] method, the simple sulphanilamide-substituted aryl-biguanides (type *A*, R' = H) yielded the chelates readily, while those with heterocyclic sulphanilamides and metachloridine as substituents showed very feeble tendency towards chelation, perhaps due to the enhanced electro-negative nature of the sulphonamido group.

m-(5-Chloro-2-pyrimidyl)-sulphonamidophenyl-azo-cyanoguanidine did not lend itself to denitrogenation to give the corresponding cyanoguanidine compound. Details will be published elsewhere.

We thank the Indian Research Fund Association for the award of a fellowship to one of us (H. L. Bami).

H. L. Bami
B. H. Iyer
P. C. Guha

Organic Chemistry Laboratories,
Indian Institute of Science,
Bangalore. Feb. 27.

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[4] Huges, Carrie and Brackett, *J. Parasitol.*, **32**, 340 (1946).

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Presence of a Parasitic Agent in Various Intracranial Tumours of Man

In a preliminary communication[1], one of us (C. J.) reported how, by following up indications that gliomas of the domestic fowl arise as foci of chronic inflammation and appear to be a response to the presence of some irritant influence, he was led to the demonstration of a parasitic agent associated with the lesions of glioma and encephalitis in this species. Bodies (*A*, *B*, *C* and *D*) were described and illustrated which were claimed to be phases of a pleomorphic parasite, while others (*E*) were strongly suspected, and still others considered possibly to represent further phases. In glioma and in chronic disseminated encephalitis, it was the *C* and *D* bodies that were especially demonstrated, while the *A* and *B* bodies tended to be more characteristic of purulent encephalitis.

These findings made it imperative to examine human gliomas for the possibility of the presence of some comparable agent; all tumours, whether gliomas or not, recently removed in the Neurosurgical Department of the Johannesburg Hospital have therefore been so examined.

The results are shown in the accompanying table.

PARASITIC BODIES IN TUMOURS FROM THE NEUROSURGICAL DEPARTMENT, JOHANNESBURG

Case No.	Diagnosis	Parasitic phases: *C* Bodies	Parasitic phases: *D* Bodies	Strongly suspected phases: *E* Bodies	Possible phases; *F*, *G*. *H*, etc.
1	Medulloblastoma	+	++*	+	
2	Medulloblastoma	+	+*	+	+
3	Medulloblastoma	+	+*	+	+
4	Spongioblastoma multiforme	+*		+	+
5	Spongioblastoma multiforme	+*	+	+	+
6	Spongioblastoma multiforme	+*	+	+	+
7	Spongioblastoma multiforme	+*		+	+
8	Meningioma Type III–IV	+*		+	
9	Meningioma Type III	+*	+	+	+
10	Meningioma Type III	+*		+	
11	Meningioma Type III	+*		+	+
12	Meningioma Type III	+*		?	
13	Meningioma, Spinal, Mixed	+*	+	?	+
14	Meningioma, Xanthomatous	+*	+	+	+
15	Pituitary adeno-carcinoma	+++*	+	+	+
16	Chromophobe adenoma	+*	+	+	+

+ Present. ++ Fairly frequent. +++ Very frequent. * More frequent or prominent than other phases. ? So rare that some doubt was felt.

In all of sixteen cases of glioma, meningioma or pituitary neoplasms, we have been able to demonstrate bodies indistinguishable from the *C* and *D* phases of the fowl parasite, while in most cases the suspicious *E* bodies and the other possible phases have also been seen.

All the varieties of *C* bodies (*C*, oval; C^1, double oval; C^2, piriform; C^3, bipolar; and C^4, ring- or horseshoe-shaped) encountered in the fowl have been identified in man.

It will appear from the table that *D* bodies tend to be more characteristic of medulloblastoma on one hand, and *C* bodies of meningiomas and pituitary tumours on the other. In the meningiomas no correlation could be found between the type of tumour and the variety of the *C* bodies which was predominant. But in the two pituitary neoplasms (one a β-cell adenocarcinoma, the other a chromophobe adenoma) the C^2 variety was predominant, and in these two cases there was a striking contrast in the frequency of the *C* bodies between the malignant and the benign tumour.

Properly differentiated Giemsa-stained paraffin sections of formol-fixed material and air-dried Giemsa-stained smears are both suitable for the demonstration of *C* bodies; but the *D* bodies are best demonstrated only in smears.

The bodies have been readily demonstrable only in a few cases, in other cases they were found after a short search; but in the majority of specimens, considerable and patient searching was necessary.

A full report of these findings will be published later.

We should point out that *D* bodies, considered alone, would probably not impress one as anything more definite than 'inclusion bodies'. On the other hand, *C* bodies might fairly be claimed on their own morphological merits as parasites. However, our opinion of the parasitic nature of the *C* and *D* bodies in human tumours is based chiefly on our ability in avian lesions to relate these bodies as phases of a life-cycle which includes the still more impressive schizont-like *A* body.

By analogy with avian pathology, we expect that a phase corresponding to the *A* body will prove to be demonstrable in man; but not necessarily in tumours, since in the fowl this body is more characteristic of the non-neoplastic lesions. Pending demonstration of the 'missing' phases in man, no opinion will be expressed regarding the identity of the human with the avian parasite.

R. A. KRYNAUW

Department of Neurosurgery,
Johannesburg Hospital.

CECIL JACKSON

Onderstepoort Veterinary
Research Institute,
South Africa.
March 16.

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[1] Jackson, C., *Nature* [161, 441 (1948)].

The Stock of Whales

IN an article on the "Effect of Present-day Whaling on the Stock of Whales"[1], Dr. Hamilton points out that in spite of a 'rest' during the War, the Antarctic catch of blue whales in 1945–46 showed a scarcity of the largest animals, a reduced proportion of this species (30·7 per cent) in the total catch, and a reduced percentage of mature females which were pregnant; and he infers that the stock of blue whales is showing clear signs of reduction. Among other matters he points out that the limit of 16,000 'blue whale units' allows the killing of many more than 16,000 whales. Although in agreement with much of what Dr. Hamilton says, I think it should be noted that the figures for the subsequent season of 1946–47 show that blue whales were taken in relatively larger numbers, and formed about 38·5 per cent of the catch. Although this is still not very high, and gives no grounds for complacency, it is a distinct improvement on 1945–46.

It is doubtful whether the results of a single season are sufficient to indicate the condition of the stock, and since the better catches of blue whales in 1946–47 can scarcely be attributed to a sudden recovery in the stock, it is difficult to avoid the conclusion that 1945–46 was in some way an abnormal season in which the blue whales in the population were not adequately represented in the catch. The explanation may be in exceptional oceanographical conditions; but on this we have no adequate evidence. It appears that the weather at least was less favourable in 1945–46 than in 1946–47. Full details of the catches in 1947–48, and of sizes and percentage pregnant in 1946–47, have not yet, I believe, been published. It is not very clear, however, that the percentage of mature females pregnant is a wholly reliable indication of the condition of the stock.

Before the War, signs of depletion of the blue whale stock persisted over a succession of whaling seasons. If now a comparison of several seasons indicated that this stock is still declining, its position would be serious indeed. If, on the other hand, it is found to have recovered to some extent (and there is evidence, as yet unpublished, which suggests good recruitment of young blue whales), then it is important that it should not again be subjected to excessive, and in the long run uneconomic, hunting.

The international regulation of whaling is a complex subject; but briefly it can be said that the limit of 16,000 blue whale units (in preference to a specified number of whales) was adopted as the best practicable means of putting a 'ceiling' to the total Antarctic 'pelagic' catch. It represents approximately two thirds of the average annual catch before the War, and it can be reconsidered from time to time. Since 1 unit = 1 blue, 2 fin, 2½ humpback, or 6 sei whales, the larger the number of whales taken, the smaller will be the number of blue whales among them. This may not be a perfect method of limiting the catch, but it is probably the most effective of the international regulations.

N. A. MACKINTOSH

"Discovery" Investigations,
Queen Anne's Chambers,
London, S.W.1.

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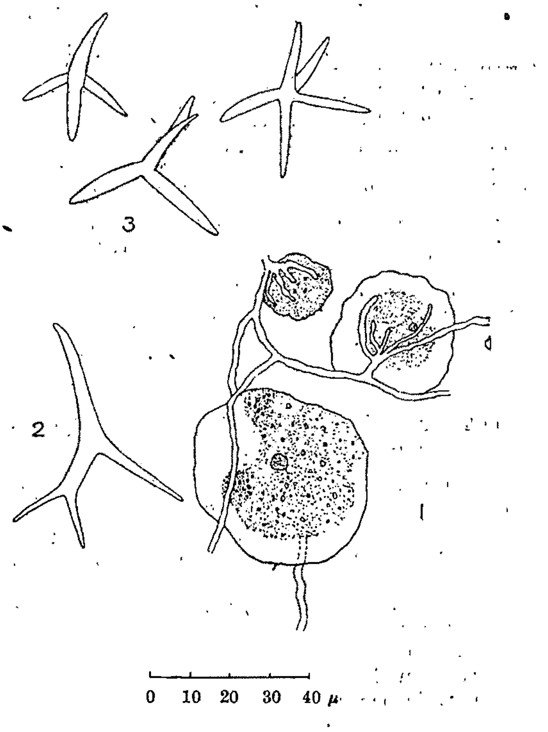
[1] *Nature*, 161, 913 (1948).

An Aquatic Predaceous Fungus, *Acaulopage dichotoma*, in Britain

IN the course of a general investigation into aquatic fungi, a predaceous Phycomycete, *Acaulopage dichotoma* Drechsler (1945)[1], has been identified for the first time in Great Britain.



The source of material was a small pond at Ken Vood, London, containing beech leaf and twig debris. n maize meal agar plates, a fungus was observed hich subsisted on aquatic amœbæ. The mycelium s extremely delicate and granular, with slight ranching, diameter varying between 1 and 2 μ ccording to age. Amœbæ, 30–45 μ in diameter, are aptured and a branched haustorium 10–30 μ in ngth is formed which persists until complete igestion is effected, when withdrawal of protoplasm ccurs (Fig. 1). When the mycelium is well stablished, conidia formation occurs, and exposure light seems to stimulate their formation. A short teral enlarges and two distal forks appear, frequently ne or both forking again (Fig. 2); less regular forking s of frequent occurrence (Fig. 3). At maturity, the istal portion of each fork appears devoid of protolasm and is termed the appendage. The conidia ave forks ranging from 15 to 40 μ in length.

This fungus agrees with the general description of *caulopage dichotoma* Drechsler, 1945, found in waterly leaf inoculum, and is named accordingly.

I found a greater variation in the degree of forking f conidia than is reported by Drechsler, and no race of the clear secretion which formed yellow eposits apparently produced by the fungus as an dhesive trap for amœbæ.

M. PEACH

epartment of Chemistry and Biology,
The Polytechnic,
309 Regent Street,
London, W.1.
April 8.

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[1] Drechsler, *Mycologia*, 37, 1 (1945).

Osmoregulatory Capacity of Contractile Vacuoles

THE view that the contractile vacuoles of Protozoa n many cases perform an osmoregulatory function as been supported by much evidence[1] which need not e repeated here. Recent observations carried out n the freshwater peritrich ciliate *Carchesium aselli* ave demonstrated the remarkably close regulation f body volume which is achieved in spite of wide ariation in the osmotic stress imposed by the nvironment.

In some experiments, in order that the internal smotic pressure might be raised, the organisms were quilibrated with 0·05–0·5 molar solutions of ethylene lycol, which is known[2] to penetrate various cell nembranes at a significant but not too rapid rate. n return of the organisms to water free from thylene glycol, the contractile vacuole increased its ate of output immediately to from two to nine imes the rate before treatment; but it subsided in he course of ten to twenty minutes to its normal level f activity, no doubt owing to the escape of the thylene glycol from the organism. Greatly increased smotic stress was thus met by increased vacuolar utput, and the swelling which would be expected in he absence of osmoregulation was prevented or after the higher concentrations of ethylene glycol) onsiderably restricted. Similarly, in experiments in which the organisms were immersed in solutions of p to 0·03 molar sucrose, which for short periods nay be regarded as not penetrating in significant mount, the body volume remained unchanged within the limits of observation) while the rate of acuolar output was appropriately reduced.

The highly developed power of accurate osmoregulation which is therefore found in these ciliates may well be useful where the osmotic pressure of the medium is liable to fluctuate, as, for example, in estuaries. Apart from this, another important ecological aspect of this question may be suggested. It has been shown[3] for the egg of the sea urchin *Arbacia* that the rate of swelling on transfer to dilute sea water is considerably faster at higher temperatures, presumably because of increased permeability to water; and I have found this to be true also for the marine peritrich ciliate *Vorticella marina*. The Q_{10} for the permeability to water of the *Arbacia* egg has been estimated as ranging from 2·1 to 3·1 ('permeability' here including any changes which may occur either in the diffusibility of water or in the properties of the membrane); and that for *Vorticella marina* appears to be of the same order, although the precision of the results does not warrant a closer statement. But I have also found that the rate of vacuolar output of a freshwater peritrich increases with rise of temperature with a Q_{10} of 2½ to 3.

It seems reasonable to postulate that the contractile vacuole responds to small changes in the hydration of the protoplasm, whether these arise from a change in magnitude of the osmotic difference across the body surface or from a change in 'permeability' of that surface to water, so that the rate of vacuolar output is adjusted to maintain a practically constant body volume. In its natural habitat a freshwater peritrich might be exposed to seasonal extremes of 0–20° C., and in some circumstances the diurnal fluctuations might amount to several degrees. It seems that the organism would have to grade its osmoregulation to meet these changes. This may apply also to other freshwater animals, and so prove to have a general ecological importance.

J. A. KITCHING

Department of Zoology,
University of Bristol.
April 9.

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[1] Kitching, *Biol. Rev.*, 13, 403 (1938).

[2] Stewart, *Biol. Bull. Woods Hole*, 60, 152 (1931).

[3] Lucké and McCutcheon, *Physiol. Rev.*, 12, 68 (1932).

Course of Untreated Infections of *Litomosoides carinii* in the Cotton Rat

THE efficacy of drugs in the treatment of human filariasis can be assessed by their effect on the microfilariæ in the peripheral circulation, and the effect on the adults merely inferred therefrom: in animals, however, the change induced in the adults can be assessed directly.

In recent years, *Litomosoides carinii*, the natural filarial parasite of the cotton rat, transmissible from rat to rat by the mite *Liponyssus bacoti*, has been studied in this laboratory and in others in Britain and America, with a view to its use for chemotherapeutic researches in filariasis. Much of the published work on the preliminary screening of drugs has been done with rats showing infections of unknown duration, naturally acquired in the field, and the results are interpreted as indicating that, while certain drugs kill the adult worms in the pleural cavity but do not affect the microfilariæ in the peripheral blood stream, the converse is true of other drugs, although, in some cases, only a transient reduction in the number of microfilariæ has been observed.[1] Our observations on untreated laboratory-infected cotton rats over the past two years lead us to conclude that there is need for considerable caution in the interpretation of such observations.

In a previous communication[1], the unsuitability of the white rat as a host for this purpose was suggested, for though the course of an infection in cotton rats and white rats follows the same pattern, in the white rat the microfilariæ do not persist in the circulation for the same length of time as in the cotton rat, and the death of the parent worms and their encapsulation occurs much earlier. Though the infection in the cotton rat has the same evolution, there is less disparity between its duration and the life span of the host. Nevertheless a cotton rat infected in its youth may outlive an infection which has undergone spontaneous cure. We have been able to follow, for a year or more, the general course of the blood infection in cotton rats exposed to infection once—usually for 24 hours—by small numbers of infective mites. Microfilariæ appear in the peripheral blood on the fifty-first day after exposure, and increase during the next month or more, after which the count tends to remain more or less constant, with wide variations about the mean. In one rat, still surviving, an infection intensity, varying between 140 and 240 microfilariæ/c.mm., has been maintained for the past twelve months. On the other hand, in another rat, the general level, varying between 80 and 190 microfilariæ/c.mm., persisted for some six months; but, during the following three or four months, the count dropped progressively until the microfilariæ finally disappeared three weeks before the animal's death, when only dead encapsulated worms were found.

In other cotton rats, infected on several occasions by mass exposure to mites, the infection has followed a similar course. Some, which showed counts of 1,500, 840, 675, 450 and 150 microfilariæ/c.mm. in the peripheral blood about the third or fourth month after infection, dropped after the seventh or eighth months to 530, 45, 30, 10 and 20 microfilariæ/c.mm. respectively, while in others, which died seven to twelve months after their last exposure, many of the adult worms were found to be dead and encapsulated.

The relationship between the death of the adult worms and the disappearance of the microfilariæ from the peripheral circulation cannot be defined in the absence of more precise knowledge of the migration-rate and the longevity of the microfilariæ. Though they are found most commonly in the peripheral circulation within one day of injection into the pleural or peritoneal cavities and the subcutaneous tissue, their persistence in the circulation in the absence of the adult varies from days to weeks and even months. Furthermore, in one such animal, a concomitant septic infection has been accompanied by a transient reappearance of the circulating microfilariæ after they had previously disappeared for a time, suggesting that redistribution may be an additional factor in their decline.

Our results cannot be taken to indicate the minimum time required before gross pathological changes are induced in the pleural sac by the adult worms, nor do they enable the duration of a particular blood infection to be estimated before the progressive and terminal fall occurs in the microfilarial count, nor can the disappearance of the microfilariæ and the death of the adult worm be correlated accurately at the moment. Nevertheless, they suggest that conclusions from treated infections should be made with due regard to the findings in untreated controls, and that results derived from wild, naturally infecte cotton rats should be interpreted with caution.

W. E. Kershaw
D. S. Bertram

Department of Entomology and Parasitology,
School of Tropical Medicine, Pembroke Place,
Liverpool 3. April 12.

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[1] *Nature*, **158**, 418 (1946).

Density of the Blackfish Petrosal

The mammalian petrosal is generally recognize by anatomists as the most compact of bones. Th physical density of the various bones does not see to have attracted much attention. The only data i the literature available to me are those of th "Smithsonian Physical Tables", where the densit of bone is given as varying from 1·2 to 2·0 gm. pe cubic centimetre.

Mr. J. T. Sorenson included a petrosal from blackfish (*Globicephala melæna*) in the collectio which he made in his second stay at Campbell Islan in the New Zealand subantarctic group. The extr ordinary density of this specimen is striking an immediately apparent when the bone is handle Although the specimen measures only 40 mm. 28 mm. × 18 mm. in its major dimensions, the dr weight is 17·5 gm. After boiling in water to expel ai the volume measured by immersion is 5·0 c.c accordingly, the physical density is 3·5, considerabl exceeding the range given in the Smithsonia "Physical Tables".

In comparison, the petrosal of a dog weighe 1·34 gm. and had a volume, measured as before, 1·0 c.c. The density of this specimen, 1·34, falls we within the limits given in the tables, and confirm the initial impression of the remarkable density the blackfish petrosal.

L. R. Richardson

Department of Zoology,
Victoria University College,
Wellington, New Zealand.

A Method for Studying the Carbohydrate Metabolism of Micro-organisms

We wish to emphasize the usefulness of the metho of paper chromatography of sugar[1,2], especially whe applied on a quantitative basis[3], in the study bacterial metabolism. As an example we quote th following experiment on the utilization of sucrose b *Leuconostoc mesenteroides* (Lister Institute strain N 3351).

Most strains of this bacterium are found to produc copious yields of a dextran from this sugar and n other[4]. The strain used had those properties.

During the production of the gum, large quantiti of reducing sugars are formed, and it has been gene ally assumed that the glucose part of the sucrose polymerized to dextran with simultaneous liberatio of the fructose moiety[5]. Considerable interest centred on the bacterium due to Hehre and Sugg' enzymatic synthesis of the dextran.

A loopful of a 48-hr. culture of the organis (growing in Tarr and Hibbert's liquid medium[4] wit the addition of 2 per cent yeast extract) was inoc lated into 10 ml. of this medium, and the cultu flask incubated at 28° C.

It is possible by the paper chromatography metho to estimate at any desired interval during growth th

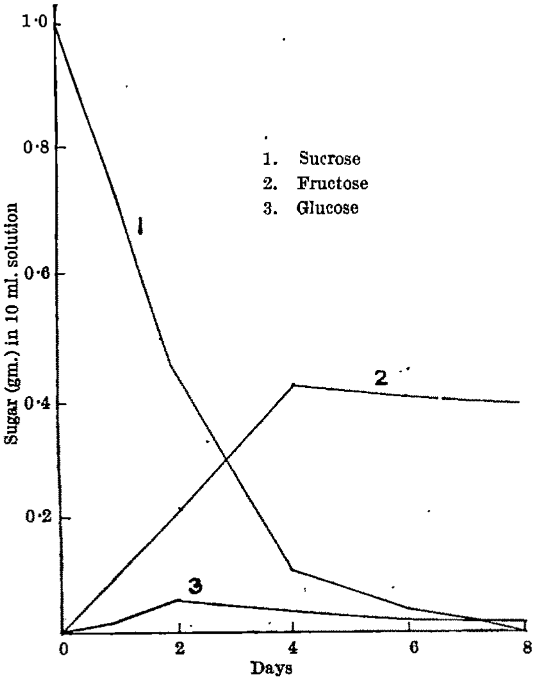

Fig. 1

glucose, fructose and sucrose present in the culture. Instead of using an internal standard[3] which might interfere with bacterial growth, an equal volume (15 µl.) measured by weighing was spotted from the culture on to a paper strip, using a flame-sterilized platinum loop for each spot. Sucrose can be detected on the paper with resorcinol[2] and estimated in the usual manner[3] after a preliminary hydrolysis with dilute oxalic acid. A check was made with known mixtures of the three sugars and nearly quantitative recovery was obtained. The results are plotted on the accompanying graph (Fig. 1) and a photograph is shown (Fig. 2) of a chromatogram obtained after two days growth. It is apparent that glucose as well as fructose is produced, although to a lesser degree. This experiment has been repeated several times with the same general result.

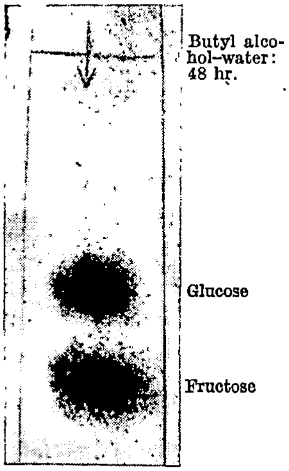

Fig. 2

We shall shortly be preparing a report of the method and further applications for publication in greater detail elsewhere.

W. G. C. FORSYTH
D. M. WEBLEY

Macaulay Institute for Soil Research,
Craigiebuckler, Aberdeen. April 12.

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[1] Partridge, S. M., *Nature*, **158**, 270 (1946).
[2] Forsyth, W. G. C., *Nature*, **161**, 239 (1948).
[3] Flood, A. E., Hirst, E. L., and Jones, J. K. N., *Nature*, **160**, 86 (1947).
[4] Tarr, A., and Hibbert, H., *Can. J. Res.*, **5**, 414 (1931).
[5] Cooper, E., and Preston, J., *Biochem. J.*, **30**, 1001 (1936).
[6] Hehre, E., and Sugg, G., *J. Exp. Med.*, **75**, 339 (1942).

Voltage Effects in Titanate Polycrystals

TITANATES of the perovskite type, such as the barium compound, possess ferro-electric properties at temperatures up to the Curie point, at which a λ-transition from a distorted to a cubic crystal structure takes place. Materials of this type possess high permittivities rising to a maximum in the temperature region of the transition. Beyond the Curie point, the relation between polarization and the applied field becomes linear; the ferro-electric influence, however, continues to make itself felt within a temperature region extending well above the Curie point.

In a previous communication[1], we described the variations in permittivity with time observed after the application of a unidirectional electric field to materials of this type. At temperatures below the Curie point, the permittivity was larger shortly after applying a strong D.C. field, and reverted at a decreasing rate to its initial value, within periods exceeding in some cases 30 min. Beyond the Curie point the permittivity had at first a reduced value and again reverted slowly to its original magnitude.

The permittivity of compounds of this type, measured with a small alternating field, is known to be decreased while a strong unidirectional tension is superimposed, at temperatures below as well as above the Curie point[2-4]. As no information appeared to be available on the variations of the permittivity during the application of a polarizing field, it was considered of interest to determine the curves relating the permittivity measured while a D.C. field (3,300 V./cm.) was superimposed to the time of application. At temperatures below the Curie point the permittivity was found to have an increased value on applying the field, and to fall at a decreasing rate to a steady value below that of the initial permittivity. Beyond the Curie point the permittivity decreased immediately and approached again slowly a final lower value.

It appears that the following mechanism may be responsible for the various effects observed. On the application of the field, oriented regions in the material grow at the expense of others, and owing to these changes anisotropic stresses[5] are produced on the crystallites, resulting in the displacement of the Curie point to a lower temperature. In the case of the tetragonal structure, for example, compressive forces in a direction parallel to the *c*-axis may predominate over those along the *a*-axis. At the same time, the maximum in the permittivity – temperature curve will be depressed progressively to lower values of the permittivity, owing to the increasing polarization in the material. On removal of the field, molecules added to the oriented regions revert again to their initial state, and the permittivity – temperature curve assumes its original position. Changes in the volume of the oriented regions, while rapid immediately on applying or removing the field, may continue to take place for comparatively long periods of time. The various effects observed can hence be explained by the depression of the permittivity – temperature curve, accompanied by the slight lowering of the Curie point, on the application of the field.

A similar explanation for the effects observed by us has been suggested by Szigeti[6]. According to this, the changes in the permittivity are due to a displacement of the permittivity – temperature curve by the external field, in a direction parallel to the temperature axis. It is suggested that the permittivity maximum is shifted to a lower temperature, retaining its original magnitude. This explanation, however, would be insufficient to account for the prolonged residual effects observed, if the depression in the permittivity – temperature curve is not taken into account, and without the assumption of a mechanism for the displacement of the Curie point, such as that suggested above.

It is interesting to note in this connexion that the permittivity maximum in this type of material has been reported to occur at lower temperatures in the case of strong A.C. measuring fields than at lower field strengths[7], and the explanation suggested for the residual effects is consistent also with this result.

We wish to thank the United Insulator Co., Ltd., Surbiton, for generously giving us facilities in its research laboratory during part of this investigation. We are greatly indebted also to Dr. B. Szigeti for helpful suggestions.

J. R. PARTINGTON
G. V. PLANER
I. I. BOSWELL
Chemistry Department, Queen Mary College,
University of London. April 6.

[1] Partington, Planer and Boswell, *Nature*, 160, 877 (1947).

[2] Roberts, *Phys. Rev.*, 71, 890 (1947).

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Chromatography of Dinitrophenyl Amino-acids and Peptides

SANGER[1] has described the use of 1 : 2 : 4-fluorodinitrobenzene to identify the free amino-groups of several proteins, employing the separation of the N-dinitrophenyl amino-acids on columns of silica gel. We have had only limited success applying this method, owing to variations in different batches of the silica gel, and the difficulty of preparing evenly packed columns, which led to diffuse bands, difficult to separate. Sanger stated that with these derivatives on paper chromatograms[2] long diffuse 'tails' formed, making the method quite inferior to the silica method. We are able to report some success with the two-dimensional method, however, without apparently using any special technique which might account for the improvement. Consden *et al.*[3] have also recently described the identification of α-δ-di-(dinitrophenyl)-ornithine running alone on a paper chromatogram, and Keston *et al.*[4] using the p-I^{131}-benzenesulphonyl derivatives of amino-acids have been able to estimate them after their partial separation on a one-dimensional paper strip.

We have tried a wide range of alcohols, phenols, amines, esters, ketones and hydrocarbons, all saturated with water, but with most of these 'tailing' was marked. Best results were obtained with n-butanol, phenol, collidine and n-butanol-acetic acid mixture, each saturated with water. The solution is applied in the usual manner to No. 1 or No. 4 Whatman paper and neutralized with ammonia vapour before the run. No solvent has so far been found which will satisfactorily resolve the group of dinitrophenyl amino-acids, containing large non-polar side-chains; for example, N-dinitrophenyl-leucine, N-dinitrophenyl-phenylalanine, αε-di-(dinitrophenyl)-lysine, etc., as the addition of the large dinitrophenyl-group still further diminishes the differences between these amino-acids. However, provided that only a few of this group are present, identification by running with the added authentic derivative is possible. 5 μgm. of a dinitrophenyl acid will give a good spot on a one-dimensional strip, but 20 μgm. may be required on a two-dimensional sheet, as the yellow colour becomes difficult to see after two traverses. Ultra-violet examination[5] shows the spots as pale yellow when weak, and as obscuring dark patches in larger quantities. There is no actual fluorescence.

Some months ago, Sanger (private communication) reported that he had separated some dinitrophenyl peptides on silica columns in a similar manner to his dinitrophenyl amino-acid separations. We find that if the hydrolysis of the dinitrophenyl peptide or protein is incomplete, extra yellow spots appear, which do not correspond to the position of the dinitrophenyl amino-acids. Further hydrolysis of such materials after elution has shown them to have been dinitrophenyl peptides, of size up to heptapeptides. This good spot formation with heavy materials extends to those of very large molecular weight. For example, the dinitrophenyl derivative of the 'protein' part of insulin of molecular weight 5,000 left after chymotryptic digestion[6] (before addition of dinitrophenyl groups) runs in phenol-water as a good spot with R_F 0·56. This material and also the mixture of relatively small peptides (average, pentapeptide) from the insulin digest, before treatment with fluorodinitrobenzene, either gave no bands on paper chromatograms in the case of the heavy insulin 'core', or a diffuse overlapping mixture of bands in the case of the peptide mixture.

D. M. P. PHILLIPS
J. M. L. STEPHEN
Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.
March 22.

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Influence of Hydrogen Ions and Neutral Salts upon the Hydration of Interstitial Connective Tissue

WHEN a piece of interstitial connective tissue covering the thigh muscles of a rat was placed in water adjusted to pH 4·5, within a few hours it became opaque, white and shrunken. On the other hand, a piece treated at pH 11·0 became translucent, grey and swollen. These changes were mutually reversible and could be repeated several times. Observations with the dark-ground microscope showed that this swelling was not due to any change in the collagen fibrils but to a widening of the spaces between them; shrinkage was accompanied by an obliteration of such spaces and by a condensation and crimping of the collagen bundles.

Clearly, an explanation of these changes must involve a consideration of the nature of the substance which lies between the collagen fibrils. Flemming[2] described a substance in this situation which, on account of its property of contraction in weak acids, he referred to as the cementing substance. He considered the substance to be a mucin. Recently[1], I have shown that its chief characteristics are those of a protein. Following what has been said above, it should be added that this protein reacts strongly with water.

According to modern theory[3,4], the degree of hydration of a protein at different concentrations of hydrogen ions will depend upon the ionization of the NH_3^+ and COO^- radicals of the side-chains. Near the iso-electric point, a maximal number of the side-chains will be oppositely charged. The attraction of opposite charges will bring the side-chains together and result in a more compact structure with exclusion of water. On the alkaline side of the iso-electric point there will be suppression of charge on the cationic centres of the protein. A large proportion of side-chains will therefore come to possess the same negative charge and their mutual repulsion will open up the structure and lead to swelling. Theoretically, therefore, the properties of connective tissue described above are those of a protein having an iso-electric point in the region of *p*H 4·5.

Schade and Menschel[5] have shown that neutral salts may cause swelling of connective tissue. I have found that this effect is morphologically identical with that which occurs in conditions of reduced hydrogen ion concentration, and also that the reaction involved has the following features: (1) At neutrality the smallest concentrations of various salts necessary to cause swelling lie between $M/5$ and $M/20$. (2) While swelling, the tissue withdraws salt ions from the surrounding solution. (3) The capacity of a salt to cause swelling is greater with reduction of hydrogen ion concentration from the iso-electric point. (4) Although, in general, the actions of salts and hydrogen ions on the hydration of connective tissue are opposite and reversible, salts have no capacity to 'unlock' tissue which has become shrunken by prolonged treatment at a *p*H value near the iso-electric point.

It is clear that the hydration of connective tissue by the action of neutral salts is accompanied by some sort of union of salt with the protein. Probably the salt ions combine in some manner with protein side-chains. To do so, such side-chains must be available and not involved in electrovalent links with oppositely charged side-chains. Perhaps this is why salt has only a feeble 'unlocking' effect on tissue constricted by treatment near the iso-electric point of the interfibrillary protein, and also why, with decrease in hydrogen ion concentration away from this iso-electric point, the hydrating effect of the salt is so much greater.

It is apparent that salts exert a hydrating influence on connective tissue in physiological concentrations. This fact alone must be a matter of considerable importance not only to biological science but also to clinical medicine.

T. D. DAY

Department of Pathology,
St. Thomas's Hospital Medical School,
London, S.E.1.
March 21.

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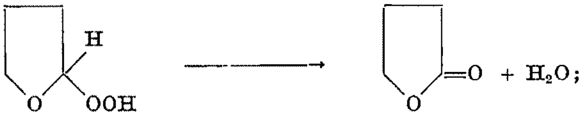
Tetrahydrofuran Hydroperoxide

A STUDY has recently been made in these laboratories of the liquid-phase oxidation of ethers. The products of oxidation may be satisfactorily accounted for by the formation of an intermediate hydroperoxide and its subsequent decomposition. As with the hydroperoxides of hydrocarbons, those of ethers are apparently often too unstable for isolation; but in the case of tetrahydrofuran the hydroperoxide has been isolated in the pure state.

The hydroperoxide obtained by the removal of unchanged tetrahydrofuran at low pressure from a sample which had undergone oxidation by prolonged exposure to air during storage was a liquid ($n_D^{20°}$ 1·6933) at room temperature. The product gave on analysis C 46·0, H 7·9 per cent (required, C 46·1, H 7·7 per cent) and liberated the theoretical quantity of iodine from acidified potassium iodide. The hydroperoxide was completely miscible with water and soluble in the common organic solvents (acetone, methanol, acetic acid), and strongly catalysed the polymerization of styrene and methyl methacrylate. The onset of thermal decomposition occurred in the range 70–80° C., and rapid heating to 100° C. did not cause detonation, though the decomposition became more violent at still higher temperatures. The normal reagents for the destruction of peroxides (ferrous sulphate, sodium hydroxide, etc.) were equally efficacious in the case of tetrahydrofuran hydroperoxide, the chief product of both the thermal and catalysed decompositions being γ-butyrolactone. The formation of γ-butyrolactone may be accounted for by loss of water:



though the fact that tetrahydrofuran hydroperoxide is a polymerization catalyst indicates that some homolytic decomposition also occurs, probably by fission of the O—O bond.

A complete account of this work will be published elsewhere.

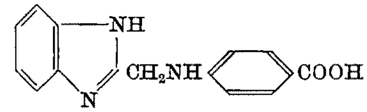
A. ROBERTSON

Imperial Chemical Industries, Ltd.,
Billingham Division,
Billingham, Co. Durham.
March 17.

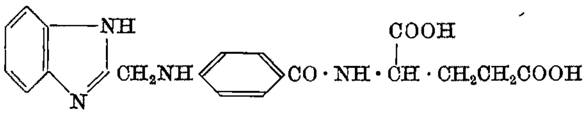
Benziminazole Analogues of Pteroic and Pteroylglutamic Acids

IN the course of experiments on the relationship of structure to biological activity in the folic acid series of growth factors, we have examined the benziminazole analogues of pteroic acid and of pteroylglutamic acid[1].

The compound (I), m.p. 281° (decomp.), in which the 2-amino-4-hydroxypteridyl residue (numbering according to the "Ring Index", Reinhold, New York, 1940) of pteroic acid is replaced by a benziminazole ring, was prepared from 2-chloromethylbenziminazole[2] and *p*-aminobenzoic acid in boiling alcohol, or *via* its ethyl ester, from ethyl *p*-aminobenzoate (found: C, 66·8; H, 4·7; $C_{15}H_{13}O_2N_3$ requires C, 67·4; H, 4·7 per cent). The benziminazole analogue of pteroylglutamic acid was obtained as a



I



II

diethyl ester (m.p. 125°) by the condensation under similar conditions of 2-chloromethylbenziminazole and ethyl *p*-aminobenzoyl-*L*-glutamate (III). Hydrolysis with cold aqueous alcoholic sodium hydroxide gave the required acid (II), isolated as a hydrochloride, m.p. 201° (found after drying at 100° in a vacuum: C, 55·6; H, 4·7; N, 12·6; Cl, 8·1; $C_{20}H_{20}O_5N_4$,HCl requires C, 55·5; H, 4·9; N, 12·9; Cl, 8·2 per cent).

The *p*-aminobenzoylglutamic ester (III) is conveniently prepared by refluxing a solution of *p*-nitrobenzoyl chloride in benzene with ethyl glutamate hydrochloride, followed by catalytic reduction of the product. The *p*-aminobenzoylglutamic acid obtained by hydrolysis of (III) has m.p. 167° and in *N* sodium hydroxide solution, $[\alpha]_D^{22°} = +29{\cdot}2°$, comparable with the recorded value for the *D*-isomer of $[\alpha]_D = -27{\cdot}4°$ [3]. Published accounts[4] of the preparation of *p*-nitrobenzoylglutamic acid from glutamic acid recommend the use of excess *p*-nitrobenzoyl chloride. We have found that by the simultaneous addition of the acid chloride (1 mol.) dissolved in dioxane and of an equivalent of 2*N* sodium hydroxide to a solution of glutamic acid (1 mol.) in its equivalent of *N* alkali, *p*-nitrobenzoylglutamic acid of m.p. 114–116° and $[\alpha]_D^{19°} = +16{\cdot}9°$ can be obtained in 70–80 per cent yield[5]. A full description of these experiments will be published in due course.

It has recently been found by Edwards, Starling, Mattocks and Skipper[6] that the benziminazole (II) replaces 'folic acid' as a growth factor for *Strep. fœcalis* R. (though at much higher concentrations), and also stimulates growth in presence of sub-optimal concentrations of folic acid. Similar experiments by us have, however, given different results. For *Strep. fœcalis* R., grown in the improved medium of Rabinowicz and Snell[7], modified by the omission of glycine and asparagine and by the inclusion of pyridoxin (100 μgm./l.), adenine and guanine (each 5 mgm./l.), the benziminazole (II) (10^{-9} to 10^{-3} *M*) did not replace pteroylglutamic acid. Growth was measured turbidimetrically after 20 hr. incubation at 37°. Nor was the organism stimulated in the presence of sub-optimal amounts of pteroylglutamic acid, but, on the contrary, under the latter conditions, growth was inhibited, although this inhibition was not observed when pteroylglutamic acid was added in amounts which afforded optimal growth in the absence of (II). Tests made with *Lactobacillus casei*, using the medium of Roberts and Snell[8] and estimating growth turbidimetrically after incubation for 22 hr. at 37° in an atmosphere of 95 per cent hydrogen, 5 per cent carbon dioxide, gave essentially the same results.

INHIBITION OF GROWTH OF *Strep. fœcalis* R. BY THE BENZIMINAZOLE (II) IN PRESENCE OF PTEROYLGLUTAMIC ACID

Pteroylglutamic acid (molar conc.)	Benziminazole (II) (molar conc.)	Absorptiometer reading*
0	10^{-3} to 10^{-9}	0·00
10^{-9}	0	0·44
,,	10^{-7}	0·43
,,	10^{-5}	0·37
,,	10^{-3}	0·28
2×10^{-9}	0	1·05
,,	10^{-4}	0·82
,,	10^{-3}	0·52
$1{\cdot}6 \times 10^{-8}$	0	1·57
,,	5×10^{-4}	1·50

* Averages of quadruplicate tubes after incubation for 20 hr.

It is possible that the discrepancy between our results and those of Edwards *et al.* may be due to variations in the respective media. It is noteworthy that the medium used by the American experimenters gave measurable growth for *Strep. fœcalis* R. in the absence of added folic acid. Unlike that described by Edwards *et al.*, which was acetate buffered and contained adenine, guanine, xanthine and uracil, the medium we have employed was buffered with citrate and contained neither xanthine nor uracil. In the light of recent work in this field[9], differences in the pyrimidine-purine content of the two media may well be significant.

The simple benziminazole (I) also, when tested with *Strep. fœcalis* R., was found to be inhibitory, though less so than compound (II), and was inactive as a substitute for pteroylglutamic acid.

F. E. KING
P. C. SPENSLEY
Dyson Perrins Laboratory,
R. H. NIMMO-SMITH
Department of Biochemistry,
University of Oxford.
April 3.

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[1] Angier *et al.*, *Science*, **103**, 667 (1946); *J. Amer. Chem. Soc.*, **70**, 14 (1948).

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[5] Cf. Steiger, *J. Org. Chem.*, **9**, 396 (1944).

[6] *Science*, **107**, 119 (1948).

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[8] *J. Biol. Chem.*, **163**, 499 (1946).

[9] Rogers and Shrive, *J. Biol. Chem.*, **172**, 751 (1948).

The Sommelet Reaction

IN a communication under this heading in *Nature* of May 8, p. 723, Messrs. Anyal and Rassach refer to a paper by Graymore and Davies[1], in which it was shown that a mixture of benzylamine and formaldehyde gives benzaldehyde in good yield on heating in solution with hexamine. They say that, contrary to Graymore and Davies' findings, benzaldehyde can be obtained from benzylamine hydrochloride in the absence of hexamine. In a later paper by Graymore[2], it is shown that hexamine may be dispensed with, and benzaldehyde produced by heating methylene benzylamine (or, for that matter, a mixture of benzylamine and formaldehyde) with two-thirds of the quantity of hydrochloric acid, as required by the equation:

$$(C_6H_5CH_2.N{:}CH_2)_2 + 2HCl = 2C_6H_5.CH_2.N{:}CH_2,HCl.$$

It was hoped to obtain benzylidene methylamine from methylene benzylamine, but the attempt failed, the experiment resulting in the formation of benzaldehyde, methyl benzylamine and dimethyl benzylamine. Work is, however, still proceeding in this field.

JOHN GRAYMORE
Plymouth and Devonport Technical College.
June 29.

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[1] Graymore, J., and Davies, D. R., *J. Chem. Soc.*, 293 (1945).

[2] Graymore, J., *J. Chem. Soc.*, 1116 (1947).

BIOGENESIS OF THE STRYCHNOS ALKALOIDS

By Prof. R. B. WOODWARD

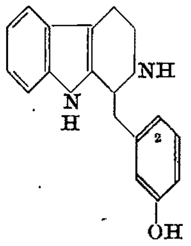
Converse Memorial Laboratory, Harvard University

ROBINSON[1] and Schöpf[2] have developed with conspicuous success the concept that a fundamental reaction of biogenesis involves the condensation between an amino (or imino) group, a carbonyl group and an anionoid centre:

$$-\overset{|}{\underset{|}{C}}{}^{\ominus} + \overset{|}{\underset{|}{C}}=O + H\overset{|}{N}- \xrightarrow{H^+} -\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{N}- + H_2O$$

Type *A* reaction

In a particular application of this idea, Hahn[3] has suggested that in the biogenesis of the alkaloids of the yohimbé group, tryptamine, from tryptophane, and 3-hydroxyphenylacetaldehyde (or an equivalent), from 3-hydroxyphenylalanine, condense by reaction (*A*) to give (I), and that from (I), by another reaction of type *A*, involving in this case formaldehyde (*or* an equivalent), N^b and the anionoid 2-position of the aromatic nucleus, (II) is produced. The latter contains the complete ring skeleton of yohimbine (III); the further changes necessary for the elaboration of (II) into (III) would not be unusual, and the various possibilities need not be discussed here.



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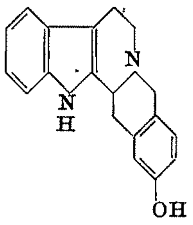
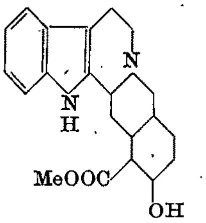
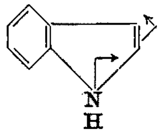


II

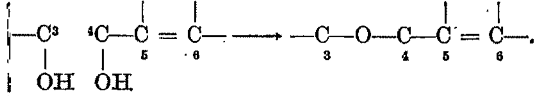


III

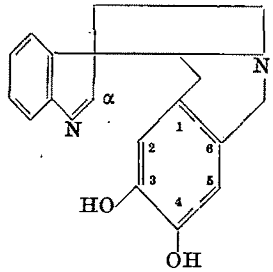


IV

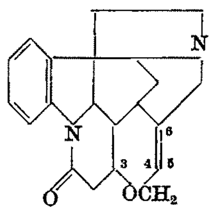
It is well known that the indole ring possesses anionoid reactivity at the β- as well as at the α-position, in consequence of the availability of electrons through the process shown in (IV, arrows). Consequently it is of interest to inquire as to the course of the reactions outlined above if condensation were to occur at the β- rather than the α-position. It is clear that, in this case, if 3,4-dihydroxyphenylalanine be considered the precursor, the product corresponding to (II) will be (V). It will be seen at once that the expression (V) contains striking similarities to many of the features of the strychnine molecule (VI). Moreover, the further elaboration of (V) in the direction of (VI) would involve for the most part relatively simple changes. Thus, since $-CH=N-$ is equivalent to $-CHO\ NH_2-$, the opportunity is present in (V) for a further reaction of type *A*, leading to the establishment of a new bond, as required, between the α-position of the indolenine nucleus and the anionoid 2-position of the carbocyclic ring. Steric considerations might bar this reaction in this simplest form, since the product, (VII), contains a double bond in an unusual position. On the other hand, it has been shown recently[4] that the *meta* positions of an aromatic nucleus can be bridged by a chain of five atoms, and, in any event, the reaction could lead to an unstrained tautomer of (VII), for example, (VIII); or alternatively, the condensation could occur at a later stage, since in the subsequent stages C_3 is likely still to bear the oxygenated substituent necessary for the conference of anionoid properties on C_2. Further, the (presumably, but not necessarily, oxidative) breaking of the carbocyclic ring (of V, VII *or* VIII) between the hydroxyl-bearing atoms C_3 and C_4 gives at once the system necessary for the formation of the seven-membered ether ring of (VI), namely,



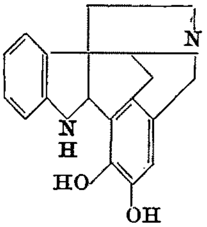
$$-\underset{OH}{\underset{|}{C^3}}\quad {}^4\underset{OH}{\underset{|}{\overset{|}{C}}}-\underset{5}{\overset{|}{C}}=\underset{6}{C}- \longrightarrow -\underset{3}{C}-O-\underset{4}{C}-\underset{5}{\overset{|}{C}}=\underset{6}{\overset{|}{C}}-.$$



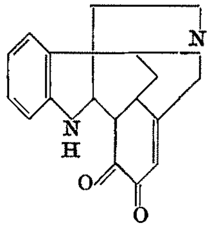
V



VI



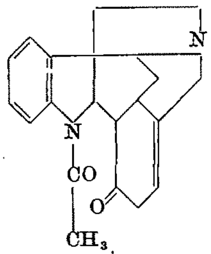
VII



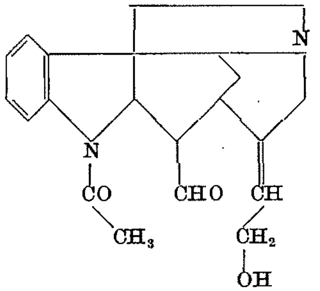
VIII

Apart from changes in the oxidation state of the molecule, the only further modification necessary for the construction of (VI) involves the interpolation of the two carbon atoms necessary for the completion of the lactam ring of (VI). It must be admitted that, at present, this part of the scheme appears to possess unusual features, and a detailed discussion of the various possibilities is scarcely justifiable. On the other hand, it may be noted that the acetylation of N^a (*cf.* aspidospermine, which may well contain a similarly situated N-acetyl group, and colchicine, as an example of the occurrence of acetylation in the biosynthesis of alkaloids), followed by condensation between an oxygenated cationoid function at C_3 and the reactive methyl group of $-\overset{|}{\underset{|}{N}}COCH_3$, would lead to a six-membered lactam ring.

Clearly the scheme as a whole is a flexible one, and many specific variants might be considered. If, for example, the intermediate (IX) were reached, through the initial participation of 3-hydroxyphenylalanine, as assumed by Hahn in the case of the yohimbé alkaloids, or through reductive processes from (VII)



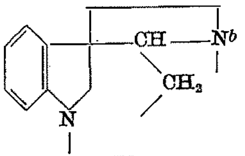
IX



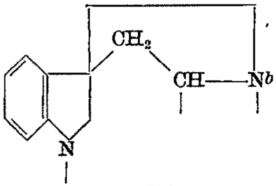
X

or (VIII), the opportunity exists for a variant of the well-known photolytic cleavage[5] of cyclic ketones, leading to (X); the conversion of (X) to strychnine itself (VI) would involve simply a single further reaction of type *A*, in which —OH replaces —NH_2. Further, it should be pointed out that the order of the stages indicated should not be considered fixed. Thus, the aldehyde component might enter the scheme after some modification of the carbocyclic ring has already occurred. For example, the condensation of tryptamine, a formaldehyde equivalent, and a *dihydro-derivative* of 3-hydroxyphenylacetaldehyde could lead directly, by the reactions indicated above, to (IX) (acetyl group missing). Finally, the possibility may be kept in mind that preliminary oxidation of the indole nucleus at the α-position might serve to force the initial condensation exclusively into the β-position.

On the whole, the possibility of building up so complicated a structure as (VI) by a series of simple reactions from plausible starting materials is so striking that it is difficult to believe that the scheme lacks significance. It is worthy of note that biogenetic considerations of this kind several years ago led us to consider that the environment of N^b in the strychnine molecule was that shown in the part structure (XI) rather than that (*cf.* XII) accepted at that time[6]. We felt, however, that in view of the relatively undeveloped state of knowledge in the field of biogenesis, the proposal of these considerations as a possible biogenetic scheme should follow rather than precede the definite chemical proof of the primary consequences of its acceptance. Since this proof has recently been brought to a successful conclusion in our Laboratory[7], our confidence in the scheme is sufficient to bring us to suggest that other alkaloids will be found which owe their genesis to less, or more, complicated variants of the same process, and investigations in this direction are already in progress.



XI



XII

SIR ROBERT ROBINSON writes:

When in New York in early 1947, I learned from Dr. Woodward that he had developed a scheme of biogenetic relations between strychnine and yohimbine. The details now available follow well-trodden paths in most respects; for example, the β-condensation would be included in any such hypothesis. The suggested fission of a benzene nucleus is, however, highly original. This daring speculation must be judged at this stage by 'the degree of coincidence' which called for it.

In the thirty years that have elapsed since my first paper on these topics, considerations of this kind have been constantly in mind and conclusions have been reviewed and modified when necessary. I therefore feel justified in stating that in my opinion Woodward's theory is probably correct in essentials. May I also venture to deprecate in advance a flood of further speculation on similar lines, unless it is supported by a comparable 'degree of coincidence'. It is obvious that by chopping up benzene rings and recombining the fragments, almost any kind of structure can be obtained.

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[1] Robinson, *J. Chem. Soc.*, **111**, 876 (1917).

[2] Schöpf, *Z. angew. Chem.*, **50**, 787, 797 (1937).

[3] Hahn and Ludewig, *Ber.*, **67**, 2031 (1934). Hahn and Werner, *Ann.*, **520**, 123 (1935). Hahn and Hansel, *Ber.*, **71**, 2192 (1938).

[4] Prelog and Wiesner, *Helv. Chim. Acta*, **30**, 1465 (1947).

[5] Ciamician and Silber, *Ber.*, **41**, 1071, 1928 (1908); **43**, 3140 (1910); **46**, 3077 (1913).

[6] Holmes and Robinson, *J. Chem. Soc.*, 603 (1939).

[7] Woodward, Brehm and Nelson, *J. Amer. Chem. Soc.*, **69**, 2250 (1947).

INTERNATIONAL CONGRESS ON ANALYTICAL CHEMISTRY

AN International Congress on Analytical Chemistry, organised under the auspices of the Netherlands Chemical Society, was held at Utrecht during June 1–3. The president of the Congress was Prof. C. J. van Nieuwenburg, of Delft Technical University, and the general secretary, Dr. H. A. J. Pieters, of the Central Laboratory of the Netherlands State Mines. The Congress was divided into five sections dealing with: (I) general methods and standardization, (II) electrical methods, (III) emission spectrography, (IV) optical measurements and physical methods of separation, (V) microbiological methods and detection of traces. The proceedings consisted of thirteen formal lectures and the reading of forty-five original papers. Full-length pre-prints of the papers had been distributed before the Congress, so that after a short summary by each author most of the time was available for discussion. The proceedings were conducted in English, with French as the second language. The lectures and papers contributed to Sections I, II, IV, and V will be published in a special number of *Analytica Chimica Acta*, and those to Section III in *Spectrochimica Acta*.

The Congress was attended by about forty British analysts and by representatives from Belgium, Czechoslovakia, Denmark, France, Switzerland, and Sweden. Papers were also contributed from the United States. Holland was represented by more than two hundred and fifty chemists and physicists.

Visitors to the Congress could not be unimpressed by the great changes that analytical chemistry has undergone in recent years. Because of the demand for greater speed and accuracy and because of the need for handling much smaller quantities of material, the old classical methods based on gravimetric and volumetric procedures are being replaced by physico-chemical techniques. As a result of this development, the status of analytical chemistry is being raised to a much higher level, and analytical chemistry is becoming a science for the specialist.

Modern analysis, with its interests in optical, electrical and microbiological techniques, makes very great demands on the training of its practitioners, and it was emphasized by speakers from several countries that the training of analytical chemists lags a long way behind the requirements of modern industry.

Prof. van Nieuwenburg, in his opening address to the Congress, remarked that most of the developments in modern analytical chemistry had originated in the requirements of industry, and pointed out that this was borne out by the type of papers contributed to the Congress. He commented on the high cost of modern analytical equipment and said that much of it could only be purchased by the larger industrial laboratories; even these have to make a selection from the wide range of available instruments. An opportunity for the exchange of experiences gained in different laboratories with these modern techniques, such as was offered by the Congress, was most useful, and the dissemination of information in this way might lead to a saving of both time and money that might have been spent on inappropriate or useless equipment.

Most of the lectures and papers dealt with problems arising directly from the demands of industry. Dr. E. C. Wood, in his lecture on statistical aspects of chemical analysis to Section I, discussed the methods of sampling which enable the information sought by the analyst to be obtained as economically as possible. He stressed the need for proper randomization both in sampling and in performing analyses, and gave a short account of the use of 'quality control' charts in analytical work. He directed attention to the possibility of estimating the standard error from the range and described a method for extracting the maximum information from analytical investigations involving the estimation of a ratio. The advantages of the 'factorial' as opposed to the 'classical' type of experimental design was demonstrated and reference made to the value of carrying out an analysis of variance when examining the experimental data. Mr. W. J. Gooderham described and demonstrated his soap-film apparatus for the continuous analysis of coal gas.

Prof. E. Leclerc lectured to Section II on electrical methods of analysis. After reviewing the available methods and discussing their speed and accuracy, he described their applications in the Belgian metallurgical and petroleum industries. Prof. C. Duval spoke on automatic gravimetric analysis in inorganic chemistry and described some new polarographic procedures. Mr. E. Loeuille (Section III) discussed the possibilities and limitations of quantitative spectrographic analysis.

The lectures to Section IV were given by Prof. G. Duykaerts and by Dr. T. I. Williams on absorptiometric methods in chemical analysis and on chromatography respectively. Dr. Williams dealt with partition chromatography, the chromatography of inorganic substances, and the theory of chromatography. He described how the urgency of the Plutonium Project had stimulated work on the theory of chromatography. Dr. W. F. J. Cuthbertson lectured to Section V on recent developments in microbiological assay. He described the different techniques by which micro-organisms may be used for the assay of vitamins and amino-acids, and indicated possible future developments. Prof. A. G. Bertrand spoke on the determination of trace elements in plants and animals.

Dr. H. W. Thompson addressed the final session of the Congress on methods based upon infra-red and ultra-violet measurements. He reviewed the war-time achievements of infra-red analysis in the petroleum field and gave a critical survey of the available commercial instruments. Prof. P. E. Wenger summed up at the conclusion of the Congress.

A high scientific standard was maintained throughout the Congress, which was held in the pleasant rooms of the Esplanade, Utrecht's modern theatre. The Dutch organisers are to be heartily congratulated on the excellent way in which the Congress was arranged.

METABOLIC ASPECTS OF CONVALESCENCE*

THE fifteenth meeting of the Conference on Metabolic Aspects of Convalescence was once again one which devoted the greater part of its deliberations to one particular topic; on this occasion the subject was "Isotopes".

Put together in printed form, the discussions make an extremely useful review of the rapidly widening application of this comparatively new technique for the study of biological problems. Already we have been forced to revise many of our long-held beliefs regarding the nature of the metabolic processes of the body. Interpretations which provided plausible explanations of previously recorded data no longer suffice. As one member of the Conference put it, "The availability of these materials [isotopes] as tools for biological experimentation will have as profound and stimulating an effect on biological and medical science as did the discovery of the microscope". Work already completed suggests that this remark is no exaggeration.

As with all newly developed techniques, however, there are pitfalls for the unwary. In this instance, in addition to the usual initial difficulties of use and interpretation, there is the physical danger of radiation injury to the workers and assistants in the laboratories concerned. Since the hazard is an invisible one, the victim remains unaware of his injury until material damage has been done. With the present rapidity of spread in the use of radioactive materials it is inevitable that they should sometimes be handled by individuals unaware of the danger, and the part of the Conference report which deals with the diagnosis of early radiation injury and the precautions that should be taken to prevent tissue damage should be carefully studied. A statement from the National Cancer Institute is included which says, *inter alia*, "It must be emphasised that the absorption of radiation is always connected with damage, no matter how small the dose. It must also be emphasised that radiation effect may be cumulative." This places a heavy responsibility on the directors of laboratories in which work of this nature is in progress. There must be no repetition of the sufferings of the early radiologists.

In addition to the discussion of these practical issues, there are detailed considerations on the measurement of isotopes, on the synthesis of labelled compounds, and on their use in clinical investigations and in the treatment of disease.

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* Conference on Metabolic Aspects of Convalescence. Transactions of the Fifteenth Meeting, New York, 31st March, 1947. Pp. 163. (Josiah Macy, Jr. Foundation, 565 Park Avenue, New York 21.) 2.25 dollars.

In all these the reader has the advantage—inherent in the form in which these transactions are published—of not only learning what an experimenter has to say about his work, but, in addition, seeing the comments it elicited from other keenly interested participants. The question and answer, and the pooling together of small observations which, in isolation, might seem unimportant or meaningless, encourage a clarification and building up of ideas. The contrasting styles of the different contributors also make the reading of these publications much more enjoyable than the reading of some technical journals in which the papers have been so zealously 'edited' that all trace of individual style of expression has disappeared.

The remaining topics discussed at this fifteenth meeting were mostly concerned with hormone studies, and several of the papers consisted in the presentation of further data from work which had already been reported at earlier meetings. The interdependence of the multifarious metabolic activities which take place in the human body and the consequent folly of trying to interpret any one in isolation become more and more evident as each set of these transactions is put together.

M. W. GRANT

MECHANICAL FOAM FOR FIGHTING PETROL FIRES

FOAM for dealing with petrol fires can be generated in two ways: by chemical reaction (chemical foam), or by mechanical agitation (mechanical or air foam). Mechanical foam is largely used in Great Britain and is produced by churning up air and water with a foam-stabilizing agent, such as saponin or soap. The foam-making branch pipe is the apparatus in general use by fire services.

The use of foam appears to have been originally suggested by Laurent in 1904. He successfully demonstrated at St. Petersburg the use of chemical foam against burning naphtha. In 1912, the first foam fighting apparatus for fire-brigade use was introduced into Britain. By 1939, one or two efficient foam compounds were available; but they were both expensive and made from imported materials. With the outbreak of hostilities there came the probability of a large increase in the incidence of petrol fires and also the danger of a shortage of raw materials. Consequently, at the request of the Ministry of Home Security, Research and Experiments Department, an investigation into the whole problem of suitable foaming agents for combating fires of inflammable liquids was undertaken at the Chemical Research Laboratory of the Department of Scientific and Industrial Research. The experimental team was under the leadership of Dr. N. O. Clark, who is the author of Chemical Research Report No. 6: "A Study of Mechanically Produced Foam for Combating Petrol Fires" (London: H.M. Stationery Office. 2*s*. 6*d*. net), in which full details of the problem, the course of the researches and the results obtained are given.

Large-scale methods were developed which permitted a quantitative estimation of the value of foam as a fire-fighting agent, and also a laboratory technique was devised for the investigation of the physical properties of foam. The nature and properties of suitable foaming agents, such as chemically broken down hoof and horn meal, or glue mixed with materials similar to soapless shampoos or chemically treated blood, were elucidated. The us of chemically treated blood—a waste material from abattoirs—as a foaming agent was discovered by the research team. This new compound had the additional advantage of a much lower viscosity than other types and so could be used without modification in R.A.F. crash tenders. It produces a high-efficiency foam for combating aircraft fires, and during the Wa production was devoted entirely to this particular type of foam.

On the purely scientific side, quantitative evidence was obtained in favour of Plateau's classical theory of foam stability. It would appear that the expansion property depends on the interfacial tension, air/liquid at the appropriate age of the surface, and the rate of diffusion of the active material into the surface, and is limited by the energy-level of the method of preparation. The hydrolysed proteins are, for example, slow in diffusing into the surface of their solutions. A close relation was shown to exist between the critical shearing stress of a foam prepared from a liquid with appreciable solidity in it surface to that of the corresponding liquid surface.

For the first time, a proper scientific background to the problem has been established, and the 'figure of merit' of foam on a petrol fire can be roughly estimated, but not accurately predicted, from laboratory measurements of the properties of foam, the mos important being heat resistance, expansion, and petrol resistance. There is still need for relating laboratory experimental data with those of large-scale tests.

S. WEINTROUB

LINEN INDUSTRY RESEARCH ASSOCIATION

THE report of the Council of the Linen Industr Research Association, Belfast, for the year ended September 30, 1947, states that the strengthening of the financial position of the Association, which now includes practically all the firms in the industry, has permitted the Council to proceed with the Director' plans for expansion, and the new buildings have been commenced. In addition to the large shed with a floor space of 9,800 sq. ft. for technological researche on line and tow preparing, dry spinning and weaving which forms the main extension, the new plans include the provision of more staff amenities and facilities, extension of the testing-room and furthe space and equipment for research in bleaching dyeing and finishing. Reference is made to th co-operation in research which has already flowe from the liaison service described in the last annua report. Comprehensive surveys of conditions o temperature, humidity and ventilation in wet spinning mills have brought to light many striking anomalies, and have led to suggestions by whic decided improvements can often be introduced ver economically into the working conditions by comparatively simple measures.

Studies in the retting of different types of straw b various methods in the large-scale retting tanks hav continued, and in view of the larger differences i yield caused by variations in weather conditions during field-drying of the retted flax, attention has een focused on treatments to prevent such microiological deterioration. Investigations are being ontinued to improve the efficiency of fibre extraction y turbine scutching machines. An investigation for e Ministry of Supply has shown that the strength f flax yarn depends on the fibre-breaking stress, the neness and the length of the fibre strands in the raw. . study has also been made of the levelness of rayon aple yarn spun on flax machinery, and one comenced on the suitability of flax machinery for pinning wool, alone and mixed with other fibres. he possibilities of automatic winding and weaving e being studied, while research on bleaching and yeing continues to have as its object the developent of existing methods and investigation of new nes to improve the quality of the product. In nishing research, the study of the application of rease-resistant finishes to linen fabrics has figured rominently and the possibility of fixing both nishes and protective agents by chemical combinaon with the cellulose has been examined.

Some six hundred testing reports have been made to embers, and much cloth testing, chiefly the measureent of tearing and tensile strength, has been underaken in connexion with the development of new ypes of flax canvas. Special attention has also been irected to the influence of the micro-structure of ax fibres on the behaviour of flax materials, both uring processing and in service.

EDUCATION IN AND FOR THE SERVICES

ALTHOUGH the education authorities of the three Services—Royal Navy, Army and Royal ir Force—frequently collaborate and meet to pool xperiences and thrash out problems common to all, was probably for the first time that all three met by vitation to present their case and reveal their main bjectives and the problems which they entail to an udience of nothing but civilian educationists on uly 14 at the Conference on "The Education of the oung Worker" organised by the Department of ducation of the University of Oxford and held at anchester College, Oxford, during July 12–17.

The case for the Royal Navy was presented by nstructor-Captain F. C. Sobey, director of studies, M.S. *Kestrel*, Winchester; that for the Army Royal Army Educational Corps) and the Army Cadet orce by Brigadier W. G. Pidsley, deputy director of rmy education, and Brigadier H. Kenyon, deputy irector cadets, respectively; and that for the Royal ir Force by Group-Captain I. B. Hart, deputy irector of education. The meeting was held under he chairmanship of a civilian, Mr. L. J. F. Brimble.

Mr. Brimble emphasized the exceptionally difficult roblems which arise in Service education—problems hich are often not appreciated by its critics. Now hat the Services, particularly the Army, have to eal with National Service entrants, their subjectaterial is not just a cross-section of the public; ndeed, it is almost the entire public at the age of 8–19 plus years. Service intakes at these age-levels nclude all grades of intelligence and all standards of ducational attainment from illiterates up to univerity graduate level. In most areas there are not nough men or women to warrant segregation into roups according to standard of intelligence or achieveent, so that frequently many different grades have to be taken together, though, of course, individual teaching and training are not overlooked. This is, perhaps, the greatest imaginable challenge to the ingenuity of the education officer or instructor. As an illustration, Mr. Brimble described a lecture-discussion which he recently led with Army men of Higher School Certificate standard and upwards, and compared this with a lecture he gave soon afterwards to a group of Army near-illiterates of ages 19–25 years in which only one had ever heard of Faraday and only two of Gladstone. In these two cases, he had his audiences segregated, which made matters much easier than they frequently are in the field.

Group-Captain Hart stated that in the Royal Air Force there are two main educational aims—education for the Service itself and education for the individual. Naturally one aim helps the other, so the distinction between the two is more imaginary than real, and both aims are integrated and correlated wherever possible. Education for the Service is compulsory, whereas that for the individual is mainly voluntary. By and large, the scheme works well in spite of two main difficulties: (1) the peripatetic nature of most Royal Air Force personnel which can frequently upset completely even the best-devised schemes, and (2) the lack of qualified instructors—a lack which is at present common to all educational projects, both Service and civilian.

Brigadier Pidsley gave a very lucid account of the recently planned scheme for the Army which, he emphasized, is still only of an interim nature since the Army itself has still to settle down to a peace-time footing. The Army absorbs the majority of National Service entrants (it is composed roughly of half regulars and half National Service men); but despite the movable nature of Army men and units and the shortage of trained instructors, the scheme, like that of the Royal Air Force, is getting well under way. Just as in the Royal Air Force, units are sent to many parts of the Commonwealth, etc.; but wherever they may be, the presence of the Royal Army Educational Corps is felt. Some units are isolated and there the ingenuity of the instructors is taxed to the limit; other units are near big towns where civilian educational facilities are available to Army men and women. The Army educational scheme is very flexible though it has three broad aims: (1) to make a man a soldier; (2) to train him in good citizenship; and (3) to enable him to develop along the best lines as an individual. Broadly speaking, Brigadier Pidsley claimed that the Army education scheme has got its horse to the water; now it is the job of the Royal Army Educational Corps to see that it drinks.

Speaking for the Army Cadet Corps, Brigadier Kenyon claimed that its educational and training scheme has a real moral purpose behind it and he described various means whereby this purpose is being achieved. The wide variety of interests, both cultural and vocational, inherent in such groups of boys is recognized and catered for so far as is possible. Though religion is recognized and encouraged, politics, and especially party politics, are not. Everything is dealt with on a voluntary basis; nothing is forced upon the boys.

As was clearly stated by Instructor-Captain Sobey in a stimulating yet amusing contribution, the case for the Royal Navy is somewhat different from those of the other two Services. The Navy has few problems arising as a result of the intake of National Service men because that intake is so small—at the rate of about two thousand a year. There is no ship, however, no matter how small or large, and no shore establishment, where there is not at least one well-qualified instructor, and in some ships such as large aircraft carriers and certain shore establishments there are several instructors. Training is, of course, mainly technical; but wider vocational and cultural interests are accepted and encouraged.

It was of interest to note that in all three Services current affairs and citizenship loom large and are compulsory. There are few subjects which appear in a civilian adult education programme which do not appear in the curricula of Service educational schemes. The ultimate aim of linking up and integrating Service education with the national civilian education should in due course be achieved with little or no difficulty.

FORTHCOMING EVENTS

Tuesday, July 27—Friday, July 30

SOCIETY FOR APPLIED BACTERIOLOGY (at Queen's University, Belfast).—Annual General Meeting and Summer Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN THE AGRICULTURAL BOTANY DEPARTMENT, a LECTURER (Grade III) IN DAIRY CHEMISTRY, and an ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (July 31).

LECTURER IN PHYSICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 31).

H.M. INSPECTORS OF FACTORIES—The Secretary, Ministry of Labour and National Service (O.E.11), 80 Pall Mall, London, S.W.1 (July 31).

SENIOR LECTURER IN CHEMISTRY, and ASSISTANT LECTURERS (one primarily in Botany and one primarily in Zoology) IN THE DEPARTMENT OF BIOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (July 31).

LECTURERS IN (*a*) PHYSICS with subsidiary MATHEMATICS, (*b*) ELECTRICAL AND MECHANICAL ENGINEERING—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (July 31).

SECRETARY OF THE DEPARTMENT OF PHYSICS—The Cavendish Professor, Cavendish Laboratory, Cambridge (July 31).

RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING, a RESPONSIBLE LECTURER IN MECHANICAL ENGINEERING, and a RESPONSIBLE LECTURER IN CHEMISTRY—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 31).

ASSISTANT PHYSICIST—The Secretary, Royal Northern Hospital, Holloway, London, N.7 (July 31).

PSYCHOLOGIST—The Secretary, National Hospital for Nervous Diseases, Queen Square, London, W.C.1 (July 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Leeds 2 (July 31).

ASSISTANT AGRICULTURAL ECONOMISTS (3, male)—The Secretary and Registrar, The University, Bristol (July 31).

FOULERTON RESEARCH FELLOWSHIP IN MEDICINE—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (August 1).

LECTURER IN PHARMACOLOGY—The Secretary and Registrar, The University, Bristol 8 (August 1).

PHYSICIST—The Secretary, British Jute Trade Research Association, Bellfield Street, Dundee (August 14).

POWER HOUSE SUPERINTENDENT in the Power House of the Fertilizer Factory, Sindri, Bihar—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 333A. (August 14).

LECTURERS IN (*a*) ENTOMOLOGY, (*b*) GENETICS, and (*c*) INSECT PHYSIOLOGY, in the Department of Zoology and Applied Entomology—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (August 17).

SENIOR PRINCIPAL SCIENTIFIC OFFICER at the Royal Observatory, Greenwich—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2207 (August 20).

CHEMISTS (men and women) in the Grades of Scientific Officer Class and Experimental Officer Class, for analytical work in connexion with atomic energy development, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.78/48A/2 (August 24).

PRINCIPAL SCIENTIFIC OFFICER, and SENIOR SCIENTIFIC OFFICERS, in the Engineering Division of the Atomic Energy Research Establishment, Harwell, Berks—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2205 (August 26).

CHIEF TECHNICAL INSPECTOR in the Ministry of Pensions—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2218 (August 28).

ASSISTANT TO THE PROFESSOR OF BOTANY—The Registrar, Trini College, Dublin (August 30).

KEEPER OF ANTIQUITIES—The Director, Museum and Art Galler New Walk, Leicester (August 30).

DIRECTOR (Professor or Reader) OF THE UNIVERSITY OF MADR BIOCHEMISTRY LABORATORY—The High Commissioner for Ind General Department, India House, Aldwych, London, W.C.2 (Ind August 31).

SENIOR LIBRARY ASSISTANT (graduate, preferably in Science Economics)—The Registrar, University College, Southampton (Augu 31).

SCHOLARSHIP for training in INDUSTRIAL RESEARCH—The Direct Institute for Industrial Research and Standards, 45 St. Stephe Green, Dublin (September 1).

MAMMALOGIST (male), and an ORNITHOLOGIST (male)—The Direct Transvaal Museum, P.O. Box 413, Pretoria, South Africa (Septemb 30).

METEOROLOGISTS for the East African and West African Meteor logical Services—The Director of Recruitment (Colonial Servic 15 Victoria Street, London, S.W.1.

LABORATORY ASSISTANT/STEWARD FOR PHYSIOLOGY—The Head the Department of Biology, Chelsea Polytechnic, Manresa Roa London, S.W.3.

GRADUATE IN PHYSICS OR CHEMISTRY in the Intelligence Divisi for Literature Research—The Secretary, Research Association British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

LABORATORY STEWARD (Grade II)—The Secretary, Northampt Polytechnic, St. John Street, London, E.C.1.

RESEARCH STAFF in the categories of PHYSICS, CHEMISTRY (main Physical), and ENGINEERING—The Director, Gas Research Boar 1 Grosvenor Place, London, S.W.1.

PHYSICISTS to work on problems connected with the measureme of motion and forces in winding and weaving machines, and to i vestigate problems of cloth structure and serviceability—The Direct Linen Research Institute, Lambeg, Lisburn, N. Ireland.

LABORATORY TECHNICIAN (Grade C) IN THE BIOLOGY DEPARTME —The Warden and Secretary, Royal Free Hospital School of Medicin 8 Hunter Street, London, W.C.1.

LECTURER IN THE PHYSICS DEPARTMENT—The Secretary, Nort ampton Polytechnic, St. John Street, London, E.C.1.

RESEARCH BIOCHEMIST IN THE DEPARTMENT OF PATHOLOGY—T Dir ctor of Pathology, Bernhard Baron Memorial Research Labor tories, Queen Charlotte's Maternity Hospital, Goldhawk Road, Londo W.6.

LABORATORY ASSISTANT (man) at Westminster Secondary Technic School, Ebury Bridge, London, S.W.1—The Education Officer (Esta 2), London County Council, The County Hall, London, S.E.1.

SPECIAL DEMONSTRATORSHIP IN THE DEPARTMENT OF BACTERIOLOG AND IMMUNOLOGY (to work principally at St. Albans)—The Dea London School of Hygiene and Tropical Medicine, Keppel Stree London, W.C.1.

RESEARCH STUDENTSHIPS IN THE DEPARTMENTS OF BOTANY, CHE ISTRY, PHYSICS and ECONOMICS—The Registrar, University Colle of the South-West, Exeter.

LECTURER or ASSISTANT LECTURER IN PURE MATHEMATICS, LECTURER or ASSISTANT LECTURER IN PHYSICS, and a LECTURER ZOOLOGY—The Registrar, University College of the South-Wes Exeter.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

University o Bristol: Department of Economics (Agricultu Economics). The Fruit Growing Industry in Kent. By L. Napolita Pp. 223–318. (Bristol: The University, 1948.) 5*s*. [1

Commonwealth Bureau of Horticulture and Plantation Crop Technical Communication No. 19: Seed Production of Europea Vegetables in the Tropics. By A. G. G. Hill. Pp. 28. (Aberystwyt Commonwealth Agricultural Bureaux, 1948.) 2*s*. [1

Commonwealth Bureau of Plant Breeding and Genetics. Technic Communication No. 14: Technique of Breeding for Drought Resistan in Crops. By T. Ashton. Pp. 34. (Aberystwyth: Commonweal Agricultural Bureaux, 1948.) 2*s*. 6*d*. [1

Empire Cotton Growing Corporation. Progress Reports fro Experiment Stations, Season 1946–1947; Programmes of Experiment Season 1947–1948. Pp. ii+152. (London: Empire Cotton Growi Corporation, 1948.) 3*s*. [2

Other Countries

Proceedings of the American Philosophical Society. Vol. 92, No. 2 Studies of Historical Documents in the Library of the America Philosophical Society. Pp. 75–126. (Philadelphia: American Phil sophical Society, 1948.) 1 dollar. [2

Annals of the New York Academy of Sciences. Vol. 49, Art. 4 Hemorrhage. By Gregory Shwartzman, C. H. Best, Robert Chambe Charles S. Davidson, John H. Ferguson, Robert F. Furchgott, I. M Gerber, Magnus I. Gregersen, Paul György, Russell L. Haden, Hyman, L. B. Jaques, Paul Klemperer, R. E. Lee, C. N. H. Lon Dickinson W. Richards, Jr., R. H. Schneider, Ephraim Shorr, Hen J. Tagnon, S. A. Thayer, Lee C. Underwood, Donald D. Van Slyk Alfred E. Wilhelmi and B. W. Zweifach. Pp. 483–660+5 plate (New York: New York Academy of Sciences, 1948.) 3 dollars. [2

Conference on Metabolic Aspects of Convalescence. Transactions the Fifteenth Meeting, New York, March 31–April 1, 1947. Edite by Dr. Edward B. Reifenstein, Jr. Pp. 163. (New York: Josia Macy Jr. Foundation, 1948.) 2.25 dollars. [25

Phytopathological Classics. No. 8: Observations, Botanical an Physiological, on the Potato Murrain. By M. J. Berkeley; togeth with Selections from Berkeley's Vegetable Pathology. Made by th Plant Pathology Committee of the British Mycological Society. P 108. (East Lansing, Mich.: American Phytopathological Societ 1948.) 1.50 dollars. [2

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SCIENTIFIC METHOD IN THE CONSERVATION OF PICTURES

IN the Golden Age, Plato and Aristotle walked in the Academy and in the Lyceum, instructing and disputing. We, in our time, are in possession of much of their labours; we have entered into them, and they have become part of our inheritance. Other searchers after truth there were too in those days—artists and craftsmen—who fashioned things for delight as well as for use. But alas! less, much less, of their works have survived to the present day. In the case of paintings (originally a great number) next to nothing now remains. In due time, men of genius in applied science appeared, men who understood how to harness natural law to immediate needs. They had to combat the Platonic tendency to discourage investigations concerned with gross matter, and for centuries there had been the lag between discovery and application. But it may be that man was not then ready for such advances. Enough to recollect that when a giant appeared—in the person of Leonardo da Vinci—he combined consummate artist, engineer, technician and natural philosopher all in one. Perhaps sensing his own incapacity to generalize, he strove against heavy odds to study afresh the works of Archimedes, and thus, with not inconsiderable success, to effect a junction between studio and laboratory.

The centuries that have passed since then have taken heavy toll of man's cultural patrimony. No nation has escaped, though losses are probably less than some people imagine. But deterioration goes on without ceasing: here a little and there a little, until some irreplaceable masterpiece stands in real jeopardy. The duty of conservation is plain enough. How is it to be shouldered? On p. 166 of this issue of *Nature*, Dr. W. G. Constable discusses the findings of the Weaver Commission, appointed last summer to examine the methods and results of cleaning pictures at the National Gallery.

In outline, the report of the Weaver Commission goes far, perhaps as far as it is permissible to go, in the direction indicated by the terms of reference. But its significance lies much deeper. For it is a wider concept than what has happened or not happened to certain pictures that is involved. It is nothing less than the place of scientific method in the task of conservation; and it may be said at once that the report provides full vindication for its introduction. Clearly, every consideration and weight must be accorded to æsthetic principles (and at a certain stage of operations these may well be crucial); but when all is said and done, supreme paintings are physical objects and subject to all the limitations, stresses and strains to which such things are prone. Restoration connotes much more than 'cleaning'; a branch of knowledge now known fairly widely as 'picture-mechanics' is indicative of the temper of responsible people who strive to understand, and then to use, the advancement of laboratory techniques for the benefit of the national collections. They are not in the least inclined to wander into other people's gardens, where they may or may not be welcome: their sole function, as they see it, is to bring to bear every kind of scientific device and experience, and to use them impersonally and impartially in the service of conservation. Again, just as the ablest physician or surgeon will realize that his patient has a personality, and that recovery from illness and sound health thereafter are closely connected with it, so the man of science in the service of the arts appreciates that a great picture was made and exists for glory and for beauty, for the enjoyment of mankind. Manifestly, the responsibility of the authorities is to the future, as well as here and now.

Realizing this, the Weaver Commission stressed the need for air-conditioning as the most important single item among those calculated to preserve the pictures in the National Gallery in the interests of posterity. Shortly after the pictures were returned from their war-time exile in Wales, the Ministry of Works, in consultation with the Trustees and Gallery officials, started to prepare plans, and intensive study of the problem—by no means an easy one in the case of such a building as that in Trafalgar Square—has been going on continuously. It is understood that, in fact, a start has already been made with the erection of the room for the necessary equipment, and much of the machinery is already on the site. Naturally, every opportunity is being taken to learn from experience, by visits and so forth to installations, both in Great Britain and overseas. The project is of necessity being conducted in stages; and there can be little doubt that a most efficient scheme will emerge in the end. Advantage is being taken of the atmospheric pollution tests made in the Gallery during 1936–37 to guide the engineers in the filtration problem; for there is no reason for thinking that the data to-day are appreciably different from those of twelve years ago. Similarly, observations already exist relating to the moisture-content of panel paintings (that is, those executed on wood) both in the public galleries and elsewhere. These figures are of considerable importance in calculating the limit between which it is desirable for the relative humidity to be stabilized.

For some months past, preliminary plans have been maturing for the more exact registration of the dimensional change in wood and fabric supports as a function of relative humidity and temperature. The experiments have been designed to reproduce as nearly as possible the actual conditions obtaining in a picture and should yield valuable information relating to warping, cracking and flaking.

These activities are perhaps but a fraction of the scientific care of paintings. An indication of the problems involved is given by Mr. F. I. G. Rawlins, scientific adviser at the National Gallery, in an article, with illustrations from some of the 'cleaned' pictures, which is published in the July issue of *Endeavour*. It is quite clear that no single institution can hope to tackle all the problems presented by an attempt to look after great pictures adequately. Before the War—in fact, ever since the research laboratory of the National Gallery was established in 1935—the policy has been to work in close co-operation with the Department of Scientific and Industrial Research. Broadly, the task is twofold: the application of scientific processes (mostly physics) to the pictures themselves, and next the 'farming out' of questions relating more to the materials from which pictures are constructed and the control of the environment. The fusion of both lines of inquiry should lead (and indeed has led) to a much fuller understanding of the whole subject. In the main, the first type of work is undertaken in the National Gallery laboratory itself; whereas the second is carried on in such establishments of the Department of Scientific and Industrial Research, and sometimes of the research associations, as convenience may suggest. In all cases, the Gallery laboratory is in control of operations and co-ordinates them all. Further, the Gallery has the unique advantage of the services of an Advisory Scientific Committee. This is an honorary body of six distinguished men of science who meet quarterly in order to help in whatever way they can in the application of scientific methods, both in conservation and as an aid to historical research. It was set up by the Trustees fourteen years ago, with the scientific adviser of the National Gallery (who is also in charge of the research laboratory) as secretary, and it is noteworthy that, apart from work on conservation, these years have seen valuable studies of æsthetic as well as scientific aspects of the pictures in the Gallery.

The result of all this is difficult to assess, since it is still something of a novelty and in the formative stage. But two tendencies are beginning to take shape: one (the short-term aspect) the value of an exact scientific and technical approach and control applied to the National Gallery's problems as such; and the other (the long-term view) a definite bridging of the gap that has so long separated the arts and sciences from one another, to the detriment of both. It is no less through doing than through thinking that the scholar and craftsman, technician and artist, can come to appreciate each other in a common quest for the beautiful.

FIBIGER: PIONEER OF EXPERIMENTAL CANCER

The Danish Cancer Researcher, Johannes Fibiger
Professor in the University of Copenhagen
By Prof. Knud Secher. Pp. 206. (Copenhagen Arnold Busck; London: H. K. Lewis and Co., Ltd., 1947.) n.p.

THE first part of this book recounts Fibiger's ancestry back to 1667: some of his ancestors including his father, were medical men; but they seem to have made no striking contributions to scientific knowledge. Fibiger's youth was not altogether happy, since his father died when he was a child and his mother was put to some difficulty to educate the children and had little time for the affection that might have softened Fibiger's character His early history perhaps explains his rather moody nature, particularly in his early adult life, when, no doubt, he had to contend with the usual difficulties common to many medical men. But he seems to have been happy in his professional career, and writes enthusiastically of his early training with rof. Salomonsen, who gave him a comprehensive aining in bacteriology which stood him in good ead in his later work.

The second part of the book deals with his pro- ssional life up to the time that he made his dis- overies of the relationship between infestation with e *Gongylonema neoplasticum* and tumours in the omachs of rats. His first scientific period was ainly concerned with controversies about the athogenicity of bovine strains of tubercle bacillus. n this work Fibiger found himself in opposition to och, who belittled the importance of bovine in- ection as a source of human disease. Fibiger and ensen upheld, successfully, the importance of the ovine strain, and at numerous international con- resses he made his case so successfully that he apidly acquired an international reputation.

During this same period, Fibiger came to hold lead- g positions in the medical and scientific world in enmark, and in 1907 was elected to the Cancer ommittee, which was originally formed to investigate ancer of the uterus. His influence was soon felt on is Committee, of which he became vice-president 1908. He sponsored a questionnaire to all Danish hysicians, dealing with the incidence of cancer, d obtained replies from 99 per cent of them. In 09 he instituted a system of free microscopical agnosis for which he was largely personally re- onsible. In the next few years he obtained cancer nsuses from the Faroes, Iceland and Greenland, hich yielded the interesting result that the incidence the Faroes and Greenland resembled that in Europe, hereas in Iceland it was only about half as high. bout this time, a chance observation diverted his tention to experimental cancer investigation, which ade his name famous throughout the scientific orld, and won for him the Nobel Prize in 1928.

The third part of the book deals with the develop- ent of this research, and is not only a convenient llection of facts which are not readily available to nglish readers, but is also a defence of Fibiger's con- usions by Secher against the criticisms that have en made since his death. There are numerous ustrations of the nematodes, of the cockroaches hich are their intermediate hosts, and of the gross d microscopic pathological lesions observed by ibiger, both in wild rats and in those experimentally fested. One can well understand how he reached is conclusions, on the available evidence, and in e light of scientific knowledge at that time; but espite the enthusiasm with which Secher supports e work of his friend, it cannot be said that he does uch to strengthen the case as presented by Fibiger imself. It is unfortunate that fire destroyed the gar factory in which the wild rats infested with ematodes were found with tumours in their stom- chs. Even the most careful attempts by Passey d his collaborators to reproduce the conditions of ibiger's experiments may have failed in some portant but apparently trivial circumstance to produce exactly the conditions in Fibiger's lab- atory. Secher stresses the heavy infestation held Fibiger to be essential for the induction of umours, and not realized by others repeating the ork. The reviewer cannot escape the conclusion at some of the tumours seen by Fibiger were nuinely malignant; but only benign tumours d hyperplasia have been recorded by others who ve tried to repeat his experiments. There seems tle doubt that some, at least, of the alleged meta- ases in the lungs were probably instances of metaplasia in bronchiectatic cavities, as clearly demonstrated by Passey *et al.* Secher illustrates, on p. 133, such a lesion as a "pulmonary metastasis"; but on the same page is a low-power photomicrograph described as a "glandular metastasis", which looks like a keratinizing squamous carcinoma. The tumours that were maintained by transplantation in Fibiger's experiments seem to have qualified as malignant.

Secher succeeds in convincing the reader of Fibiger's integrity, and of the great thoroughness with which he pursued his investigation. He seems to have left nothing to chance, and to have been highly critical of his own results. If he failed to give a completely satisfactory explanation of them, that must be attributed to lack of knowledge of the influence of vitamins and other factors on hyperplastic lesions, in the period about the time of the First World War, when this work was done. It must be said, however, that there are many irritating features in this book. It is written in English, and yet it is filled with the most curious phrases and words, which make the meaning obscure. For example, the stomach is referred to as the 'ventricle' very frequently, and a number of strange words occur throughout the text. Fortunately their meaning is usually clear, as, for example, "irritaments", "cancerated", and so on. The spelling of foreign names varies from page to page, and even on the same page. It would have been of considerable advantage to the reader if the text had been edited by an Englishman before publication.

P. R. PEACOCK

CLOCKS AND WATCHES

Horology

The Science of Time Measurement and the Construction of Clocks, Watches and Chronometers. By J. Eric Haswell. With Supplement. Pp. xvi+288+19 plates. (London: Chapman and Hall, Ltd., 1947.) 16*s.* net.

IT is now about eight years since the previous edition of this book was sold out, and a measure of the esteem in which it was held by horologists is that second-hand copies were unobtainable. Its reappearance is therefore very welcome. The book commences with a clear exposition of the fundamentals of time and time measurement, which are treated at considerably greater length than is usual. The section on pendulums deals principally with those types used in precision clocks; it is unfortunate that the question of temperature compensation and temperature errors is not treated quantitatively, as this does not require difficult mathematics, such as the author has evidently taken much trouble to avoid. Also there is no mention of the magnitudes of circular and barometric errors. A point of terminology which seems doubtfully correct is the use of the term a 'free' pendulum, since all clocks described as having 'free' pendulums have their pendulums, in fact, coupled to constant-force escapements of one kind or another. The term, however, has a wide usage among horologists, and it is perhaps as well to retain it.

Clock and watch escapements are treated in Chapters 4 and 14; here, unfortunately, the author deals only with special cases of escapement lay-out and proportions. In the case of the lever and cylinder watch escapements, this is not very serious, as their designs are fairly stereotyped nowadays; but in cases such as the dead-beat and recoil clock escapements, which may, in fact, be constructed with widely varying proportions, the information available is not of much use. Also references to the impulse tangent circle are misleading, since impulse is, in fact, delivered at right-angles to these lines, and in most of the drawings of clock and lever watch pallets there are small but nevertheless important geometrical errors.

Gearing is dealt with in Chapter 5, and in the supplement, and an interesting section has been included on epicyclic trains for revolving-escapement watches. There is a very useful section on the balance and spring, covering both the questions of temperature and positional errors; the supplement includes a section on modern hairspring alloys.

A good description of striking and chiming mechanisms, general lay-outs of clocks and watches, and much interesting and useful information on complicated watches, such as chronographs, calendars and repeaters, with a good chapter on the marine chronometer, combine to make this book very useful and informative to those interested in horology from a descriptive point of view. R. A. Fell

LABORATORY ORGANIC CHEMISTRY

Newer Methods of Preparative Organic Chemistry

Translated and revised from the German. (Published and distributed in the Public Interest with the consent of the Alien Property Custodian.) Pp. xiii + 657. (New York and London: Interscience Publishers, Inc., 1948.) 8.50 dollars; 51*s*.

Semimicro Qualitative Organic Analysis

By Nicholas D. Cheronis and John B. Entrikin. Pp. xiv + 498. (New York: Thomas Y. Crowell Company; London: Constable and Co., Ltd., 1947.) 25*s*. net.

Reactions of Organic Compounds

By Dr. Wilfred John Hickinbottom. Second edition. Pp. x + 482. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 25*s*. net.

THESE three books cater for the needs of the student and the worker in organic chemical research.

"Newer Methods of Preparative Organic Chemistry" comprises fourteen articles each written by a German expert, which have been translated and revised by American chemists. It thus presents the reader with authoritative accounts of the application in the laboratory of a number of the most useful of modern methods and special reagents. Oxidations using lead tetra-acetate or periodic acid and dehydrogenations with sulphur, selenium or platinum and palladium catalysts are described. Catalytic reductions with Raney nickel or copper chromite are reviewed in detail. Another chapter is devoted to oxidations and reductions in presence of aluminium alkoxides. An account of biochemical oxidations and reductions deals with the employment for preparative purposes not only of micro-organisms but also of higher animals.

Other sections of this book discuss various substitution reactions of aliphatic substances, the chemistry of organic fluorine compounds and the uses of boron fluoride and hydrofluoric acid in organic reactions. The fact that the chapters on diene syntheses a the uses of diazomethane were written by Alder a Eistert respectively is a guarantee of their excellenc and in conclusion an account is given of the uses organolithium compounds.

The volume is an excellent and timely producti which will be of great service to the research worke

"Semimicro Qualitative Organic Analysis" aims providing a general course in qualitative orga analysis for students, and a manual and referen book for workers in all types of laboratory, wheth academic, professional or industrial.

The rapid expansion of our knowledge of t chemistry of biological materials has been largely d to the use of microchemical methods, the advantag of which are generally recognized, and the resear worker in organic chemistry must sooner or lat acquire the necessary technique. The princip adopted by the authors of this book is that the stude should learn to work on the semimicro scale in t organic laboratory from his first year, and t advantages in economy of material and valuab training are obvious. All the necessary operatio and equipment are, therefore, described at the outse and the rest of the book gives a systematic procedu for the identification of a substance, special emphas being placed on observations of solubility. Suitab derivatives are listed for each class of compound a exact directions are given for their preparation a careful purification on the semimicro scale.

Numerous lists of selected references are include and the book concludes with a valuable collection tables of compounds arranged in classes in order melting or boiling point together with particulars various derivatives or figures for physical properti such as density, refractive index or rotatory pow to assist the identification. A final table includ many more complex bases, drugs, vitamins a hormones.

This volume will not only be useful to the studen but will also prove most valuable as a book reference.

A new and revised edition of Hickinbottom "Reactions of Organic Compounds" will be general welcomed. It reviews in detail the reactions of the main classes of compounds and gives in an appe dix a scheme for their identification. New materi has been added, particularly in the sections saturated and unsaturated hydrocarbons, on organ lithium compounds and on the uses of diazomethan The book is a valuable source of information wi many preparative details, and it is packed wi references to the literature.

APPLIED SURFACE CHEMISTRY

Surface Chemistry for Industrial Research

By J. J. Bikerman. Pp. ix + 464. (New Yor Academic Press, Inc.; London: H. K. Lewis a Co., Ltd., 1948.) 8 dollars.

THE author states in his preface that "Th volume is an exposition, adapted to Industri Research, of the fundamentals of Surface Science In fact, it is nothing of the sort; it is an assembla of data of surface phenomena with the fundamenta badly scamped. Too frequently also, the auth introduces a topic with a definite statement and the proceeds to cite reservations and evidence against without afterwards summing up. The reader is left confused.

The book is comprehensive ; it has the conventional subdivision into liquid–gas, liquid–liquid, solid–gas, solid–liquid–gas, solid–liquid–liquid, and a final hapter on electric surface phenomena. It is extremely well and thoroughly documented and the international cope of the references is most praiseworthy. Taking chapter at random, out of 284 references, 23 were to books, 71 to technical journals and, of the remainder o academic publications, 45 were German, 51 British, 23 Russian, 21 American and the remaining 0 assorted European. As usual, of course, this completeness of bibliography has led to lack of ritical assessment and to citing papers which will e found to add nothing to accepted statements. It has also led to a curious tendency to cite results obtained from rather exotic systems without enough data upon simple ones and common substances. To give examples, the section of four pages on unimolecular films contains a statement that "Since the ength" (of what, is not stated) "does not differ much rom the length of an 'oil' molecule, films of a similar r smaller thickness are termed unimolecular". his is all the introduction to this important branch f surface chemistry that the author gives to the ndustrial worker. No force/area curves are reproduced. Shortly afterwards, foams receive 14½ pages.

The section on emulsions is a good example of the econd chief fault of the book, namely, that of making an exact statement and following it by a collection of bservations, usually showing noticeable critical hought. The diagrams are unusually well designed and drawn, but the type used for numerals in the ext is bad and the '2' is a continuous offence to the eye.

This miscellany should be welcomed by those cturers who like to enliven their teaching with eferences to practical applications and perhaps by tudents wishing to heckle their lecturers. It cannot e recommended to anyone else, which is a pity, ecause the book does contain much acute and critical hought.

Compilations of this sort are nothing new ; they re a sort of crude operational research in technology hich has been practised for centuries. Another ecent book in this same field—"Emulsions and oams", by Berkman and Egloff—is an example of ork of this character in its extreme form, undulterated by critical discussion or theoretical oundation. Such authors can properly retort, specially in the case of emulsions, that there exists o such fundamental foundation and that their ooks are a criticism of, and a challenge to, academic orkers. Here the Irishman's definition of a net as lot of holes tied together with bits of string is apt. undamental theory and experiment is the string ; omewhere in the holes is the practical application ; me of the holes are very large ones, especially in a cience of such recent growth as surface chemistry. pplied science cannot alone fill them, and fundamental work must do more to bridge the gaps. Their o-operation, however, is not encouraged by publication of masses of facts and figures not correlated with any organised net-work of knowledge, and not apable of being so correlated because they are bserved without any intention of seeking such orrelation.

Books of this sort are an indictment of the failure academic workers to come down from their 'ivory towers' and help to clean up the mess ; but they also indict the applied worker in industry, often engaged as a research worker. There are far more of these in industry than there are in the universities ; they are able men ; they have more time and often better facilities for research. Why do they not play a more serious part in bridging the gap between pure and applied science ? Why is this serious wastage tolerated ? Perhaps because the 'practical' man is in charge and he says : "cut out the theoretical stuff and tell me how it works". Bikerman's book will appeal to such so-called practical men.

A. S. C. Lawrence

THE SCIENCE OF NUTRITION

Science and Nutrition

By A. L. Bacharach. Third edition. Pp. xii+142. (London : Watts and Co., Ltd., 1947.) 6*s.* net.

THE usefulness of this book, and its success, are sufficiently well attested by the fact that it has now run into its third edition. The scope is well indicated by Sir Jack Drummond, who in the preface to the first edition published in 1938 wrote that it should be read "not only by the intelligent 'man-in-the-street', whom for no very clear reason one assumes to be a layman, but also by the medical profession, until quite recently lamentably behindhand in recognizing the significance of experimental dietary studies, and perhaps even by the politicians who are at the moment very timorously testing the strength of 'nutrition' as a party plank".

A second edition, thoroughly revised and in many parts rewritten, was published in 1944, when the author wrote : "The last five years have shown a very marked change in the attitude of the public to the problems of nutrition. An enlightened Ministry of Food of which the effectiveness was no doubt in large measure due to its youth and its freedom from the trammels of precedent ; to a Minister who not only understood human nature, but also appreciated the value that science can have for the community ; to a scientific adviser—the writer of the Preface to this book—whose grasp of practical possibilities proved as shrewd as his knowledge of nutritional science was wide and flexible, and whose practical and scientific services have, since this book was first published, been fittingly rewarded by Knighthood and the Fellowship of the Royal Society ; last, but by no means least, to a Public Relations policy that has been as persistent and enthusiastic as it has, generally, been honest and intelligent : all these factors have helped to make tens of thousands of people realize for the first time that eating and drinking may be as important in their effects on our physical health as a few have always realized them to be on our spiritual well-being".

That is very true, and well said ; and what is equally important now is that the ground gained during the War should be extended further, and that public opinion should continue to be enlightened. In that aim, anyone seeking a balanced and interesting introduction to the science of nutrition can be recommended unhesitatingly to study this book. The new edition contains a number of minor changes and corrections and also a brief new allusion to folic acid, research on which has led to such remarkable developments since 1944.

CLEANING AND CARE OF THE NATIONAL GALLERY PICTURES

By W. G. CONSTABLE

Curator of Paintings, Museum of Fine Arts, Boston, Mass.

NOW that the dust of controversy over the cleaning of certain National Gallery pictures has to some extent settled, it is possible to judge some of its results. The ineptitude of much of the criticism should not blind us to its value. Apart from witnessing how greatly some of the owners of the pictures care about them, both the praise and blame meted out to the National Gallery authorities have revealed a fundamental confusion of thought over the cleaning of pictures—confusion between how a painting looks after treatment, and how its physical condition has been affected. Whether the spectator likes the appearance of a painting is a matter of taste, whereas its physical condition is a matter of fact; but only too often those who by habit or conviction like to see paintings as in a glass darkly make reckless charges of removal of original glazes, abrasion of surface and so on. That is not to say that criticism of appearance is unjustifiable. Pictures are meant to be looked at, and when all excrescences such as dirt, discoloured varnish and later repaints have been removed, a painting does not necessarily look as the artist meant it to look. Colours may have changed ; there may be breaks in the surface ; cracks may have developed ; the pigment layer may have become more transparent with time, revealing the painter's earlier intentions or, in the case of paintings on a dark ground, causing the tone of whole areas to be lowered and so obscuring detail. It therefore becomes a problem for those in charge of paintings to decide what should be done in such cases ; and the decision will range from merely 'in-painting' with a neutral colour the most obvious and disturbing breaks, to an elaborate tinting out of all blemishes and the use of a toned varnish, or retention of some of the old, to unify the whole. One thing is certain, however, we can never be quite sure how the painter intended his work to look ; and since succeeding generations will have their own opinions on the matter, anything added to or left on a painting in the interests of appearance should be incapable of doing harm, and should be easily and safely removable.

This particular problem, however, was only raised by implication during the controversy ; and both the National Gallery authorities and the Committee of Confidential Inquiry appointed by the Trustees have confined themselves to the question of the physical condition of the pictures, and how it has been affected by cleaning, both recently and in the past. The National Gallery presented its case in the form of the "Exhibition of Cleaned Pictures", which was reviewed in an article in *Nature* of October 18, 1947 ; and what follows is concerned only with the Report of the Committee. This consisted of Dr. P. Coremans, head of the Central Laboratory, Belgian National Museums ; Dr. G. L. Stout, former head of the Department of Conservation, Fogg Museum of Art, Harvard University, now director of the Worcester Art Museum, Massachusetts ; and Dr. J. R. H. Weaver, president of Trinity College, Oxford, who acted as chairman. It is difficult to imagine a committee technically better equipped, and more independent and judicially minded ; and the report should become a *locus classicus* on certain aspects of cleaning. Presumably for reasons of economy, the report has not bee published, but mimeographed copies may b consulted at the Victoria and Albert and the Britis Museums ; an article on the report by Dr. Weave appeared in *The Times* of May 8.

The report falls into two main parts. The firs gives the results of intensive examination of te recently cleaned pictures of diverse types, includin all those the cleaning of which has been most severel criticized, notably Rembrandt's "Woman Bathing" Rubens' "Chapeau de Paille", and Velazquez' "Philip IV when elderly". The second part summarizes the results of this examination, and make a series of recommendations on future practice an policy in cleaning, and on general measures for conservation. In the examination of the ten selecte pictures, not only were all available records of cleanin taken into account, but also the criticisms an comments which have been made in the Press The broad result cannot be more succinctly state than in the words of the report. "In the ten picture which were examined no damage was found to hav resulted from the recent cleaning either becaus of a partial solution of original paint or because o abrasion or rubbing of original paint at the tim when extraneous materials were removed from it.' As regards particular pictures, of the Rembrand it is said, "Adverse comments . . . centered o alleged damage, during recent cleaning, to th proper right wrist and hand. There is no evidenc to support the view that such damage has occurred" the conclusion concerning the Rubens' "Chapeau d Paille" is that "the procedure in the cleaning o 1946 seems to have been sound ; there is no evidenc of loss at that time or of any substantial deposit of extraneous material left on the original paint" while of the Velazquez it is said, "Losses in the pain are minor ones and all were present before th cleaning began in 1946. Part of the former surfac coating still remains. There is no evidence of an damage from recent treatment."

All this is interesting enough in itself and mos reassuring. But equally interesting are the metho by which the conclusions were reached. The Committee was presented with a new type of proble Analysis of a painting to ascertain its presen physical condition, by such means as X-ray, ultraviolet light, microscopic and chemical analyses, etc is nowadays standard procedure ; but to discove what, if anything, had been removed from a paintin at different periods in its history meant adaptin these methods of investigation to new uses, an inventing others. A procedure used in every cas was to test the solubility of the original paint laye with various solvents. This varied according t whether a resin had been mixed with the oil medium but in all cases the original paint layer resiste much stronger solvents than those recorded to hav been used in the recent cleaning. Close examinatio of the structure of the paint layer also prove valuable. In the "Chapeau de Paille", for exampl a greenish-blue paint visible in part of the sky wa alleged by a critic to have once covered the blu of the sky as it now appears ; but this greenish-blu is now proved to be below the blue, which wa applied in places to modify it. To estimate whether urface had been abraded, comparison with areas which could reasonably be regarded as in their riginal state was the standard test. X-ray photographs taken in the past were a means of judging whether paint that had been removed was original r a later re-paint, notably in the case of the Rembrandt; and ultra-violet light was extensively used to ascertain whether, in areas alleged to have een damaged, old varnish still remained. Occasionally, as confirmatory evidence, the material in swabs used in cleaning a painting was analysed. n one case, at least, zinc white was discovered—a pigment unknown at the date of the painting, nd so an indication that a later re-paint had been removed. Rightly, however, the report discounts the value of such evidence, owing to the difficulty—often impossibility—of distinguishing original pigment from that used later.

Though the report thus completely vindicates the National Gallery authorities on the main charges brought against them, it has also found occasion for ome mild criticism. One ground for this, which may prove disconcerting to those who have assailed recent cleaning, is that some pictures, notably the Rubens' "Brazen Serpent", "Autumn: The Château de Steen", and "Peace and War", have not been cleaned enough, either in the interests of safety or f appearance. Old varnish or re-paints left on a picture are potential agents in disrupting the original urface, and if softened by partial cleaning may penetrate deeper into the interstices of the original paint, and so increase the difficulty of their removal, nd their power to do harm; while their effect in throwing part of the painting out of tone may be considerable. In this connexion, the report brings ut the difficulty of removing an old varnish or a re-paint, if the medium used by the artist contains resin similar to that present in the extraneous elements, since the solvents used for removal may attack the original pigment layer. This danger was iagnosed by Faraday so long ago as 1853, and creates a difficulty in cleaning Constable's "Cornfield". In fact, in this picture and Rubens' Rape of the Sabines", while noting the presence f extraneous and therefore possibly deleterious elements, the Committee holds that "special problems encountered in the process of cleaning would be considered to warrant accepting the present state as the best that could practically be reached".

Considerations of this kind lead to the more eneral conclusion that "materials used for cleaning . . can be considered safe or unsafe only with respect to a particular piece of paint", and that it is not even certain that the same solvent . . . can e considered quite safe over the entire area of one icture. In any part of a picture, safety is relative o other factors, particularly to timing and manipulation." This emphasizes how important is full iagnosis before a painting is cleaned. X-ray, ltra-violet light, infra-red rays, the tintometer, analysis of pigment layer and varnish, experimental tests in unimportant areas, must all be made and their results checked against each other. No one man can be expected to apply all these means of investigation; and so the system of modern medical practice must be followed, of specialist reports eing put at the service of the man in charge, the cleaner. He, too, should be the centre of another set of specialist researches concerned with the materials he uses. Much has been discovered about olvents and protective coating materials; but much remains to be done in selecting and adapting them for use on paintings. In the last resort, however, it is the wisdom and skill of the cleaner which count. The scientific investigator can give him the facts, but he has to interpret them, estimate their significance and act upon them. In incompetent hands, any materials can do harm to a painting, especially if camouflaged by a little scientific knowledge; and the ideal cleaner adds, to wisdom and skill, sensibility and integrity. It is easy to produce a result which will fool for a time anyone save an expert, but which has either damaged the painting or sown the seeds of future trouble. The cleaner's responsibilities, moreover, do not end with cleaning. The report emphasizes the necessity of full and precise record, not only of diagnosis but also of treatment, as an indispensable guide to possible future action; and in preparing such a record the cleaner must play a leading part.

Another criticism suggested is the need for greater attention to the supports of paintings. It is not always sufficiently realized that an oil painting consists of several layers: the support, usually canvas or panel; the ground; the pigment held in a medium; and the protective covering. Each of these layers is liable to expand, contract or disintegrate on its own account, and thereby affect the appearance and condition of the painting; and imperfect bonding between the layers may intensify the trouble. Cleaning, in the ordinary sense of the term, is concerned with the protective coating and the pigment layer alone, in the interests of safety and of enabling the picture to be seen at what is thought to be its best. But properly considered, cleaning is only one part of the business of keeping every element of a painting in good health. Treatment of the supports of painting, however, requires more investigation and thought than it has hitherto received. It is not so long ago, for example, that glue was the universally accepted adhesive for attaching a new canvas on the back of an old one (the process known as 'lining'); while defective panels were always 'cradled', that is, secured on the back by a series of criss-cross slats. Both methods are now known to be at best unsatisfactory, and at worst dangerous; but though they are now falling into disrepute, no completely satisfactory substitutes have yet been found. It is to be hoped, therefore, that any campaign to put the supports of National Gallery paintings in order will be tentative, and based upon experiment and research.

One step, however, can be taken at once which can only have the most salutary results, that of controlling temperature and humidity conditions in the National Gallery. Experience in the quarry at Manod, where the paintings were stored during the War, proved how beneficial such control can be; while the disastrous effect of its absence is demonstrated by the cracking and warping of the panel on which Rubens' "Autumn: The Château de Steen" is painted, during the hard frost of January 1947. Let no one think, however, that air-conditioning is a complete answer to the problem of keeping pictures in good health. In a public gallery, the public themselves introduce variable elements of heat and humidity, which so far no system has been able to control. But it will not be the least of the services of the Committee of Inquiry to the public, if its recommendation that full air-conditioning be installed in the National Gallery is accepted and speedily implemented by those responsible.

OBSERVATIONS ON THE PRODUCTION OF MESONS BY COSMIC RADIATION

By Dr. G. P. S. OCCHIALINI
AND
Dr. C. F. POWELL
H. H. Wills Physical Laboratory, University of Bristol

In examining photographic plates exposed to cosmic radiation at a height of about 10,000 ft. on the Jungfraujoch and the Pic du Midi, and at about 18,000 ft. on Kilimanjaro and Chacaltaya, we have now observed twenty nuclear 'explosions' which are accompanied by the emission of slow mesons. In this communication we give a number of photomicrographs of the tracks of these 'ejected' mesons. An analysis of the observed secondary effects which they produce enables us to show that at least the majority of them interact with nuclei and are therefore negatively charged; and that on the average they produce more vigorous nuclear disintegrations than most of the negative mesons which stop in the emulsions after being generated outside it. The main features of our present knowledge of charged mesons, with masses in the interval from 100 m_e to 400 m_e, can be accounted for in terms of two types of particles of different mass[1,2], which can be either positively or negatively charged, the heavier being generated in processes associated with the explosive disintegration of nuclei, and decaying spontaneously to produce the lighter ones. The possibility is not excluded, however, that the phenomena are more complicated than has been visualized hitherto.

In discussing the new material, we employ the previous classification of the different types of mesons recorded by photographic plates, which is based on their observed behaviour at the end of their range in the emulsion[2]. Thus we use the term 'σ-meson' for any particle, with a mass intermediate between that of a proton and an electron, which leads to the disintegration of a nucleus with the emission of one or more heavy particles of which we distinguish the tracks. Similarly, a 'π-meson' is one which, at the end of its range, gives rise to a secondary meson, of range $\sim$ 610 μ in the emulsion, the secondary particle being referred to as a 'μ-meson'. In addition, it is convenient to distinguish, by the symbol 'ρ', those mesons which enter the emulsion at the surface or from the glass of the plate, and which give rise to no observed secondary particles. It is certain that the different categories of particles thus defined are not all homogeneous. The ρ-mesons, for example, must contain a large number of both positive and negative particles; and we may also include among them some π-mesons of which we fail to distinguish the track of the associated μ-meson. It is nevertheless desirable to retain this phenomenological classification at the present stage in the development of our knowledge.

There are two features, peculiar to the pho
graphic method of detecting nuclear particles, wh
are of importance for the present experiments.
particle, with a given initial energy, is brought
rest in a solid material in a time interval about t
thousand times shorter than the corresponding per
when it is moving in a gas. A meson, for examp
with an initial energy of 4 MeV., is stopped ir
photographic emulsion in about 10^{-12} sec., as co
pared with 5×10^{-8} sec. in normal air. It follo
that it is possible, in principle, to arrest particles
an emulsion, and to study any secondary effec
associated with the emission of heavy charged p
ticles, which they produce at the end of their ra
—even although their 'life-time' is so short that wh
moving in a gas or a vacuum they would, alm
certainly, decay 'in flight'.

In contrast with this extremely extended 'tin
scale', the powerful 'integrating' property of t
photographic method—its continuous sensitivity
sometimes gives rise to difficulties owing to the cha
juxtaposition of unrelated events. As an examp
Fig. 1 shows a mosaic of photomicrographs in wh
the 'stars' *A* and *B* are joined by a common track
At first sight it might have been concluded that t
two events are associated, but a closer inspecti
indicates that the two stars represent two separ
nuclear explosions; and that the particle τ, wh
originated in star *A*, passed by chance near the cen
of star *B*. This interpretation depends upon t
observation that the two portions of the trajecto
τ, on either side of star *B*, are precisely in lin
that there is no significant change in grain density
the two portions of the trajectory near star *B* a
on either side of it; and that the track does n
pass precisely through the centre of star *B*, but a
distance of about 2 μ from it. While events of t
type are very rare, they emphasize the need
caution in interpreting the observations made wi
photographic plates, and the importance of beari
in mind the possibilities of confusion due to t

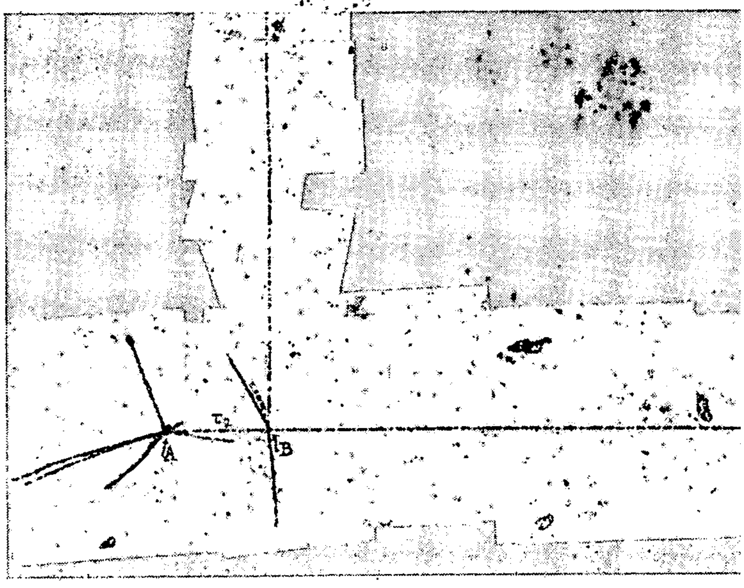

Fig. 1. Chance juxtaposition of unrelated events

The particle, τ, emitted from the star *A*, passes by chance within a distance of 2 μ of star *B*. The interpretation depends upon the observation that the two portions of track τ, on each side of *B*, are precisely in line; and that they show no signific difference in grain density

Observer: Miss P. Dyer Exposure: Jungfrauj

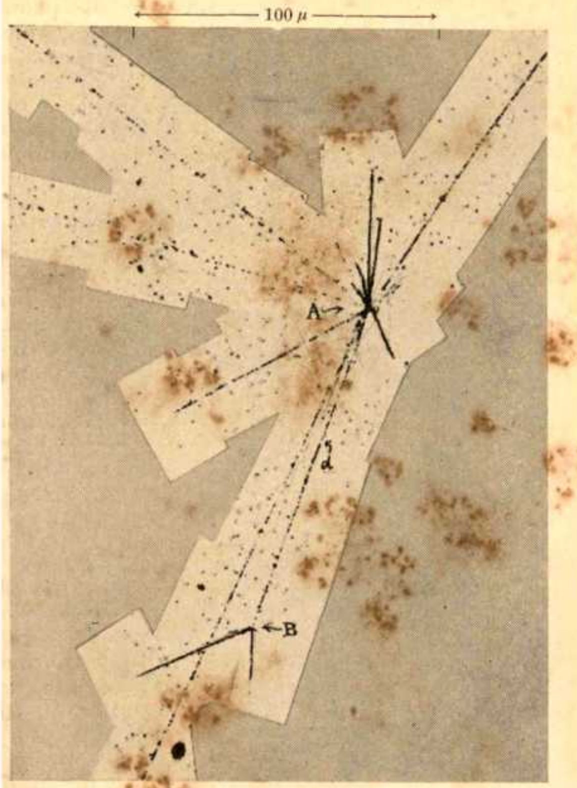

Fig. 2. Secondary disintegration produced by a particle emitted during the explosive disintegration of a nucleus. We assume that the particle producing the track d originated in star A, and collided with a nucleus at the point B. The track d is too short to allow us to establish its direction of motion by observations on the distribution of grains in the track. The secondary disintegration, B, can be explained in conventional terms if the emitted particle is a deuteron or a triton. We cannot assume that the particle d is emitted from B and leads to the disintegration A, unless d is a particle of charge $> 2e$ and with an energy greater than we have hitherto encountered

Observer: Miss P. Dyer Exposure: Chacaltaya

hance juxtaposition of the tracks of unrelated articles.

In addition to such fortuitous events, we have ow found many examples of secondary effects prouced by particles emitted during nuclear explosions. hese include the elastic collisions of protons, euterons and tritons with the nuclei of hydrogen nd other elements present in the emulsion. In other stances, of which Fig. 2 shows an example, we have bserved fast particles, emitted from 'stars', which roduce disintegrations by collisions with nuclei. he particle producing the track d in Fig. 2, which d to the secondary disintegration B, cannot have een a proton; for its velocity, as indicated by the rain-density' in the track, is too low. The distegration can, however, be explained in conventional terms, if the particle producing track d is ssumed to have been a deuteron, or one of greater ass.

In a previous paper, examples were given of distegrations produced at the end of their range by esons observed to be ejected during the explosive isintegration of nuclei. Two further events of this ype are shown in Figs. 3 and 4. In these photoraphs, the characteristics of the tracks of the articles producing the secondary disintegrations, S, ake it certain that they are produced by mesons. both cases, protons are emitted from one or other of the disintegrations which reach the end of their range in the emulsion. Their tracks can therefore be compared with those of the associated mesons, in conditions which are unaffected by 'fading'.

In conformity with our classification, we refer to such particles as 'ejected σ-mesons'. In other similar events, such as those represented in Figs. 5 and 6, the ejected particles producing the secondary disintegrations are of short range, but the tracks show changes in direction due to scattering, so that we can identify the corresponding particles as mesons with confidence.

While the ejected mesons are commonly observed to be created in processes which lead to the disintegration of the parent nucleus with the emission of several charged particles, the event represented in Fig. 7 has different characteristics. The meson originates in an interaction which leads to the emission of a single heavy charged fragment of short range. In no case have we observed the origin of the

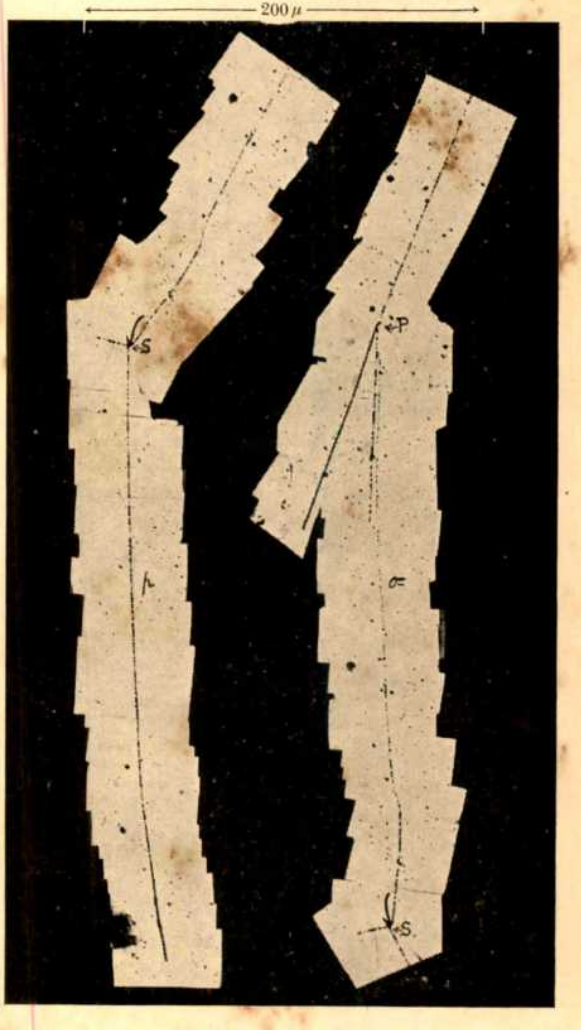

Fig. 3. Ejected σ-meson

A meson, σ, created during the explosive disintegration of a nucleus at the point P, reaches the end of its range and produces the secondary disintegration at S. Four particles are emitted during the secondary disintegration, one of which is a proton, p, of nearly the same range as the meson. The mosaic has been arranged to facilitate a comparison of the characteristics of the two tracks

Observer: Mrs. W. J. Van der Merwe Exposure: Jungfraujoch

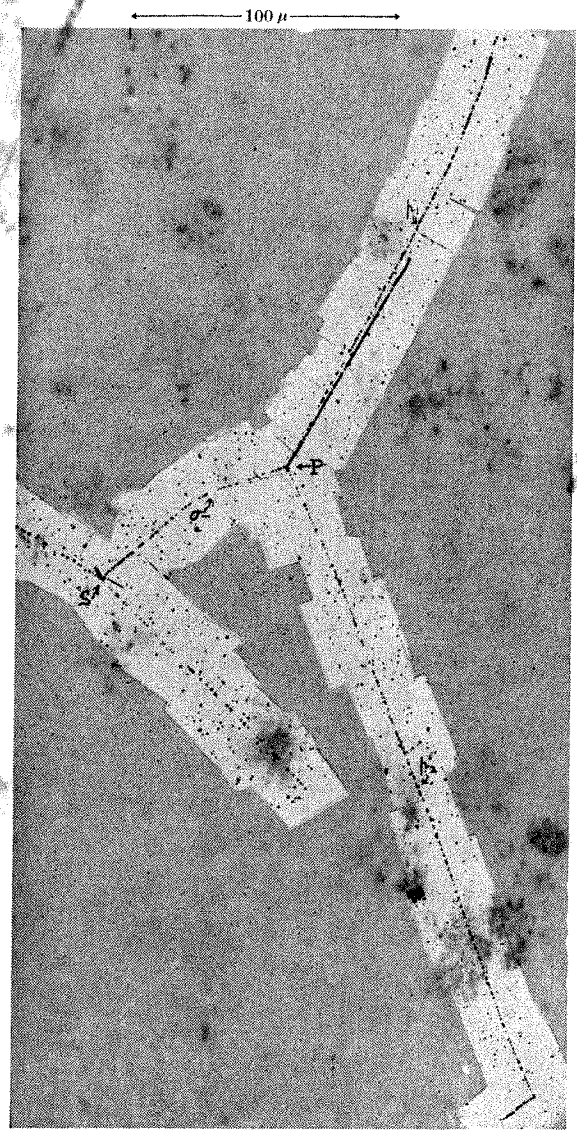

Fig. 4. Ejected σ-meson

Observation in a plate exposed at sea-level. The tracks are faded, and the event probably took place more than a month before the development of the plate. We interpret the event as due to the emission of a meson, σ, from the star P. The meson reaches the end of its range and produces a disintegration with the emission of three particles, of which we can distinguish the tracks. We attribute p_1 and p_2 to protons, which came to rest in the emulsion and of which the tracks can be compared with that of the meson
Observer: P. H. Fowler Exposure: Bristol (200 ft.)

track of a meson in the emulsion, unaccompanied by the emission of one or more heavy charged particles. In one or two cases where such an event is suggested by a casual inspection, closer observation shows that the meson has entered the emulsion at a large angle of 'dip', and has been scattered through a large angle, afterwards moving in a plane nearly parallel to the surface of the emulsion. As a result, the track becomes suddenly more clearly visible after the point of scattering.

Figs. 3–7 are characteristic of seventeen events which we attribute to the ejection of σ-mesons. In addition, we have found three examples of ejected mesons which stop in the emulsion without producing an observed nuclear disintegration. In determining the frequency of occurrence of these ejected ρ-meso we meet the following difficulty. We have n observed more than 10,000 'stars' each of which accompanied by the emission, on the average, several protons. Among such a large number, must expect to find some protons which su abnormally large deflexions in passing through emulsion, and which might therefore be wron identified as mesons. On the other hand, by ov emphasizing the frequency of occurrence of su abnormally scattered protons, we may reject tra which were, in fact, produced by mesons. T difficulty is serious only when the particles are short range, so that the additional evidence provi by observations on the change of grain-density al the track is meagre. Because of these difficulti we cannot be certain that, apart from statisti fluctuations, the relative numbers of ejected ρ- a σ-mesons are accurately represented by the pres observations. We can say with confidence, howev that the number of ejected σ-mesons greatly exce that of the corresponding ρ-mesons.

Disintegrations Produced by Ejected σ-Meson

We have now observed the tracks of more th 5,000 slow ρ-mesons and 600 σ-mesons, which or inate outside our emulsions. It is reasonable assume that approximately half the ρ-mesons ha a negative charge. Assuming that the true p portion is 40 per cent, a figure which is consiste with recent measurements of the charge and t mass of cosmic ray mesons by magnetic deflexi experiments[3], we can determine the relative f quency with which negative mesons of all typ

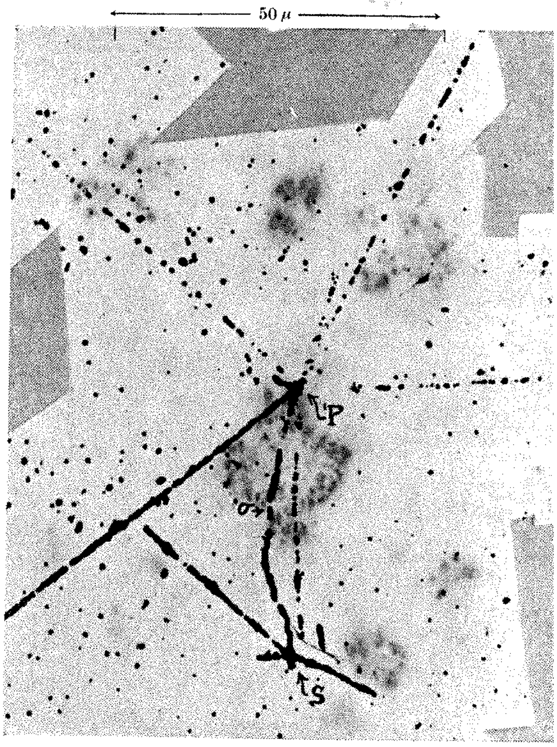

Fig. 5. Ejected σ-meson

The meson originates in the star P, and produces the disintegration S from which four charged particles are emitted. The track of the meson has a large angle of 'dip' in the emulsion, and the apparent 'grain-density' is increased through foreshortening
Observer: Mrs. G. Cohen Exposure: Kilimanjaro

at the end of their range in our emulsions, lead to he production of different numbers of heavy charged particles of which we distinguish the tracks. The result is shown in Fig. 8*a*.

We can also determine the corresponding distribution for those slow mesons which originate in nuclear explosions in the emulsion; see Fig. 8*b*. In spite of the uncertainty in the true numbers of ejected ρ-mesons—which lead to no secondary particles of which we distinguish the tracks—and the relatively small total number of ejected mesons observed hitherto, it is clear from Fig. 8 that there are substantial differences between the two distributions. In particular, a much greater proportion of the ejected mesons lead to disintegrations with the emission of heavy particles than is the case with negative mesons which come to the end of their range n the emulsions after being generated at points outside it. Thus, suppose the ejected mesons to be dentical in type with the ordinary negative mesons. From the distribution shown in Fig. 8*a*, it can be shown that for every negative meson which produces a disintegration with the emission of one or more heavy charged particles, there are four which give rise to no observed secondary particles. We should therefore expect the observed seventeen 'ejected' σ-mesons to be accompanied by about seventy cases in which an ejected meson produces no observed disintegration at the end of its range in the emulsion. This number is to be compared with the three actually found. We must conclude that the ejected mesons are of a different nature from the majority of the negative mesons which enter the emulsion from points outside it. A similar result follows if the fraction of the ρ-mesons which are assumed to be negatively charged is reduced to 20 per cent or lower.

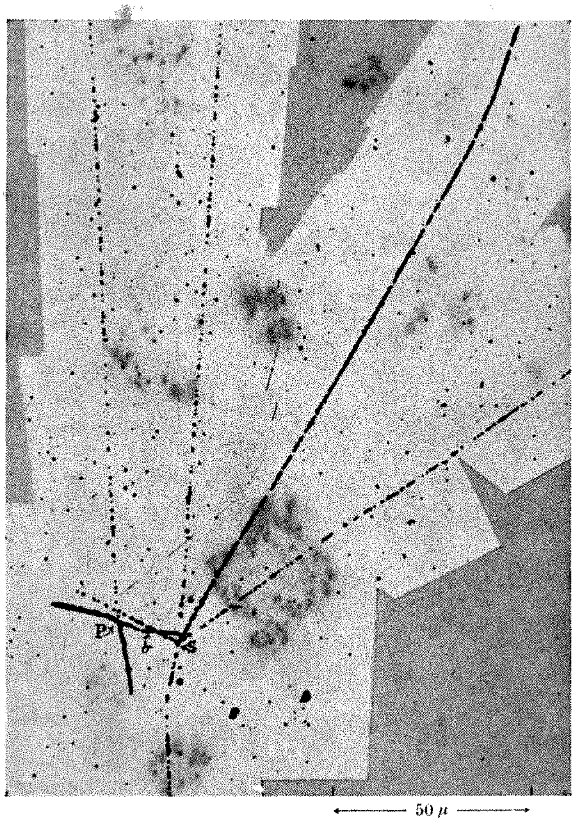

Fig. 6. Ejected σ-meson of short range
We interpret this event as due to the ejection of a σ-meson from the point *P*, the particle producing a secondary disintegration at the point *S*. The scattering of the particle producing the track is clearly marked, but its direction of motion is ambiguous. Our interpretation is based on the large deviation of the track near *S*, a feature commonly observed with mesons at the extreme end of their range
Observer: Mrs. W. J. Van der Merwe Exposure: Jungfraujoch

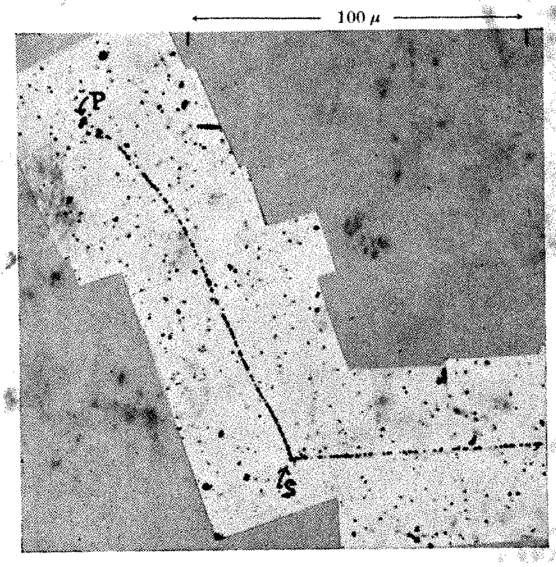

Fig. 7. In this event, a meson is produced at the point *P*, and at the end of its range it produces a disintegration at the point *S* from which a single proton is emitted. In contrast with the other events, the production of the meson appears to be accompanied by the emission of a single heavy particle of short range
Observer: Mrs. B. A. Moore Exposure: Jungfraujoch

The results also appear to have a bearing on the important question of the atomic capture of mesons by atoms. A large proportion of the ejected mesons observed in the present experiments must have been brought to rest in the gelatine, and have produced the disintegration of a light nucleus. In a subsequent paragraph we suggest that the ejected mesons are heavy particles ($300\,m_e$) with a short life-time, $\tau \sim 10^{-8}$ sec. If this is correct, the time which elapses before they are captured into a *K*-orbit must be less than this value. A similar result follows, presumably, for mesons of mass $\sim 200\,m_e$. The present results, therefore, give strong support for the view that the delayed coincidence experiments cannot be explained as due to the time taken by a negative meson to reach a *K*-orbit[4,5].

Absence of Ejected π-Mesons

A second striking feature of the observations is the absence of any ejected π-mesons, particles which recent experiments by Gardner and Lattes[6] prove to be positively charged. We cannot be certain that all the ejected mesons we have found are negatively charged, for some of the three ejected ρ-mesons might be assumed to be positive. We can be sure, however, that most of the ejected mesons, and it is reasonable to assume that all of them, are negative.

We can account for the failure to observe a positively charged ejected meson, in the conditions of our experiments, in terms of the repulsive forces exerted on such a particle during its escape from the parent nucleus; forces which will ensure that it will be emitted with an appreciable kinetic energy. Because of the rapid increase of range with energy, an increase in speed of emission of a particle will greatly decrease the probability of its coming to rest in the emulsion and being identified. It is therefore

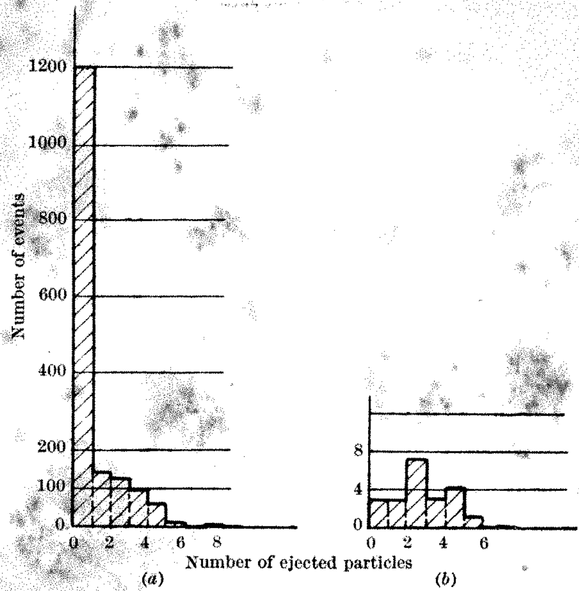

Fig. 8. Relative frequency of the disintegrations produced by negative mesons which lead to the emission of different numbers of heavy charged particles ; (a) mesons entering the emulsion ; (b) mesons created in the emulsion

reasonable to attribute the marked inequality between the observed numbers of ejected positive and negative mesons to the particular conditions of our experiments, and the effect of the nuclear charge.

Interpretation of the Results

In accord with previous assumptions, it is possible to give an account of the present observations in terms of two types of mesons, of mass $\sim 320\, m_e$ and $\sim 200\, m_e$, which can be charged either positively or negatively. We assume that the heavy particles have a strong interaction with nucleons, and that they are produced in processes which commonly lead to the explosive disintegration of nuclei. A heavy meson is regarded as having a short life-time, so that when it is produced in the atmosphere, it usually decays in flight to produce a light meson and a neutral particle. Further, from measurements of the masses[9], it is reasonable to assume tentatively that these light particles are identical with the mesons of the penetrating component of the cosmic rays. It then follows, from the delayed coincidence experiments[7], that the negative particles of this type which are brought to rest in the gelatine will decay with the emission of an electron, and will appear in the present experiments among the ρ-mesons. On the other hand, some of the light negative mesons which stop in a silver bromide grain may produce disintegrations with the emission of heavy particles, and so appear among our σ-mesons ; otherwise they will contribute to the ρ-mesons.

These assumptions allow us to explain the difference in the two distributions, shown in Fig. 8 ; for an ejected σ-meson is to be regarded as a heavy meson which, at the end of its range in solid materials, is captured by an atom, afterwards interacting with the nucleus, whatever its atomic number, and leading to its disintegration. On the other hand, the majority of the negative mesons entering the emulsion are regarded as light mesons, which, if captured by an atom of low atomic number, decay with the emission of an electron[7] ; and which, even if captured by one of high atomic number, may give rise to no observed secondary heavy particles.

It may be noticed that the observation that a fe of the ejected mesons do not produce disintegration with the emission of heavy charged particles is no inconsistent with the view that they are all of mas $\sim 320\, m_e$; for, in some cases, one or more neutron may alone be emitted in the disintegrations the produce. On the other hand, we cannot exclude th possibility that some of the ejected particles are ligh negative mesons. The evidence strongly suggests however, that the proportion of light particles of the type commonly found among the penetratin particles of the cosmic radiation, which are produce directly in the observed processes, is less than 20 pe cent.

The origin of the different types of mesons in th cosmic radiation, according to the present assumptions, is shown schematically in Fig. 9. It is assume that the 'primary radiation', possibly neutrons an protons, in collisions with nuclei, gives rise to th emission of both positive and negative particles o mass $\sim 300\, m_e$, π^+ and π^-. When formed in the hig atmosphere, these particles decay in flight to produc particles, μ^+ and μ^-, of mass $\sim 200\, m_e$, and a neutra particle ν^0. The indicated decay of this neutra particle into two photons is speculative. Those o the μ-particles formed by decay in flight can stop in th emulsion either in the gelatine ○, or in a silver bromide grain ▨. The positive particles, μ^+, are assume to decay with the emission of an electron and neutral particle, both of which are unobserved in th emulsion. It is further assumed that the μ^--particles when stopped in gelatine, also decay with the emission of a negative electron. These particles, μ^+ an μ^-, together constitute the majority of the ρ-mesons Some of the μ^--particles which stop in a silve bromide grain may possibly produce disintegration with the emission of heavy particles. In this cas they will appear in our experiments among th σ-mesons.

When the primary radiation interacts with th nuclei of matter in the immediate neighbourhoo of the plate, the π^+- and π^--particles, if ejecte with a suitable kinetic energy, can stop in th emulsion. The π^--particles then interact wit either light or heavy nuclei to produce nuclear disintegrations ; they thus contribute at least th majority of the σ-mesons. The π^+-particles come t the end of their range and suffer μ-decay ; they thu appear as our π-mesons. Finally, if the collision o the primary radiation with a nucleus occurs in th emulsion, we sometimes observe the ejection of π^--particle. In accord with the present assumptions we also postulate that π^+-particles are sometime emitted in such explosions, but that they commonly escape detection because of their higher energy o emission.

In accordance with the relationships suggested in this scheme, we should expect to observe approximately equal numbers of σ- and π-mesons. Recent experiments have enabled us to increase the accuracy of the determination of the relative frequency of occurrence of the two types, and we have obtained the value $N\sigma/N\pi = 1{\cdot}05 \pm 0{\cdot}25$.

In spite of the qualitative agreement between the new experimental results and the present assumptions, it is clear that the latter must be accepted, at present, with reserve. Prof. Klein[8] has raised the question, for example, as to whether the heavy negative mesons, which produce disintegrations and which are produced artificially, are, in fact, the negative counterparts of the positively charged

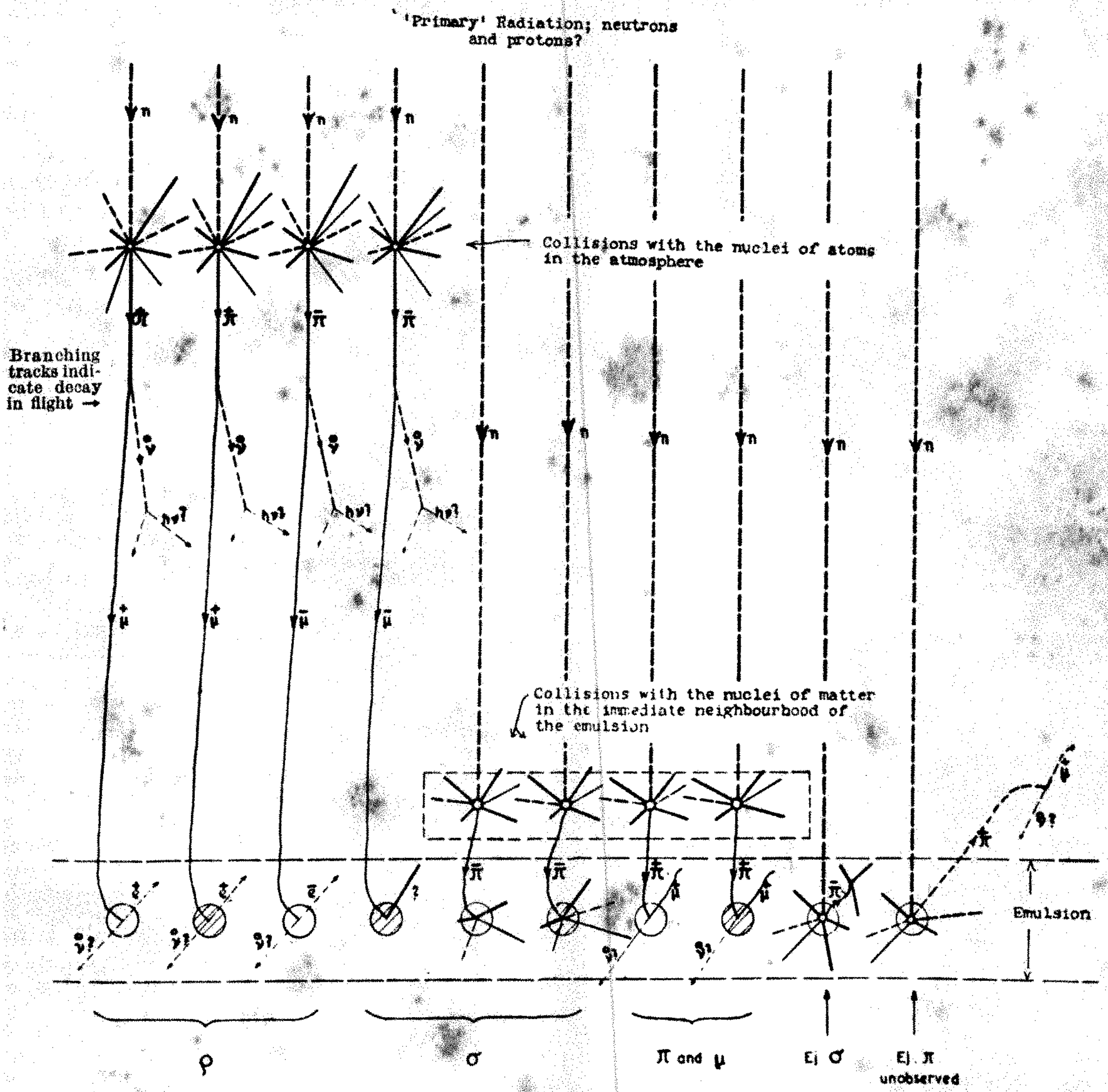
'Primary' Radiation; neutrons and protons?
n
Collisions with the nuclei of atoms in the atmosphere
π
Branching tracks indicate decay in flight →
ν
hν?
μ
Collisions with the nuclei of matter in the immediate neighbourhood of the emulsion
Emulsion
ρ
σ
π and μ
Ej σ
Ej π unobserved

Fig. 9. Tentative schematic representation of processes giving rise to the different classes of mesons, ρ-, σ-, π- and μ-mesons, observed in photographic emulsions

-mesons. While the approximate equality in the umbers of σ- and π-mesons observed in the cosmic adiation, and the determinations of their masses, ive strong support to the assumption that they are articles of the same type, it cannot be regarded as inally established. Secondly, the limits of error in he determination of the masses of the individual osmic-ray mesons are such that we cannot yet xclude the possibility that most of the ρ-mesons are mixture of different types, of different mass. Both hese points of uncertainty will presumably be larified when more accurate determinations of the nass of the different classes of particles have been nade.

In view of the above reservations, and of the ossibility that the ejected σ-mesons are composed f particles of different types, we may summarize he results of the present experiments in the following eneral terms. The mesons which we observe to be roduced also have a high probability, when reuced to low velocities, of producing nuclear disntegrations of both light and heavy elements, with the emission of heavy particles. Their behaviour is therefore consistent, in both respects, with the view that they have a strong interaction with nucleons.

We are indebted to Dr. Franzinetti and Dr. S. Rosenblum for some preliminary information on the sign of the charge of ρ-mesons obtained in magnetic deflexion experiments; to Dr. H. Fröhlich and Mr. P. H. Fowler for discussions on the relative numbers of ejected σ- and π-mesons; and to Mr. A. G. Meek for organising a safari for the ascents of Kilimanjaro to obtain the exposures at 16,000 ft.

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[2] Lattes, Muirhead, Occhialini and Powell, *Nature*, **159**, 694 (1947). Lattes, Occhialini and Powell, *Nature*, **160**, 453 and 486 (1947).

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NEWS and VIEWS

Hope Professorship of Zoology at Oxford:
Prof. G. D. Hale Carpenter, M.B.E.

THE best wishes of scientific men everywhere go to Prof. G. D. Hale Carpenter on the occasion of his retirement from the Hope professorship of zoology at Oxford. He has occupied this chair since 1933 when he succeeded the late Sir Edward Poulton. After taking his degree in the honours school of natural science at Oxford, Prof. Carpenter gained a scholarship at St. George's Hospital Medical School, London. There he completed the usual medical courses, and obtained the certificate with distinction of the London School of Tropical Medicine. Thus qualified, he joined the Colonial Medical Service in 1910 and was appointed in the same year to the Royal Society's Sleeping Sickness Commission in Uganda. In the First World War he served in the East African Campaign during the years 1914–18. Afterwards he was made specialist officer for the control of sleeping sickness in Uganda from 1920 until 1930 and, in the following year, he retired from the Colonial Service.

Settling in Oxford amid highly congenial surroundings, Prof. Carpenter identified himself with the aims of the Hope Department, and it must have been a source of gratification to him when he followed in the footsteps of the great protagonist of Darwinism only two years later. All through his African career he was an ardent field naturalist. His duties in connexion with tsetse-fly problems took him constantly into the field. Many of his experiences and observations are embodied in his two books "A Naturalist on Lake Victoria" (1920) and "A Naturalist in East Africa" (1925). While at Oxford he has established a teaching course in entomology and published in collaboration with E. B. Ford a handbook on "Mimicry" in Methuen's Biological Series. This latter book embodies much of Carpenter's original work and notably his field observations on mimetic Lepidoptera and their enemies. In this way he has replied to the many critics of the mimicry theory who, as often as not, had no such first-hand information with which to support their contentions. During his tenure of the Hope professorship, in addition to his writings on Lepidoptera, he has developed the scientific value of the associated collections along sound lines. In particular, predaceous insects and their prey and the evidence of bird attacks on Lepidoptera deserve special mention. Prof. Carpenter has served as president of the Royal Entomological Society of London (1945–46), and as a vice-president of the Linnean Society.

Dr. G. C. Varley

DR. G. C. VARLEY, who has been appointed to the Hope professorship of zoology at Oxford, was educated at Manchester Grammar School and went up to Cambridge with a major open scholarship in natural science at Sidney Sussex College in 1929. He obtained a first class in both parts of the Natural Sciences Tripos and was awarded the Frank Smart Prize for zoology in 1933. In the same year he was appointed to a research studentship at Sidney Sussex College and became superintendent of the Entomological Field Station. During 1935–38 he was a research fellow of his College and in the latter year he obtained the degree of Ph.D. for a thesis on "The Natural Control of the Knap-weed Gallfly". In 1938 he was appointed to a University demonstratorship and became curator of insects in the University Museum of Zoology at Cambridge. During the early part of the War, he was engaged in research on wire worm control, and in 1941 he joined the Army Operational Research Group of the Ministry o Supply. Here he did distinguished work on the application of radar to coast defence and was pro moted to the rank of senior experimental officer After the end of the War, in 1945, he was appointed to the readership in entomology in the Department of Zoology at King's College, Newcastle-on-Tyne Dr. Varley's main interests lie in the field of population studies with particular reference to insects, and he has a wide knowledge of the whole field of ecology He is a first-class naturalist and a man who has exceptional powers for interesting his students in al branches of his subject. His new appointment wil give him the opportunity of developing to the ful his chosen field of work at a university which has already made such important contributions to the study of animal ecology.

Paris Academy of Sciences:
Prof. Robert Courrier

THE Paris Academy of Sciences has two 'secrétaires perpétuels': Prince Louis de Broglie, and very recently, Prof. Robert Courrier, who was elected in May in succession to the late Prof. Alfred Lacroix Prof. Courrier, who was born in 1895, began his medical studies at Nancy, but they were interrupted by the First World War. On demobilization in 1919 he went to Strasbourg to work in the laboratory o the well-known endocrinologist, Prof. P. Bouin. He was appointed a professor in the Faculty of Medicine at Algiers in 1926, and went to Paris in 1938, where he has since held a chair in the Collège de France He was elected to the Academy of Medicine in 1941 and to the Academy of Sciences in 1944.

Prof. Courrier's work has been on the glands o internal secretion. One of his first investigations concerned the thyroid, when he showed that one can inhibit this gland by massive doses of the thyroid hormone. He produced important evidence in support of the theory of Prof. Bouin, on the elaboration of the male hormone by the interstitial tissue of the testicle. He played a large part in the early researches on the female sex hormones; he found in the human female the follicular hormone which Allen and Doisy had just discovered in the sow; he found this hormone outside the ovary, and in particular in the amniotic liquid, and he remarked that it could pass through the placenta and the mammary gland, and powerfully affect the fœtus and the newly born. He demonstrated the hormonal dualism of the ovary, at a time when leading workers held the view that only one hormone was secreted. With his pupils he has studied for a long time the functional relations connecting the two ovarian hormones, and he has made a detailed analysis of the endocrinology of gestation which he has described in a recently published book

Mathematics at University College, Bangor:
Mr. D. E. Littlewood

MR. D. E. LITTLEWOOD, whose appointment to the chair of mathematics at the University College o North Wales, Bangor, in succession to Prof. T. G Cowling, has recently been announced, is well known as an algebraist. His best-known work is concerned with the theory of group characters, a branch o algebra which has been extensively developed in the last fifty years and which has an unusually wide application to fields as diverse as the algebraic theory of invariants and modern quantum mechanics. Littlewood's work is in the direct line of tradition associated with the names of Frobenius, Alfred Young, and Schur; and his book, "The Theory of Group Characters" published in 1940, is a standard work on the subject. In recent papers, Littlewood has developed a calculus of a class of symmetric functions known as Schur functions which have recently been shown to have extensive applications in invariant theory.

Promethium, the New Name for Element 61

At a symposium held by the American Chemical Society at Syracuse University on June 30, J. A. Marinsky and L. E. Glendenin, who during the War had succeeded in separating element 61 from the other uranium fission products, proposed to christen this element 'promethium'. They explained their choice by a reference to Prometheus, "who stole fire from heaven for the use of mankind and for his audacity was chained to a mountain by the gods and set upon by vultures. This name not only symbolizes the dramatic way in which the element may be produced in quantity as a result of man's harnessing of the energy of nuclear fission, but also warns man of the impending danger of punishment by the vulture of war." In a review published some eighteen months ago (*Nature*, **159**, 8; 1947) the conclusion was reached that Prof. C. D. Coryell's group, to which Marinsky and Glendenin belong, had the strongest claim to the discovery of element 61 and was entitled to give it a name. Some may perhaps think the present proposal a little far-fetched, since there are more impressive effects of atomic energy known than the production of small quantities of a new rare earth, and classical students may take exception to the vultures—since Prometheus' quarrel was with Zeus, the bird sent by his antagonist to torture him was, naturally, an eagle; but the etymology of this new name will soon be of as little importance as that of dozens of other element names which are much less appropriate. There are still the rival claims for 'illinium' and, more recently, for 'cyclonium' (see *Chemical and Engineering News*, **25**, 2555; 1947), and it is, therefore, too early to say whether the chemists of Coryell's group will be generally recognized as the discoverers of element 61; but their brilliant work seems to merit this international recognition, and there is a great likelihood that promethium (symbol Pm) will take its permanent place in the table of the chemical elements.

Commonwealth Plant Breeders' Meeting

An informal meeting of Commonwealth plant breeders was held at the School of Agriculture, Cambridge, during June 24–25. Representatives from Australia, Canada, England, Malaya, New Zealand, Northern Ireland, Scotland, Sierra Leone, South Africa, Sudan, Tanganyika and Wales were present; Dr. P. S. Hudson, director of the Commonwealth Bureau of Plant Breeding and Genetics, acted as chairman. The proceedings of the meeting included a review by Dr. P. S. Hudson and Mr. R. H. Richens of the work of the Commonwealth Bureau of Plant Breeding and Genetics since the last similar meeting, short reports by the delegates of the principal lines along which plant breeding is developing in the various Commonwealth countries, and an account by Dr. P. S. Hudson of the results of the meeting held at Washington last April, between the Food and Agriculture Organisation, the Commonwealth Agricultural Bureaux, the U.S. Department of Agriculture and other bodies, on genetic stocks. Among the resolutions passed at the meeting, several deprecated any reduction in the number or length of the abstracts appearing in *Plant Breeding Abstracts*, the periodical published by the Commonwealth Bureau of Plant Breeding and Genetics; support was given to a proposal to institute a standing inquiry service whereby plant breeders should be sent details at regular intervals of all published articles bearing on their own field of research; and suggestions were made to provide for an efficient service for the maintenance of genetic stocks of crop plants. The proceedings of the meeting will be circulated to the delegates and to other interested bodies.

Olympic Torches

The Organising Committee of the XIVth Olympiad approached the Department of Scientific and Industrial Research in 1946 for assistance and advice on the design of a torch to be carried by relays of runners across Europe from the plain of Olympia to Wembley Stadium in London, and on the most suitable fuel. This problem was undertaken by the Fuel Research Station, and the actual investigation was carried out by Dr. L. R. B. Shackleton. After many trials, it was decided that the most suitable fuel was hexamine in the form of tablets. Hexamine gives a non-luminous flame, and to make the flame visible in all weathers 6 per cent of naphthalene was added. The fuel was manufactured by Promedico Products, Ltd., 22, Turle Road, London, N.4. Prototype torches made at the Fuel Research Station were tried out by runners, first from the South London Harriers and, after certain modifications in design, by officers from the Royal Naval College, Greenwich. In the final design of the torch, seven tablets are enclosed in a perforated metal cylinder with an inner sleeve concealing the lower three tablets. As the upper tablets burn away, the lower reserves are forced up into the burning zone by a spring. In order to facilitate lighting, the Wessex Aircraft Engineering Co., Ltd., Salisbury, provided a tablet of nitrate composition which was introduced on top of the fuel pack. A quick-match, provided for ignition, protruded through the perforated container. One or two final refinements were introduced at the concluding stages to safeguard the effectiveness of the torches during transport to the various countries through which the relay runners had to pass. The fuel tablets were totally enclosed in a nitro-cellulose cover provided by Cascelloid, Ltd., High Holborn, London. This cover burned immediately on ignition, leaving no carbon residue. The perforated metal fuel container was also capped and sealed with adhesive tape. Both of these precautions were considered necessary to preserve the fuel and to avoid any risks of accidental ignition.

Museum of the History of Science, Oxford

Since 1940 the Museum of the History of Science, Oxford, has been making inquiries as to the whereabouts of a number of valuable and irreplaceable objects which had been stored at the beginning of the War by the late curator of the Museum, Dr. R. T. Gunther. These included the oldest dated instrument in the world, an astrolabe dated A.D. 984, the astrolabes of Queen Elizabeth and Archbishop Laud, the sundial made by Nicolaus Kratzer for Cardinal Wolsey, and many other treasures. Dr. Gunther died without revealing the place where he had stored these valuables. They have now been found in the stone-vaulted basement of the Museum, packed in three cases which were labelled as containing various astronomical instruments of the late eighteenth century and mixed with a number of cases actually containing such instruments. By this means, it is conjectured, Dr. Gunther had intended not only to protect them from air attack but also from the searches of a possible invader. It is hoped that the Museum will open next October, when these treasures will be displayed once more to public view.

Use of Selenium for Pest Control

INVESTIGATIONS have shown that selenium salts, among other substances applied to the soil, are taken up by plants and will make the plants so treated poisonous to certain pests that attack them. Selenium compounds, such as sodium selenate, have lately been tried by a few growers for the control of chrysanthemum eelworm and some other pests of flower crops. This is dangerous because selenium compounds are poisons to man; moreover, they may persist for long periods in the soil, and if food crops are grown later in treated soil the plants may take up the poison in sufficient amount to make them injurious to health if eaten. For the present, neither sodium selenate nor any selenium compound should in any circumstances be used for pest control purposes. The Ministry of Agriculture and Fisheries understands that no proprietary insecticide containing selenium is manufactured in Great Britain.

Astronomical Instruments

SIR HOWARD GRUBB, PARSONS AND CO. have issued a catalogue of some of the astronomical equipment designed and manufactured by the Company. The photographs and illustrations are arranged in sections as follows: reflectors, refractors, domes, driving mechanism, breechpieces, transits, coelostats, objectives and mirrors, and also "In the Workshops". The illustrations do not represent in every detail the latest design practice because advances in engineering technique during the War are now applicable in some cases to the design of astronomical equipment. At the end of the book there is a list of the large telescopes—twelve altogether—manufactured by the Company between 1927 and 1947.

The Night Sky in August

NEW moon occurs on Aug. 5d. 04h. 13m., U.T., and full moon on Aug. 19d. 17h. 32m. The following conjunctions with the moon take place: Aug. 2d. 07h., Venus 9° S.; Aug. 9d. 05h., Mars 2° S.; Aug. 14d. 04h., Jupiter 4° N.; Aug. 31d. 03h., Venus 8° S. Mercury, which rises an hour before the sun on Aug. 1, is in superior conjunction on Aug. 11, and is badly placed for observation during the greater portion of the month. Venus rises at 1h. 40m., 1h. 20m. and 1h. 15m. at the beginning, middle and end of the month, respectively, and can be seen for some hours before sunrise. The stellar magnitude of the planet is about −4·2 throughout August, and the visible portion of the illuminated disk varies from 0·3 to 0·47. Mars sets at 21h. 38m., 20h. 55m. and 20h. 10m. at the beginning, middle and end of the month, respectively, and can be seen for a short time after sunset. Jupiter, in the constellation of Ophiuchus, can be seen low in the evening, setting at 0h. 25m. and 22h. 30m. on Aug. 1 and 31, respectively. The planet is stationary on Aug. 16. Saturn, in conjunction with the sun on Aug. 19, is not well placed for observation. On Aug. 31 the planet rises an hour before the sun but is practically unobservable. No occultations of stars brighter than mag. 6 occur during August. The Perseid meteors attain a maximum about Aug. 10–12, but moonlight will partly interfere with the observation of the shower at that time.

Announcements

WE regret to announce the death of Sir Clifford Paterson, O.B.E., F.R.S., director of the Research Laboratories of the General Electric Co., Ltd., which occurred on July 26.

PROF. RAOUL COMBES, professor of plant biology in the University of Paris, has been elected to the Section of Botany of the Paris Academy of Sciences in succession to the late Prof. P. A. Dangeard.

IN commemoration of the centenary of the birth o Baron Roland von Eötvös (see *Nature*, July 24 p. 135), a small collection illustrating his work has been arranged at the Science Museum, London. It will remain on view until September.

THE Managers of the Royal Institution have appointed Dr. D. P. Riley, University demonstrator in the Department of Mineralogy and Petrology Cambridge, to the Dewar Research Fellowship tenable in the Davy Faraday Laboratory of the Royal Institution. Dr. Riley will undertake a programme of research on the application of methods of X-ray diffraction analysis to the study of the structure of colloidal systems and biological materials

PART of the exhibition of photographs demonstrating the value of air photography to archæology recently held in London (*Nature*, July 17, p. 96) has been transferred to the Ashmolean Museum, Oxford for the period August 2–September 4.

A SYMPOSIUM on the "Chemistry, Metabolism and Biological Effects of Steroid Hormones" will be held in the University of Wisconsin, during September 6 8, under the auspices of the University of Wisconsin and the U.S. National Research Council Committee on Growth, acting for the American Cancer Society Among the topics to be discussed are: clinical use of steroids in gynæcology; growth and fattening of animals; metabolism and excretion of steroids relation of structure to function of steroids; lactation and reproduction in animals; clinical and experimental work on cancer; metabolism of convalescence; sex differentiation and steroids. The symposium will be open to the public. Further particular can be obtained from Dr. Edgar S. Gordon, chairman Symposium Committee, University of Wisconsin.

THE Science Co-operation Office in Cairo of th United Nations Educational, Scientific and Cultura Organisation has compiled a very useful list o scientific papers published in the Middle East and received by the Office up to March 1, 1948. Th papers are classified under mathematics, mechanic and physics, chemistry, geology and geophysics botany, zoology, medical sciences, engineering agriculture and psychology, and there are single entries under palæontology and biology. Most o the entries are under zoology, medical sciences, agriculture and psychology. A list of periodicals reviewed includes particulars of frequency, price an the name and address of the publisher, the periodicals being arranged by countries.

LETTERS TO THE EDITORS

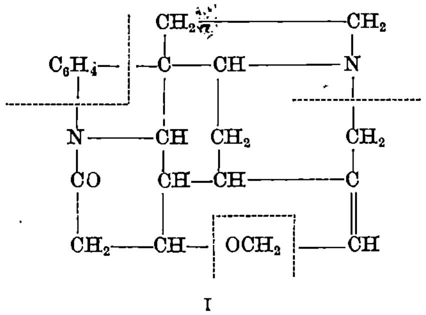
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Synthesis of Vomipyrine

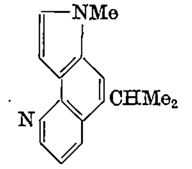
An outstanding result of Wieland's long series of investigations of vomicine was the degradation of the alkaloid to a base, $C_{15}H_{16}N_2$, termed vomipyrine[1]. This afforded yellow salts, and the spectrochemical behaviour clearly indicated its constitution as an alkylated pyrroquinoline, $C_{11}H_7N_2 . C_4H_9$, although the position of fusion of the rings and the position and distribution of the alkyl group or groups (2Et, Me, Pr, Bu, etc.) was unknown. Guesses based on the earlier strychnine formulæ were disproved by synthesis[2].

Even with the strychnine formula (I) now considered to be established beyond doubt[3] there remained some ambiguity. Our first idea was that vomipyrine should be 5-*iso*butyl-7 : 8-pyrroquinoline[4]; but a few months ago, Prof. H. Wieland kindly informed us that vomipyrine contained a methylimino-group. This modified our view and the base was then thought to be Ind-N-methyl-5-propyl-7 : 8-pyrroquinoline or Ind-N-methyl-5-*iso*propyl-7 : 8-pyrroquinoline (II). There was little evidence to enable a choice to be made between these, or, what is the same thing, to locate the carbon atom which is extruded from the skeleton.

However, a carbon atom had been lost once before, namely, in the distillation of the products of reduction of methylstrychninium salts. In this case the conclusion was reached that a carbon atom attached to oxygen had been eliminated[5]. Therefore, the constitution with an *iso*propyl group was favoured for vomipyrine.



I



II

The dotted lines in (I) indicate the fissions assumed to occur; the N-methyl group of (II) is not present in (I) but occurs in the related vomicine structure[6].

We therefore decided to synthesize a base of the constitution (II), and in the first place studied methods for the preparation of the hitherto unknown 7 : 8-pyrroquinoline itself. An application of the modified Skraup reaction[7] to 6-nitro-*o*-toluidine afforded 7-nitro-8-methylquinoline, m.p. 134–134·5°, and this, by reduction and formulation, was converted into 7-formamino-8-methylquinoline, m.p. 157°. Cyclo-dehydration to 7 : 8-pyrroquinoline, m.p. 216–217°, occurred on heating with potassium *t*-butoxide, although the yield was small. Treatment of this base with potassamide in liquid ammonia, followed by methyl iodide, yielded Ind-N-methyl-7 : 8-pyrroquinoline, m.p. 112°. The salts of the two tricyclic bases were yellow and the absorption spectra of the bases were like those of vomipyrine and other pyrroquinolines.

The way was thus open to an unambiguous synthesis of (II). *p*-Cymene was dinitrated[8] and reduced to 6-nitro-2-amino-*p*-cymene. The Bradford, Elliott and Rowe technique[7] was used in the preparation of 7-nitro-8-methyl-5-*iso*propylquinoline, m.p. 88°. This was reduced to the amine, m.p. 109°, which was formylated (m.p. 123°) and cyclo-dehydrated as above to 5-*iso*propyl-7 : 8-pyrroquinoline, m.p. 182–183° (hydrochloride, sinters at 222°, liquid at 226°; Wieland's base, $C_{14}H_{14}N_2$, obtained as a by-product in the formation of vomipyrine, was an oil; hydrochloride, sintered at 220°, m.p. 240°). The potassamide – liquid ammonia – methyl iodide method then gave the desired Ind-N-methyl-5-*iso*-propyl-7 : 8-pyrroquinoline (II), m.p. 108–108·5°. The base crystallized from light petroleum (b.p. 60–80°) in flat, rectangular, colourless plates, but two opposite angles were usually truncated, giving a six-sided outline. The ultra-violet absorption in methanol showed maxima at 2660 A. (log ε, 4·17) and 3380 A. (log ε, 3·75). There is a slight discrepancy here since Wieland and Horner[9] give for vomipyrine maxima at 2677 A. (log ε, 4·4) and 3347 A. (log ε, 3·8); the possible error indicated was, however, ± 20 A.

All doubt was dispelled when Prof. Wieland kindly furnished us with a small specimen of authentic vomipyrine. We are very grateful to him for this collaboration. This specimen crystallized from light petroleum in the characteristic six-sided plates and had m.p. 106·5–107·5° after drying at 50°/20 mm. Mixed with our synthetic base, the melting point was 108·5° after sintering at 107°.

Crystallographic, including X-ray, comparisons of the two specimens showed complete identity, and we are greatly obliged to Mrs. D. Hodgkin for kindly undertaking this work.

The bases fluoresced identically blue-violet in ethereal solution and gave identical (characteristic) Hopkins – Cole and pine-splinter reactions.

The importance of vomipyrine, always great, was enhanced by the recent demonstration of the relation of vomicine to strychnine[6]. It was then pointed out that vomicine chemistry had acquired a direct bearing on the strychnine problem. Although it is true that the constitution of strychnine is already established, the proof is a long one and, though rigid, it demands a close and critical study of a most complex branch of structural chemistry. The synthesis of vomipyrine facilitates a more direct approach. It confirms the constitution (I) in regard to those features that have been regarded by some authors as most open to criticism.

It is worthy of note that degradation products, which have been synthesized, cover the entire carbon and nitrogen skeleton and all the rings except that which includes the cyclic ether group. These products are dinitrostrychol, tryptamine, carbazole, vomipyrine and β-collidine. There is sufficient overlap to fix the positions of fusion of the rings.

R. ROBINSON
A. M. STEPHEN

Dyson Perrins Laboratory,
University, Oxford.
July 7.

[1] Wieland, H., and Horner, L., *Annalen*, 528, 73 (1937).
[2] Horner, L., *Annalen*, 540, 73 (1939); cf. ref. 9.
[3] Robinson, R., *Experientia*, 2, 28 (1946). Openshaw, H. T., and Robinson, R., *Nature*, 157, 438 (1946). Chakravarti, R. N., and Robinson, R., *Nature*, 160, 18 (1947).
[4] Pausacker, K. H., and Robinson, R., *J. Chem. Soc.* (in the press, 1948).
[5] Perkin, W. H., Robinson, R., and Smith, J. C., *J. Chem. Soc.*, 1239 (1932).
[6] Bailey, A. S., and Robinson, R., *Nature*, 161, 433 (1948).
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[8] Kyker, G. C., and Bost, R. W., *J. Amer. Chem. Soc.*, 61, 2469 (1939)
[9] Wieland, H., and Horner, L., *Annalen*, 536, 89 (1938); cf. ref. 2.

Structure of Dunnione

THE investigation of dunnione and its transformation products by Price and Robinson[1] did not completely establish the structures of these compounds. The work was interrupted by the War; but Dr. Price has recently suggested that the further examination of these substances be included in a programme of research on quinones which is proceeding in this Laboratory. As closely related work is being done in the United States, it seems desirable to give a brief preliminary report of the scope of the present investigations, and of the results already obtained.

The structures previously assigned to dunnione and the *iso*-dunniones have been confirmed by the synthesis of *dl*-dunnione and β-*iso*-dunnione. Claisen rearrangement of 2-γγ-dimethylallyloxy-1 : 4-naphthaquinone gives rise to two products: the normal rearrangement product, 2-hydroxy-3-αα-dimethylallyl-1 : 4-naphthaquinone (m.p. 70–71°), and the abnormal product, 2-hydroxy-3-αβ-dimethylallyl-1 : 4-naphthaquinone. The latter compound proved to be identical with the *iso*-dunniol of Price and Robinson (*loc. cit.*), and by ring closure with sulphuric acid it is converted to αββ-trimethyldihydrofurano-1 : 2-naphthaquinone identical with the β-*iso*-dunnione derived from natural dunnione. Similarly, ring closure of the normal rearrangement product gives ααβ-trimethyldihydrofurano-1 : 2-naphthaquinone (m.p. 93–94°), which is evidently the racemic modification of dunnione. Its melting point is not depressed by mixing with the natural dextrorotatory pigment (m.p. 98–99°), and on treatment with cold alkali it is gradually converted to two products, which are evidently *dl*-α-dunnione (m.p. 110–111°) and *dl*-*allo*-dunnione (m.p. 141–142°). The first of these gives β-*iso*-dunnione on heating with sulphuric acid, and the second shows the characteristic absorption spectrum previously recorded[2] for the dextrorotatory *allo*-dunnione derived from natural dunnione.

It is noteworthy that the normal Claisen rearrangement of the γγ-disubstituted allyl ether was accomplished simply by boiling an alcoholic solution under reflux for a few hours. The yield was 93 per cent. When the ether was heated for a few minutes, without solvent, at a temperature slightly above its melting point, the main product was that resulting from abnormal rearrangement.

The structure of β-*iso*-dunnione has also been proved by an independent synthesis starting from 2-hydroxy-3-βγγ-trimethylallyl-1 : 4-naphthaquinone (m.p. 169–170°).

With the structures of these compounds thus established, it seems evident that the change from the dunnione to the *iso*-dunnione structure is simply a somewhat unusual example of the Wagner–Meerwein type of rearrangement.

Furthermore, it seems probable that the rearrangement of dunnione to *allo*-dunnione involves a reaction characteristic of 2-hydroxynaphthaquinones having a tertiary alkyl group in the quinone ring. This hypothesis is supported by the observation that 2-hydroxy-3-αα-dimethylallyl-1 : 4-naphthaquinone undergoes a similar reaction when heated with aqueous alkali, giving a product (m.p. 148–149°) which dissolves in aqueous sodium bicarbonate to give a *yellow* solution. An analogous product is obtained by the action of alkali on 2-hydroxy-3-ααβ-trimethylallyl-1 : 4-naphthaquinone (m.p. 81–82°).

Full details of this work will be published elsewhere.

R. G. COOKE

Organic Chemistry Laboratory,
University of Melbourne.
April 2.

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A Natural Precursor of the Folic Acid Complex

RECENTLY Elvehjem and his co-workers[1] have demonstrated the presence, in rat liver homogenates, of a natural precursor capable of conversion by enzymes also present in liver to material having folic acid activity. They base the use of the term 'folic acid' on the fact that there is no evidence that the material produced is identical with pteroylglutamic acid. The same considerations apply to its use in the present communication.

Following observations made some time ago[2] that similar activity can be produced chemically by the interaction of histidine with certain components of an acid hydrolysate of casein, I have indicated[3] that this amino-acid may also act as a biological precursor of some member of the folic acid complex, and it now appears that in all probability it is identical with the precursor described by Elvehjem.

An enzyme capable of converting histidine into material having growth-stimulatory activity for *Streptococcus fæcalis* R. has been shown to be widely distributed in Nature. It occurs in relatively high concentration in mouse skin tissue, mouse and cat liver, hog spleen and duodenum and in horse heart. Certain of these tissues contain preformed growth factor, as is shown by the fact that samples heated to destroy enzyme activity induce marked growth and acid production in cultures of *S. fæcalis* R. (cf. Table 1). Also apparently they contain appreciable amounts of the precursor postulated by Elvehjem, since incubation of fresh samples causes an increase in activity.

Table 1. The activity of cat liver extract in producing folic acid from histidine at *p*H 7·4, estimated in terms of ml. *N*/20 acid produced in 10 ml. cultures of *S. fæcalis* in 18 hr. after the addition of 1 ml. of the mixture

Mixture incubated for 18 hr.	Acid production (ml. *N*/20)
0·5 ml. liver + 5·5 ml. phosphate buffer	4·45
0·5 ml. liver (boiled) + 5·5 ml. phosphate buffer	4·10
0·5 ml. liver + 5·0 ml. phosphate buffer + 0·5 ml. 0·1 per cent histidine	5·45
0·5 ml. liver (boiled) + 5·0 ml. phosphate buffer (solution + 0·5 ml. 0·1 per cent histidine solution)	4·15

These preparations, in addition to the activity lready present, are capable of producing increased ctivity when incubated in the presence of histidine. 'able 2 shows the increased acid production in ultures of *S. fæcalis* induced by the addition of 1ouse skin extract after incubation with various uantities of histidine at *p*H 7·4 for 18 hr.

able 2. Activity of 0·2 ml. mouse skin extract incubated for 18 hr. at 37° C. with histidine

Addition of histidine (μgm./ml.)	Acid production (ml. *N*/20)
150	3·31
75	3·32
37·5	2·91
18·0	2·47
0	1·45

As a preliminary to a separation of the active omponent of the enzyme complex present in an xtract of cat liver, a preparation of vitamin B_c onjugase using this extract as source was made. Vhen tested for folic acid production, it was shown hat the fraction soluble in 50 per cent saturated mmonium sulphate solution which contained the onjugase was not adequate, but that the precipitate om this fractionation was also necessary for the eaction with histidine to take place.

The presence of relatively large amounts of folic cid in the liver preparations made separation and esting rather difficult, and the possibilities of horse eart were examined, since although it has only bout one quarter the activity per mgm. dry weight, he preformed folic acid content is about one half hat in the liver preparations. Partial purification as been effected by making use of the absorption f the protein on paper pulp in the presence of concentrations of ammonium sulphate which were insufficient to produce a precipitate. Treatment of his material with lower concentrations of ammonium ulphate elutes the activity quite effectively.

25 mgm. of dried horse heart (prepared at 40° C. by iobin, Ltd.) was extracted with 200 ml. of *M*/15 hosphate buffer at *p*H 7·4. After filtration through Seitz filter, the filtrate was diluted to 600 ml. with uffer one-third saturated with ammonium sulphate, nd 50 gm. of paper pulp added. It was shaken or two hours and filtered. The paper was resusended in 600 ml. of *p*H 7·4 buffer, 8·3 per cent aturated with ammonium sulphate, and reshaken. he paper after filtration was resuspended in 600 ml. vater and treated as before. Table 3 records the ctivity of the various stages in this fractionation, howing that the majority of the enzyme is eluted y the dilute sulphate solution.

Table 3. Activity of fractions of a horse heart extract

Mixture incubated	Acid production ml. 0·5 *N* acid	
	Actual	Increase due to histidine
·1 ml. Original extract	0·12	
·1 ml. Original extract + 500 μgm. histidine	0·46	0·34
·3 ml. Paper filtrate	0·01	
·3 ml. Paper filtrate + 500 μgm. histidine	0·08	0·07
·3 ml. Paper $(NH_4)_2$ SO_4 eluate	0·14	
·3 ml. Paper $(NH_4)_2$ SO_4 eluate + 500 μgm. histidine	0·50	0·36
·3 ml. Paper water eluate	0·04	
·3 ml. Paper water eluate + 500 μgm. histidine	0·08	0·04

In view of the fact that the enzyme system escribed above has been shown not to be identical vith vitamin B_c conjugase, and the fact that Elvehjem as shown his enzyme to have a different *p*H optimum om the conjugase, it would appear likely that the two may be identical. The partially purified enzyme, after elution from the paper, has an optimum activity at *p*H 7·8, as opposed to the *p*H 7 optimum observed by Elvehjem. Such a drift, however, often occurs on purification. Assuming that the enzyme systems are identical, it would follow that the substrates are also related, if not identical. It has been shown that arginine and, to a certain degree, glutamic acid can replace histidine as substrate for the folic acid producing enzyme. Edlbacher[4] and Walker[5] have postulated the production of unstable intermediates in the oxidation of histidine in the liver. These intermediates, formamidino glutaric acid and formyl glutamine, bear a considerable structural similarity to arginine; and glutamic acid is the end point of the degradation. It may therefore be that the true substrates for the enzyme producing folic acid may be the unstable hexone bases produced during the oxidative deamination of histidine.

The implications of these observations are far-reaching in their effect on firmly held theories regarding the mammalian metabolism of the folic acid complex. If tissues of such a large variety of animals are capable of synthesizing folic acid *in vivo* as well as *in vitro*, doubt must be cast on theories attributing sulphonamide-induced blood dyscrasias to intestinal sterilization. Also it may be expected that the presence of amino-acids in biological materials will tend to produce discrepancies in microbiological assays of the growth factor.

A fuller account of these investigations will be given elsewhere.

DAVID A. HALL

Department of Medicine,
School of Medicine,
Leeds.

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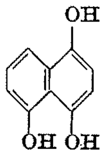
Hydrojuglone and Apparent Vitamin C in Walnuts

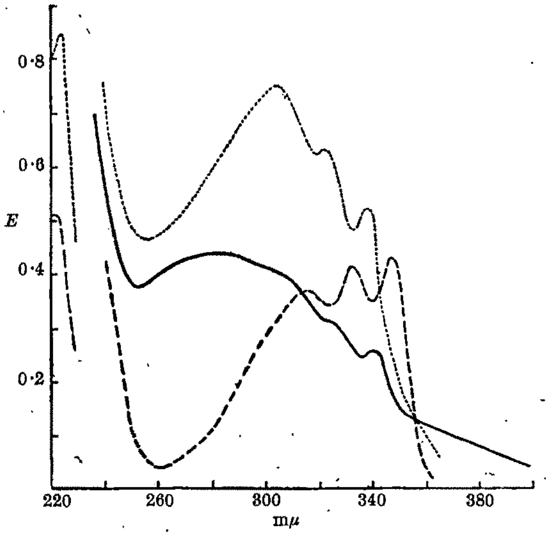
PREVIOUS communications from these laboratories[1-4] have shown that associated with the remarkably high concentrations of true vitamin C in different tissues of the walnut (*Juglans regia*) and allied species are considerable amounts of non-specific dye reductants provisionally termed[5] 'apparent vitamin C'. The proportion of apparent vitamin C in the total dye reductants varies from less than 5 per cent in the endocarp to more than 90 per cent in resting buds and catkins. We have now obtained evidence that this so-called apparent vitamin C in walnuts is mainly, if not entirely, a derivative of hydrojuglone or 1 : 4 : 5 trihydroxynaphthalene:



Extracts of resting buds and catkins from various walnut trees around London were made in ethanol containing 5 per cent v./v. hydrochloric acid AnalaR, which inhibited enzyme action and rendered the extracts stable for one to two weeks when stored in the refrigerator under nitrogen. The clear green extracts diluted with acid alcohol or alcohol and examined in a Beckman Model DU spectrophotometer gave absorption curves with the following maxima:

$$\sim 270,\ 283\text{–}285,\ \sim 305,\ 325,\ 342,\ \sim 360\ \text{m}\mu$$

(see graph). When these extracts were adjusted to pH 4·0 with N sodium hydroxide and chromatographed on alumina the following bands were obtained (reading from top): dark green, light greenish-yellow, lilac (turning green in acid alcohol). On development with 60–70 per cent alcohol the lilac band readily washed out of the column and was collected with the filtrate. Mineral acid was needed to remove the other two bands. The filtrate contained practically the whole of the dye reductants present in the original extract and showed maxima at 225, 305, 326 and 342 mμ in acid alcohol. The relative intensities of the peaks were unaffected by further adsorption on alumina, barium sulphate or lead acetate. Oxidation with N/100 iodine at pH 1 formed a yellow compound, soluble in ether, giving maxima at 249 and 425 mμ, corresponding with those for juglone.



Absorption curves of synthetic hydrojuglone — — —, of hydrojuglone derivative separated from male catkins of *J. regia* - - - -, and of the original acid alcoholic extract of the catkins ——. The maxima at 221–224 mμ for synthetic hydrojuglone and for the hydrojuglone derivative were obtained with dilutions of 1 in 4 and 1 in 5 respectively of the extracts used for obtaining the main parts of the curves

Hydrojuglone, which we prepared from juglone by reduction with zinc and hydrochloric acid, and by shaking out an ethereal solution of juglone with an aqueous solution of sodium hydrosulphite, gave the four maxima detected in the filtrate, but at slightly longer wave-lengths (namely, 225, 315, 334 and 348 mμ), these differences being probably due to ester formation in the natural product. The movement to shorter wave-lengths of the reduced form on esterification has been checked using juglone acetate. Such ester formation would also explain the much greater stability of the natural product as compared with synthetic hydrojuglone, which can lose most of its dye-reducing power and change back to a juglone within a few hours, especially on exposure to sunlight. Such change is accompanied by development of yello colour, which also occurs when walnut extracts containing apparent vitamin C are titrated with th indophenol dye, and the increase in yellow colour thu produced has been found to be roughly parallel t the content of apparent vitamin C in numerou extracts prepared from different walnut tissue during the last two or three years. The dye titratio value of synthetic hydrojuglone has been found t vary with the titration pH in the manner which on of us (F. W.)[6] has previously shown to be characteristic of apparent vitamin C in walnut extracts, thu clearly distinguishing it from reductone and othe possible constituents of apparent vitamin C.

The occurrence of hydrojuglone in different walnu tissues has been known for many years[7]. We hav not been able to find in the literature any referenc to naturally occurring compounds of hydrojuglone o to its possible relationship to vitamin C. Mor recently, Lugg and Weller[8] considered the possibilit of hydrojuglone being present among the non-specifi dye reductants in walnuts, but (owing probably t their attention being concentrated on fairly matur fruit) did not find any significant amount of it i their experimental materials. Our spectroscopic an dye titration results show that in resting buds an catkins there may be more than 3 per cent of hydrojuglone, calculated on the fresh material, an accounting for practically the whole of the dy titration. During growth and development this percentage gradually falls, concurrently with a stead increase in the concentration of ascorbic acid. Ou evidence indicates that in growth and developmen of walnut tissues hydrojuglone, in association wit ascorbic acid, may play a more important part tha has hitherto been suspected. We hope to publis more details later.

We are indebted to Dr. R. Melville, of the Roya Botanic Gardens, Kew, for samples of walnuts an botanical information, and to Miss Nora Baxter an Miss Elaine Finnegan for assistance in preparatio of numerous extracts.

This investigation forms part of the work for University of London Ph.D. thesis by one of u (C. D.).

C. Daglish
Frank Wokes

Ovaltine Research Laboratories,
King's Langley, Herts.
April 23.

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Effect of Salt on Partition Chromatogram

THE adverse effect of salt on partition chromatograms on paper has been mentioned by Consde Gordon and Martin[1], and a method for removing sal from mixtures of amino-acids and peptides has bee recently described by these authors[2]. If such desalted solutions are then fractionated on pape chromatograms and the individual spots washed o the paper and hydrolysed with 6 N hydrochloric acid in capillary tubes, some salt is reintroduced, presumably from the glass. Electrodialytic desalting is now scarcely practicable owing to the number and very small volume of these solutions.

Fortunately, the amount of salt present is insufficient to prevent the final analysis of the hydrolysates on further paper chromatograms. Under these conditions, the effect of salt on the ninhydrin-treated chromatograms is usually seen as a yellow spot in the glycine – alanine region when phenol – coal gas – ammonia has been used as solvent. Sometimes there is also an opaque 'waterlogged' spot visible nearer the origin of the chromatogram while still wet with solvent. The salt effect is much smaller when 'Pyrex' instead of soda glass capillary tubing is used.

If the chromatogram, prior to treatment with ninhydrin, is extracted with toluene to remove traces of phenol and then sprayed, after drying, with thymol blue solution, a blue spot appears in exactly the same part of the chromatogram as would have been occupied by the yellow (ninhydrin) spot, thus indicating the presence of alkali in this area. Spraying with methyl red solution instead of thymol blue reveals a red (acid) spot nearer the origin corresponding to the position of the 'waterlogged' spot.

These effects were reproduced on chromatograms of amino-acids mixed with sodium chloride or sulphate (10–20 μgm. of each) and on chromatograms of these salts alone. The observations suggested that the alkalinity which often prevents the full development of the colours with ninhydrin of those amino-acids which occur in that region might be eliminated by the use of acidified ninhydrin solution. This proved to be the case when acetic acid (1 per cent v./v.) was added to the ninhydrin solution (0·1 per cent in *n*-butanol). With mixtures containing relatively high concentrations of salt, waterlogging becomes so important as seriously to distort the top part of the chromatogram, and the alkalinity may be sufficiently high to prevent entirely the development of the colours of glycine, threonine, alanine and tyrosine with unacidified ninhydrin. Nevertheless, even under these conditions, by the use of acidified ninhydrin, the colours of these amino-acids are revealed and show no distortion and no alteration of their R_F values. The separation of salts into cations and anions has also been observed with other solvent systems. With *s*-collidine, the effect is reversed, the acid spot being the faster and appearing in the valine – leucine region, and the alkali spot appearing near glycine.

It is hoped that these observations may be helpful to those investigators who are using chromatographic techniques.

P.S.—Since submitting this letter, we have seen the paper by Partridge and Westall[3], who also observe the separation of inorganic salts into ions, on paper chromatograms.

R. CONSDEN
A. H. GORDON

Wool Industries Research Association,
Torridon,
Headingley,
Leeds 6.

April 20.

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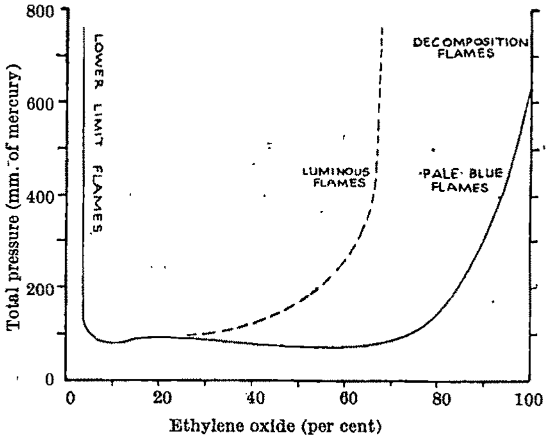
Ethylene Oxide Explosions

THE occasional occurrence of ethylene oxide explosions during the fumigation of dried fruit has led us to undertake a detailed study of the combustion characteristics of the vapour. An examination of the effect of pressure on the spontaneous ignition temperatures has yielded results somewhat like those for acetaldehyde[1,2]. Cool flames can be *initiated* in ethylene oxide – air mixtures in the neighbourhood of 330° C. at atmospheric pressure.

The effects of pressure on flame propagation in ethylene oxide – air mixtures have been observed in a closed glass tube, 5 cm. in diameter, using hot-wire ignition. With the tube vertical and ignition at the lower end, continuing flame propagation can occur at atmospheric pressure in all mixtures containing more than 3·6 per cent of ethylene oxide. With increasing proportions of the combustible above the lower limit, the flame changes from non-luminous to luminous in the usual way, and approaching about 68 per cent a normal upper limit flame is obtained. Beyond this point, however, the flame loses its luminosity and becomes pale blue; this continues while any air is present in the mixture. In the absence of air, ethylene oxide propagates an even less luminous blue decomposition flame, but at a higher speed and with greater pressure increase.

The effect of reduced pressure on these phenomena, under the conditions of experiment, is shown in the accompanying graph. The decomposition flame is propagated down to 630 mm. pressure; but below this an upper limit for ethylene oxide – air appears and the inflammable range is narrowed, being finally eliminated at about 70 mm.

Neither the blue flame with rich mixtures nor the decomposition flame is propagated vertically downwards, and under such conditions an upper limit is observed corresponding approximately to the boundary for luminous flames shown as a broken line in the graph.



The blue flame obtained with the rich mixtures no doubt corresponds with that observed under slightly different conditions by G. W. Jones and R. E. Kennedy[3], and by R. M. Jones[4] with mixtures containing up to 80 per cent of ethylene oxide. Coward and Jones[5] suggest that the flame is analogous to the cool flame of diethyl ether, but our investigations indicate that this is not so. The flame is, in fact, initiated at too high a temperature and too low a pressure for such to be the case, and we have tentatively formed the opinion that it is associated with the endothermic character of ethylene oxide. Very similar behaviour has been noted by Forsyth and Townend[6] using ethylene – air and ethylene – oxygen mixtures, and recently, Mr. G. Williams-Leir, working with one of us in this Department, has obtained further evidence of a range of non-luminous flames beyond the recognized upper limit of ethylene in air at atmospheric pressure[7].

We have also succeeded in establishing limiting conditions of temperature and pressure for the spontaneous explosive decomposition of ethylene oxide, and are studying the kinetics of the explosion limit in relation to the work of earlier investigators of the kinetics of the slow decomposition[8–10].

The investigation as a whole is being continued and detailed results will be published in due course.

J. H. BURGOYNE
F. A. BURDEN

Department of Chemical Engineering and
Applied Chemistry,
Imperial College of Science and Technology,
London, S.W.7.
April 5.

[1] Kane, G. P., Chamberlain, E. A. C., and Townend, D. T. A., *J. Chem. Soc.*, 436 (1937).

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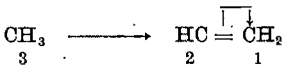
Radical Addition Reactions

VARIOUS theories have been advanced to explain the direction of addition of neutral unsymmetrical radical reagents to unsymmetrical unsaturated systems. Such addition is often 'abnormal' as compared with the 'normal' additions observed with ionic reagents. Thus Waters[1] states that "free radicals . . . react preferentially at points of high electron density", and Mayo and Walling[2] have suggested that the direction of addition is governed by the relative heats of formation of the two alternative intermediates in the addition. No disagreement with the views of the latter authors can be advanced because there is, in general, no method of accurately evaluating such constants. The statement by Waters, on the other hand, is not in agreement with the present experimental data, since his view would imply that neutral radicals are electrophilic in character.

Recorded observations on the addition of radicals to unsymmetrical unsaturated systems can be explained if it is presumed that radicals attack preferentially at points of high 'differential electron density' —differential, that is, with respect to the symmetrical *unsubstituted* systems. Examples will make this clear. With benzene, already substituted by either *o*-, *p*- or *m*-directing groups, the greatest differences in electron density with respect to unsubstituted benzene occur at the *o*- and *p*-positions; the *m*-position is relatively unaffected. Free radicals attack benzene derivatives principally at the *o*- and *p*-positions[3].

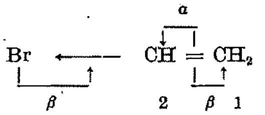
In propylene the inductive effect (+ *I*) of the methyl group is usually considered to initiate a mesomeric effect as in (I), which more than compensates for the drift of electrons from C_3 towards C_2.



I

C_1 is thus more negative than C_2 and also has the higher differential electron density with respect to unsubstituted ethylene; in agreement, atomic bromine, in abnormal addition, adds to C_1.

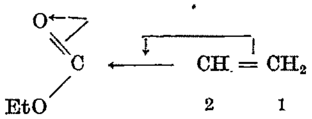
A similar argument applies to (say) vinyl bromide (II). Here the position is more complicated in



II

that the inductive effect (– *I*) of the bromine atom initiates the mesomeric effect (α), which in turn is partially compensated by the mesomeric effect (β). Although (β) is of dominant importance for ionic addition, where it becomes an electromeric effect in the transition state, the negative end of the dipole in vinyl bromide lies at the bromine atom, thus showing that (α) is more important in the unexcited compound. Following the argument given for propylene, the position of maximum differential electron density is at C_1 in agreement with the direction of 'abnormal' addition of bromine atoms.

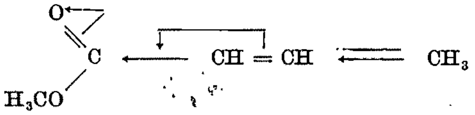
In α : β-unsaturated esters, such as ethyl acrylate (III), both ionic and radical addition of unsymmetrical



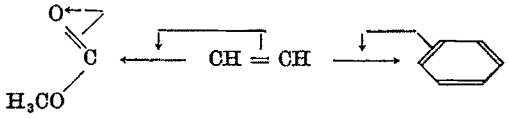
III

addenda furnish the same products[3]. This is again in agreement with prediction. The $-CO_2Et$ group exerts an inductive effect (–*I*) on the ethylenic linkage and also the mesomeric effect (–*M*) illustrated. For electrophilic attack C_2 obviously has a greater electron density than C_1, as indeed is shown by the direction of electrophilic ionic addition, which is contrary to the Markownikoff rule. But radical reagents, like bromine atoms, do not attack C_2 but C_1, where the differential electron density is clearly greater than at C_2. This last example is one where it is possible to distinguish without ambiguity between the predictions of Waters' theory and the one propounded here.

It has recently been shown by Koelsch and Boekelheide[4] that aryl radicals add to the β-position in methyl crotonate (IV), but to the α-position in methyl cinnamate (V). Such reversal of addition is easily understood when it is remembered that the inductive effect (–*I*) of the carbomethoxyl group is greater than that due to phenyl, and that the change in electron density at the β-carbon atom in methyl cinnamate, due to the mesomeric effect (– *M*) imposed by the carbomethoxyl group, is compensated by the mesomeric effect (+ *M*) of the phenyl group.



IV



V

D. H. R. BARTON
(I.C.I. Fellow)

nperial College of Science and Technology,
London, S.W.7.
March 23.

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DR. BARTON's term 'high differential electron ensity' is quite useful for explaining more precisely y early, and vague, statement that "free radicals tack molecules preferentially at points of high ectron density"[1]. Obviously *electron-availability* is n essential requisite for free radical reactions. Free eutral radicals, such as Br·, CH_3·, or C_6H_5·, are ectrophilic reagents in so far as they tend to comlete their electron octets, and this end they can hieve (*a*) by combining with another unpaired ectron, as in $CH_3\cdot + \cdot NO \rightarrow CH_3{-}NO$; (*b*) by mbining additively at one of the easily available electrons of an olefinic bond; or (*c*) by abstracting n outer atom *plus* one electron from another moleule, as in $Cl\cdot + HCH_3 \rightarrow Cl{-}H + \cdot CH_3$. The ease reaction is $a > b > c$, and this is the order of vailable electron densities at the atom which is ttacked.

Dr. Barton concerns himself with process (*b*), and ere it is the differential electron density at the two nds of the π-electron bond of the olefine which is nportant. It is to be judged, as he points out, by aking into account both inductive and mesomeric fects of substituents upon the static structure of e olefine, but not the inductomeric or electromeric rocesses which arise when an olefine molecule bemes polarized by an approaching heterolytic agent[1]. One should remember, however, that these dical reactions are all bimolecular, and hence the sential criterion of the reactive tendency is the nergy difference between the initial and the transition tates. Often, as in the cases of vinyl bromide, thyl crotonate and ethyl cinnamate, this energy ifference can be gauged most easily by writing down e structures of the alternative radical addition proucts; for example, $Br{-}\dot{C}H{-}CH_2{-}Ph$ and $Br{-}$ $H(PH){-}CH_2\cdot$, where mesomerism is obvious in the rmer, but not in the latter, case. This, of course, is e point of view of Mayo and Walling, and is much ore accurate than my original electron density icture, which was not intended to cover all mesomeric ystems.

In the case of aromatic systems, Dr. Barton's escription of the experimental facts, though unfortunately current, is somewhat misleading, since the substitutions of aromatic compounds by free radicals have not, on account of inherent practical difficulties, been studied quantitatively. It would be truer to say that whereas the *para*-substituted product can always be isolated, both the *ortho-* and the *meta*-isomeride are often formed in comparable amount. Forthcoming papers in the *Journal of the Chemical Society* by Prof. D. H. Hey and myself will deal with this question.

W. A. WATERS

Balliol College,
Oxford.
June 3.

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Nickel Plating by Chemical Reduction

Brenner and Riddell[1] have described a method for nickel and cobalt plating by chemical reduction of the metal salts with sodium hypophosphite under both acid and alkaline conditions. Aside from its utility, this reaction is one of considerable interest by virtue of its catalytic nature. Thus, in the concentrations they use, deposition occurs only if certain metals are immersed in the solution and, even in their presence, deposition is inhibited by the addition of such materials as potassium thiocyanate and lead in small amounts. It is suggested that some insight on both these effects and also on the unusual kinetics of the reaction is obtained by the mechanisms outlined below.

I. *Alkaline Solutions.* The initial reaction step is one of electron transfer involving nickel and hydroxyl ions at the catalytic metal surface, *M*.

$$\begin{aligned} Ni^{++} + M &= Ni^{+} + M^{+} && (1)\\ OH^{-} + M^{+} &= OH + M && (2)\\ 2Ni^{+} &= Ni + Ni^{++} && (3)\\ H_2PO_2^{-} + 2OH &= H_2PO_3^{-} + H_2O. && (4) \end{aligned}$$

The overall reaction is:

$$Ni^{++} + H_2PO_2^{-} + 2OH^{-} = Ni + H_2PO_3^{-} + H_2O.$$

The interchange of electrons between the nickel ion and the surface will, following Michaelis[2], take place in one-electron steps. The Ni^{+} ion first formed can then acquire another electron or disproportionate[3] to give the atom as in reaction (3).

This mechanism accounts for: (i) The necessity of a metal surface to act as an electron source and sink as in reactions (1) and (2). The generally unfavourable free energy change[4] of reactions as $OH^{-} + M_{aq.}^{++} = OH + M_{aq.}^{+}$, where $M_{aq.}^{++}$ is the ion in solution, shows this oxidation-reduction reaction not to involve dissolved ions of the catalytic metal but electrons present at various levels in the bulk metal as such. (ii) The non-catalytic nature of glass and plastic in their inability to take part in the electron transfer reactions (1) and (2). (iii) The action of inhibitors and the incidence of passivity in their effect on the electron availability at the surface. (iv) The independence of reaction-rate on the nickel concentration in the rapid nature of the electron transfer steps. (v) The dependence of the rate in linear fashion on the hypophosphite concentration in reaction (4), which involves an atom transfer step. This reaction is favourable thermodynamically, ΔG being approximately − 130 k.cal.[4].

II. *Acid Solutions.*

$$H_2PO_2^- + M = H_2PO_2 + M^- \qquad (5)$$

$$H_2PO_2 + H_2O = H_3PO_3 + OH. \qquad (6)$$

The reactions of the nickel ion remain as given above. The overall reaction is:

$$H_2PO_2^- + Ni^{++} + H_2O = H_2PO_3^- + Ni + 2H^+.$$

This mechanism differs from that in alkaline solution in the nature of the anion primarily involved in the electron transfer step at the metal surface—reaction (5). The unusual features of the deposition reaction in acid media accounted for include: (i) The independence of rate on both nickel and hypophosphite concentration, since both ions take part in electron transfer steps at the metal surface. The hypophosphite radical, first formed afterwards reacts with water to give the OH radical and hypophosphorous acid, which, as they are formed in juxtaposition, will rapidly interact to give the final products of oxidation. This reaction has a free energy change of – 130 k.cal.[2]. (ii) The increase in deposition-rate with agitation of the metal surface is due to impoverishment at the surface of the ion $H_2PO_2^-$.

A curious feature of unexplained origin is that, in mixed nickel–cobalt solutions, only the former is deposited, providing the process is worked under acid conditions.

I wish to thank Mr. D. A. Dowden for helpful discussions.

J. G. M. Bremner

Imperial Chemical Industries, Limited,
Billingham Division,
Billingham,
Co. Durham.
April 9.

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Deamination of Amino-Acids by X-Rays

Recently we have isolated products of hydroxylation from dilute aqueous solutions of benzene and benzoic acid irradiated with ionizing radiations (X-rays, γ-rays, neutrons)[1]. The formation of phenolic compounds in these experiments furnished experimental evidence in support of the theory put forward by one of us[2] in 1944, according to which the primary action of ionizing radiations results in the splitting of the water molecules according to

$$H_2O \rightarrow \ldots\ldots \rightarrow OH + H,$$

presumably through the ions H_2O^+ and H_2O^-. These reaction products are similar to those obtained from the same substances by the action of OH-radicals produced chemically (for example, by the hydrogen peroxide – ferrous salt system), or in the biological oxidation of these substances[3]. We have now found that irradiation by X-rays of dilute aqueous solutions of certain simple amino-acids results in an (oxidative) deamination yielding ammonia, and the corresponding aldehydes similar to those obtained from the same substances *in vitro* by the action of OH-radicals produced chemically[4].

The experimental conditions were similar to those reported previously[1]. For example, aqueous solutions of serine (100 ml. solution containing 400 mgm.) were irradiated with doses of the order of 10^6 r. uni
The ammonia formed in the irradiated solution w
determined by the method of Parnas[5]; the yie
being of the order of 0·3 millimoles. (The yields r
ported in our previous communication also refer
100 ml. of solution.) The glycolaldehyde was isolat
as the dinitrophenylhydrazine derivative (m.p. 156°
The presence of hydroxypyruvic acid was indicat
by positive colour reactions[7].

Corresponding products were isolated in varyi
yields from irradiated solutions of other simp
amino-acids. Full details will be published elsewhe

The irradiations were carried out at the X-R
Department of the Royal Victoria Infirmary, Ne
castle-upon-Tyne. We are greatly indebted to D
F. T. Farmer, who has made all the quantitati
determinations of X-ray dosage.

Gabriel Stein
Joseph Weiss

King's College,
University of Durham,
Newcastle-upon-Tyne.
April 6.

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Influence of Low Temperatures on the Mec anism of the Austenite – Martensite Transformation

Systematic investigations have been carried o
on the influence of low temperatures on the latt
parameter of austenite and martensite and on t
axial ratio *c/a* in martensite.

Two plain carbon steels were chosen containi
0·89 per cent and 1·2 per cent of carbon respective
In order to obtain a martensite structure, the samp
were quenched from 930° in brine solution af
holding for 15 min. at this temperature in a carb
monoxide atmosphere. Rods of 0·5 mm. diame
were cut from the quenched specimens by cutti
very slowly with a carborundum wheel, applyi
efficient water-cooling. The rods were afterwa
etched in order to remove the surface layer.

X-ray photographs of the rods from these ste
were taken in 9-cm. and 19-cm. Debye – Scher
cameras using cobalt radiation and an iron filt
The rods were then immersed in liquid air for c
hour and liquid nitrogen for 30 min. and X-r
diffraction photographs again taken. In cert
cases, instead of using liquid air or nitrogen, some
the rods were immersed in a liquid helium bath
about 1·5° K. for approximately 6 hr. After liq
air or liquid nitrogen treatment and X-ray exami
tion, some of the rods were treated in liquid heli
and examined by X-ray diffraction methods aga

The photographs were photometred by means
the Hilger non-recording X-ray microphotomet
Readings were taken at intervals of 0·1 mm. a
sometimes in more interesting cases 0·01 mm. alo
the entire length of all films, and correction for n
linearity in the blackening intensity curve was ma
from calibration strips put on the film by means

a rotating stepped sector. This correction was necessary in only a few cases.

The lattice parameter was measured. A value for he axial ratio was obtained from M_4, using the designations adopted by Lipson and Parker[1], and his was used in calculating c and a from each of the lines M_6. The value a was also obtained from M_8 (220) and the true value was found by extrapolating linearly rom $\sin^2 \theta = 0$ to $\sin^2 \theta = 1$.

The lattice parameter c of the martensite decreases, while the parameter a shows very little change. The diminution of the parameter c in liquid helium is much more noticeable than in liquid air or nitrogen.

The axial ratio c/a in tetragonally distorted marten-ite[2] distinctly decreases after the specimen is immersed in liquid air or nitrogen. The ratio c/a decreases very strongly after cooling the specimen in liquid helium.

The lattice parameter of austenite decreases after he specimen is cooled in liquid air and nitrogen, and especially after cooling in liquid helium.

The immersion of the specimens in liquid air, nitrogen or helium has apparently the same effect as the shift in the position of the smaller carbon content in Honda and Nishiyama's[3] curves, which how that the c and a lattice parameters for marten-ite, their ratio c/a and the a lattice parameter for austenite vary linearly with the carbon content.

Investigations on the breadths of X-ray diffraction lines and grain size of martensite and austenite are in progress and a full report on the subject will be published elsewhere in the future. This work has been carried out in the Royal School of Mines, London, under the direction of Prof. C. W. Dannatt. Grateful acknowledgment is due to Prof. J. F. Allen for facilities in the Royal Society Mond Laboratory, Cambridge.

JÓZEF MAZUR

Metallurgy Department,
Royal School of Mines,
Imperial College of Science and Technology,
London, S.W.7.

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Photodisintegration of the Deuteron

THE photodisintegration of the deuteron into a proton and a neutron is a case of the two-body problem in nuclear physics; the effect was first discovered by Chadwick and Goldhaber[1]. Accurate measurement of the cross-section for this effect can give information about nuclear forces which is of nterest in view of the several theories which have been put forward recently[2-5]. These theories predict values between 13 and 17 × 10^{-28} cm.^{2}. The cross-section has been measured three times before[1,3,6]; but since these values are all considerably below those predicted by theory, and in view of the significance of this constant, it was thought worth while to make use of improvements in technique that have been made in the meantime.

The measurement was made by direct counting of the photoprotons in an ionization chamber filled with deuterium to a pressure of six atmospheres using a calibrated source of radiothorium, which gives 2·62-MeV. γ-rays. This method is independent of a neutron standard and also avoids counting the disintegrations caused by the 2·2-MeV. line emitted by such a source[6,7]. To ensure counting of all photoprotons, which have an energy of only 0·2 MeV., in the presence of the strong γ-radiation, electron collection is essential. To achieve this at six atmospheres pressure the hydrogen must be exceptionally pure (less than 1 part in 10^6 of oxygen). We were greatly encouraged in attempting to obtain electronic conduction in a metal ionization chamber by the work of Mr. G. H. Stafford[8], using extremely pure hydrogen in an all-glass ionization chamber. The counts were found to be reproducible from day to day within 2 per cent.

The source was placed at 1 metre from the chamber, at which distance (52·5 ± 1) counts per minute were observed. In order to obtain the cross-section from this observed rate of counting of photoprotons, the following facts must be known.

(1) The γ-ray flux. The radiothorium source was compared with a radium standard using an ionization chamber similar to that used in the Curie Institute in Paris, so that the absolute millicurie content could be calculated using a result of Ricoux[9]. It is well known that one 2·62-MeV. γ-ray is emitted for every disintegration of the thorium-C″ nucleus, with the exception of the few disintegrations (1 in 10^4) which give a long-range α-particle. The branching factor (0·35) is also well known[7]. A correction of 6 ± 0·5 per cent has to be made for the absorption of γ-rays in the brass walls of the ionization chamber.

(2) The sensitive volume of the ionization chamber. The chamber is a closed cylinder with a small hole for entry of the collector electrode. The cylinder is connected to a negative high voltage (5 kV.), which is ten times the saturation voltage to ensure complete collection. The sensitive volume is then assumed to be the geometrical volume (51·7 ± 0·2 c.c.), which was obtained by filling with distilled water and weighing. Corrections have to be made for those photoprotons which lose most of their energy in the walls (5 ± 1 per cent at this pressure) and for the region in the immediate vicinity of the central wire which is insensitive because of the effect of positive ions. Use of a cylindrical chamber with a small collector makes this correction small (2·2 ± 0·5 per cent).

(3) The pressure in the ionization chamber. This was obtained by expanding into a known volume and reading the pressure on a mercury manometer. This, when corrected to N.T.P., gives 6·01 ± 0·03 atmospheres.

(4) The purity of the gas in the chamber. This was afterwards checked with a mass spectrometer. The gas entered the mass spectrometer through a palladium leak giving an assumed enrichment for the lighter isotope of 1·33. Using this figure, the purity of gas was 95 ± 1 per cent deuterium.

The final result for the total cross-section (magnetic plus electric photo effect) is: $\sigma = (16{\cdot}2 \pm 1{\cdot}0) \times 10^{-28}$ cm.^{2}.

It is interesting to compare this result with the predictions of meson theory. The results of recent theoretical calculations of the total photo-nuclear cross-section have kindly been sent to us by Prof. Hulthén and are given below (see also L. Rosenfeld[4] and Pais[5]).

Type of meson theory	Assumed meson mass	$\sigma \times 10^{28}$
Møller–Rosenfeld	197	15·1
Neutral	197	16·8
Møller–Rosenfeld	296	13·3
Neutral	296	13·7

Our result therefore eliminates the substantial discrepancy with theory which previously existed, and favours a light meson mass. The precision of our measurements is insufficient to decide between the different types of theory.

We have to thank the Ministry of Supply for the loan of the radiothorium source, the Department of Scientific and Industrial Research for a maintenance grant, Dr. Reaf and Mr. Thoneman for the analysis of the deuterium, and Lord Cherwell for his continued interest in the work.

Note added in proof.—Dr. Gentner has kindly pointed out to us that the high value obtained for the cross-section could be due to a γ-ray line at 3·2 MeV. of uncertain intensity reported by Simons and Zuber (*Proc. Roy. Soc.*, **159**, 383; 1937). An examination of our proton energy spectrum shows that the line (if it exists) has an intensity too small to influence the result.

R. Wilson
C. H. Collie
H. Halban

Clarendon Laboratory,
Oxford.
June 10.

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Nuclear Isomeric Transitions of Short Periods

The elements copper, molybdenum, silver, cadmium, indium and lead have been irradiated by a pulsed beam of X-rays, activity ascribable to metastable states being sought in the intervals between pulses. The electrons producing the X-ray pulses had energies up to 1·05 MeV., the pulse width was 5 μsec., repetition frequency 200 per sec. and mean current 15 μamp.; the mean current during the pulse was thus approximately 15 m.amp. The elements were irradiated within Geiger–Müller counters, counts between pulses being displayed on an oscillograph with time-base triggered by the pulses. No evidence of activity was obtained. Periods greater than 100 μsec. could have been detected. Some details are given below of the experimental arrangements whereby a particular spurious effect can be eliminated, since these may be of interest in similar studies where more energetic X-rays are available.

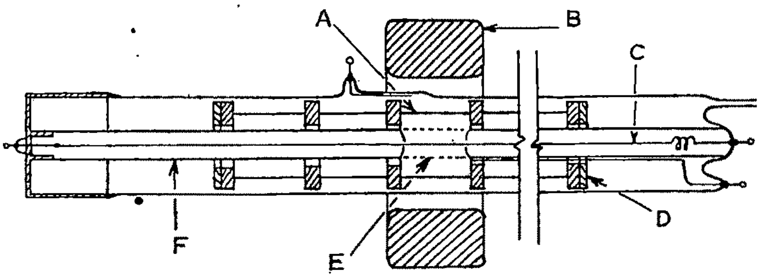
The electron beam was generated by a pulsed linear resonant-cavity accelerator, working at 1,200 Mc./s., constructed by the Radiophysics Division of the Council for Scientific and Industrial Research, Sydney; an earlier type of accelerator, using similar principles, has been described[1]. As a result of developments by Mr. B. Y. Mills, of the Radiophysics Laboratory, electron energies up to 1·25 MeV. have been obtained with a single cavity.

When counters with the metals under investigation as cathodes and filled with argon (pressure 15 cm.) and ether (pressure 15 mm.) were irradiated, a short-period ‘activ dying away in approximately 0·01 sec. was served; a high X-ray intensity increased counting-rate between pulses, in some cases an apparently continuous discharge. In the cop cathode counter the counting-rate was less inte than in those with other metals as cathodes. Th effects were shown to be extra-nuclear in origin follows.

The six metals were placed within the envel of a screen-wall counter; this type of counter[2] be used for magnetic measurements of energies particles produced by nuclear disintegration. design adopted for the present experiments is show the accompanying diagram. The envelope is of gl with one brass end; the cathode is a cylindri copper wire mesh, and the material to be irradia a cylinder placed outside the cathode. By slid each outer cylinder in turn into position facing cathode, differences due solely to the different me can be detected. A filling of argon–ether mixture to 4 cm. pressure was employed, so that scat ing effects could be neglected in the measurement energies of any particles emitted from metasta nuclei. It was found that the application to the ou cylinder of a potential more than 2 volts above t of the cathode in each case reduced the counti rate between pulses to a value not significan different from that occurring when there was outer cylinder facing the cathode mesh. Thus counts between pulses could not have been produ by electrons of energy more than 2 eV. Their act origin is being investigated.

The absence of any observed long-period activ with lead requires comment, as one might exp that the 1·6 min. isomer of threshold 0·65 M previously discovered by Waldman and Collins[3] wo have been produced by X-rays of maximum ene 1·05 MeV. However, an approximate calculation the assumption of the yield quoted by the ab experimenters shows that in the present experime an increase in counting-rate of more than 5 minute should not have been expected, and suc low rate would not have been regarded as significa All known isomers in the other metals require m energetic X-rays for their activation.

With regard to short periods, the presence in l of a metastable state with period of order 1 m.s if such existed with an activation cross-section the order 10^{-34} cm.^{2} or more, could have b detected; this estimate is based on the assumpt of an activation-level at 0·65 MeV. It seems lik that there are no suitable activation-levels bel 1·05 MeV. in the nuclei of silver[4], cadmium[4] indium[5]. It is interesting to note that no isom transitions of periods of the order of 10^{-3} sec. h yet been reported, although some activities w



Screen-wall counter. Envelope, 3 ft. × 3 in. diameter. *A*, outer cylinder; *B*, magnetic field coil; *C*, anode wire, 3½ mil. tungsten; *D*, outer support and shield; *E*, copper cathode mesh (80 per inch); *F*, glass support for cathode icro-second periods have been discovered which are roduced by radioactive decay into stable isotopes[6].

A study of the behaviour of nuclei immediately llowing nuclear reactions and inelastic collisions ay show evidence of short-lived isomers. In order examine such effects, it is proposed, using a method milar to that here described, to irradiate various aterials with neutrons produced by a pulsed ion eam in a (D + D) generator.

Grateful acknowledgments are due to Dr. E. G. owen, chief of the Radiophysics Laboratory, for aking available facilities for the experiments deribed, and to Dr. R. E. B. Makinson for suggesting is work. Financial assistance has been provided y a Commonwealth Science Research Grant.

P. B. TREACY

School of Physics,
University of Sydney.
March 30.

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A Gravitational Field with a Curious Geometrical Property

IT is well known[1] that there are fourteen indeendent absolute scalar differential invariants of the econd order associated with the gravitational metric,

$$ds^2 = g_{\mu\nu}\, dx^\mu\, dx^\nu. \qquad (1)$$

can be argued that the vanishing of all the inariants need not imply the vanishing of all the venty independent components of the curvature nsor R_{hijk}. On the other hand, it may be pointed it that, when the invariants vanish, there are urteen differential equations to be satisfied by the n $g_{\mu\nu}$ components; and it is not at all obvious at a gravitational field with a Riemannian metric cists for which the fourteen invariants vanish. We port here the existence of such a gravitational field escribed by the metric

$$\begin{gathered} dS^2 = -A(dx^2 + dy^2 + dz^2 - dt^2) \\ A = A(\xi),\ \xi = x - t, \end{gathered} \qquad (2)$$

r which the surviving components of the energyomentum tensor satisfy the relations,

$$T_1{}^1 = T_1{}^4 = -T_4{}^1 = -T_4{}^4, \qquad (3)$$

ch being equal to

$$\frac{1}{8\pi}\left[\frac{1}{A^2}\frac{d^2A}{d\xi^2} - \frac{3}{2}\frac{1}{A^3}\left(\frac{dA}{d\xi}\right)^2\right]. \qquad (4)$$

he above metric with the conditions (3) may be mpared to the gravitational field corresponding to directed flow of radiation as given by Tolman[2]. or (2), the conformal curvature tensor vanishes and $_{\mu}{}^{\nu}$ has the structure of the electromagnetic energyomentum tensor; these circumstances together eing responsible for the vanishing of the complete t of invariants.

V. V. NARLIKAR
K. R. KARMARKAR

enares Hindu University.
April 12.

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Interpretation of Data from Electrical Resistivity Geophysical Surveys

MR. J. M. HOUGH has described in *Nature* of May 22 a graphical method of analysing results from the four-electrode method of determining electrical resistivity, when applied to a horizontally stratified earth. He cites particularly the case of a two-layer earth. In a paper published in the *Proceedings of the Physical Society*, **47**, 589 (1935), we described this graphical method and gave the universal curves for the case when the four electrodes are equally spaced. The analysis for the distribution of an alternating current with parallel flow in a two-layer earth was also given. Comparisons were made between results obtained with alternating currents and those obtained with the four-electrode method.

The graphical method just mentioned was used to some extent in the preparation of the electrical resistivity maps of Great Britain and southern Scotland issued by the Electrical Research Association in 1935.

S. WHITEHEAD

British Electrical and Allied Industries
Research Association,
Greenford, Middlesex.

W. G. RADLEY

General Post Office.

BEFORE I commenced an investigation of the interpretation of data from electrical resistivity surveys, unfortunately I failed to find any reference to the paper by Drs. Whitehead and Radley.

There are two points in the treatment of this method by Drs. Whitehead and Radley on which I should like to comment. They suggest that this method is not as accurate as that due to Tagg. For the ideal case of two perfectly homogeneous layers separated by a plane boundary parallel to a perfectly plane surface of the earth, this is probably true. In actual surveys, these conditions are never completely fulfilled, and deviations caused by irregularities in the boundary planes and inhomogeneities in the layers make any two-layer curve into only an approximation to the actual curve: under these conditions, I suggest that either method would be equally applicable.

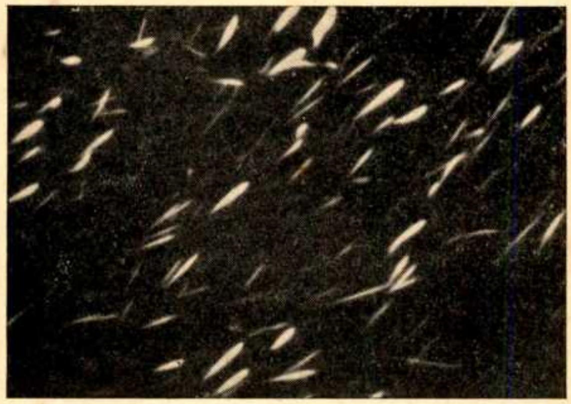
In their paper, Drs. Whitehead and Radley only apply the method to a two-layer problem. I believe that the method is especially useful in the case of certain types of multi-layer earth. In my communication, I did not discuss this at length as the method is essentially the same as that proposed by Tagg, but, in my opinion, very much more convenient than that of Tagg. I have used the method on some results obtained by Prof. L. S. Palmer in Holderness for deposits which have three main layers, topsoil, low-resistance boulder clay (this layer is not usually homogeneous but contains thin strata of sand, etc.), and high-resistance chalk. In the eight cases examined, four showed a curve of three-layer type, and for these the specific resistance of the boulder clay ranged between 130 and 80 ohm ft., and that of the chalk between 240 and 570 ohm ft. The topsoil varied from 2½ ft. and 6 ft. in thickness, and in two cases where bore-hole data were available the chalk was within 10 per cent of that for the bore-hole.

J. M. HOUGH

University College,
Hull.

Open Hearth Furnace Models

A DESCRIPTION was given in a letter in *Nature* of March 27, p. 479, of the use of aluminium powder for flow visualization in a water model of an open hearth furnace. It has since been shown that part of the pattern was due to air bubbles, and that if these are eliminated the aluminium shows up as extremely short light streaks due to the rapidly changing orientation of the disk-shaped particles during the exposure period.



At the suggestion of Mr. F. H. Saniter, director of research, further tests were made in which a stream of gas (initially oxygen) was introduced into the water before the 'checkers', after all the original bubbles had been eliminated by suitable adjustment of the control valves. This technique resulted in an immediate improvement both in the ease of observation and photographic clarity. Not only were the individual bubble streaks far more clearly discernible, but also the falling off in light intensity of the flash from the discharge tube during the exposure results in a point on the tracks that enables their direction of movement to be easily recognized. This latter feature is proving a great asset in the study of such highly turbulent conditions.

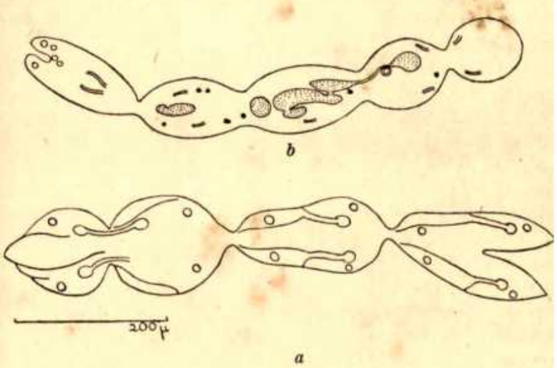
A. R. PHILIP
The United Steel Companies, Ltd.,
Research and Development Department,
Swinden House,
Moorgate, Rotherham.
June 8.

Induced and Spontaneous Abnormality in Ciliates

MOTTRAM[1,2], by means of various physical agents and by means of certain cyclic hydrocarbons—all factors, except one of the latter group, said to be carcinogenic—disorganised a ciliate and found some persistence of abnormality in the offspring of the disorganised cells. At first he named the ciliate *Paramecium aurelia*[1] and later *Paramecium* and *P. colpoda* Ehr., but finally adjusted the identification to "an amicronucleate race of *Colpidium*"[2]. It is important to realize that his ciliate, being without a micronucleus, was intrinsically abnormal. In the reaction he suggested an analogy to tumour formation and surmised that where such abnormals arise spontaneously in culture there has been unwittingly some exposure to a carcinogenic factor.

Such abnormalities, the origin of which is in
double cell, have been produced by merotomy[3,4], b
exposure to sodium bromide[5], hydrogen cyanide
benzene hexachloride ('Gammexane')[7], by transf
of a culture to hard chlorinated tap water[8]; also
a sequel to conjugation[9].

In the case of 'Gammexane' and *Parameciu*
caudatum, up to a 56 per cent conversion to a
abnormal form has been obtained. These doubl
cells become monstrous and multinucleate. The
give rise to both normal and abnormal cells, bu
usually there is no suggestion of persistence of al
normality, which disappears at the death of th
primary or secondary abnormal forms. One of ninet
such cases closely followed has behaved differentl
with constant difficulty in parting of the cells
division, and yielding frequent double cells, vario
distorted individuals and monsters for six mont
until the clone was abandoned. The greatest develo
ment of abnormals occurred eight to ten weeks aft
the exposure to 'Gammexane'.



Chain-forming spontaneous abnormal *Paramecium caudatum*. *a*, From life, showing doubling of mouths and contractile vacuoles and bifid tendency. *b*, Showing disorganisation of nuclei and intercalary division. Macronuclei are shown stippled, healthy micronuclei as black dots, degenerate ones as circles, gullets as slits

In spite of the fact that this experience was uniq
in the series, it would have been attributed to
residual effect of the 'Gammexane'; but, about th
same time, a double cell appeared in a stock cultu
which formed part of the control. This spontaneo
instance has maintained abnormality in its offspri
for more than a year, and the clone is still vigoro
though with a morbid tendency. The cells are e
tremely sticky in division, so that chains of up
nine cells are produced. There is a tendency
bilateral symmetry in organelles, but the nuclei
the chains are completely disorganised (see figur
It gives off normal cells, and normal side-lin
can be obtained by selection. In some respec
it resembles a case reported by Jennings[10] whi
also arose spontaneously but has better viability
the chains will live alone in culture, whereas his di
unless normal cells were included to aerate th
medium. He recorded no doubling of organelles a
did not report on nuclear conditions. The sto
cultures, maintained in 0·5 per cent linseed infusio
were exposed to no conceivable carcinogenic agen
and the origin of this abnormal clone was, witho
doubt, due to some intrinsic cause.

In the light of such observations, the basis
Mottram's hypothesis does not exist. Neverthele
having regard to the present wide use of benze
hexachloride as an insecticide, it was thought wi

test it for possible carcinogenicity (see following tter).

LL. LLOYD

Department of Zoology,
University, Leeds 2.

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bsence of Carcinogenic Activity of Benzene Hexachloride ('Gammexane')

FOR reasons given in the preceding letter, benzene xachloride has been tested for carcinogenic pro- erties. A 0·5 per cent solution in acetone has been plied twice weekly for fifteen months to the inter- apular skin of a group of thirty mixed stock mice. further twenty mice were subcutaneously im- anted with pellets of paraffin wax containing 3 per nt of 'Gammexane', and have since been observed r ten months.

No tumours have been induced in either group. oreover, there have been none of the changes seen ith known carcinogens during the latent period, r example, epilation, local thickening and con- estion of the skin, epidermal hyperplasia, and brillary changes in the dermis of the first group[1]; the characteristic failure to form a firm collagenous psule round the pellet in the second group[2]. The rvival-rate has been satisfactory, twenty-one and elve out of the original thirty and twenty respect- ely being still alive at the time of writing. Of the ad mice, one showed leukæmia at autopsy and other was killed following the observation of a rcinoma of the breast; both these lesions occur ontaneously in the stock, and there is no reason to tribute them to the treatment.

It is perhaps worthy of mention that the general ndition of the mice in the first group has been finitely superior to that obtaining in an average periment; this we attribute to the reduction of rasitic cutaneous infestation. In certain types of olonged experiment, periodical treatment of the imals in this way might prove of general value.

J. W. ORR

epartment of Experimental Pathology,
University, Leeds 2.

rr, J. W., *J. Path. Bact.*, **46**, 495 (1938).
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Rhythmic Respiration in the Sea Urchin

I AM much interested in the note by Dr. Erik uthen on the presence of rhythmic respiration in a urchin eggs[1]. Fifteen years ago, while at Harvard, erformed a number of experiments on the fertilized gs of another species of the sea urchin, *Arbacia nctulata*, using the Warburg microrespirometer chnique. I found rhythmic variation in the rate of ygen consumption by these more or less uniformly eaving eggs. The phenomenon is quite pronounced 25°, but not so at 15°. The oxygen consumption time, or oxygen consumption *v.* cleavage curves are very much the same as those given by Dr. Zeuthen. I also discussed in detail the reasons for the failure of previous workers to find such variations. In Warburg's first experiments[2] the readings were taken at too long intervals, and Gray's[3] experiments were made at too low a temperature (11°) for the variations to be significant. Shearer's data actually showed such a variation if his data were replotted differentially as rate against time, rather than as an integral curve of amount of oxygen consumed against time, which was the way he plotted the results.

The results of my experiments, together with the discussion, were published, upon my return to China, in *Wuhan University Journal of Science*, **7**, 1 (1937). Unfortunately, war broke out soon after, and very few copies of the journal are in existence now. Even I myself have no copy. I am trying to locate this article, both in China and in libraries abroad.

PEISUNG TANG

Physiological Laboratory,
Tsing Hua University,
Peiping.
March 5.

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Use of Rotifera for Testing Analgesics, Narcotics and Similar Drugs

THE assay of the analgesic power of therapeutic substances by means of rats cannot be carried out with any degree of precision. It has been found that the Rotifera can be employed for this purpose since they are extremely sensitive to killing agents unless they are previously narcotized[1].

Through the courtesy and active help of Mr. E. D. Hollowday, regular supplies of the rotifer, *Brachionis calyciflorus*, were obtained, and lots of 1·0 ml. of the water containing 10–15 of the Rotifera pipetted into small tubes. An equal volume of a solution of the drug under test at a known concentration was slowly added, the tube being gently rotated to ensure even mixing. After allowing to stand for 10 min. the Rotifera were examined under the microscope. After noting their condition, the animalcules were killed with formalin and the state of the cilia determined.

The various states were defined as follows:

(i) *Dead.* These had died from 'natural' causes and generally consisted of the lorica containing a more or less decomposed internal mass.

(ii) *Killed.* These had contracted on contact with the formalin or other drug without passing through a state of narcosis. This was indicated by contraction of the cilia, generally accompanied by contortion of the internal organs.

(iii) *Narcotized.* These showed no contraction or contortion, the Rotifera being free from movement but with the cilia outstretched. On the addition of formalin, no immediate obvious changes took place.

(iv) *Alive but not narcotized.* These were either static or else free-swimming with the normal movement of the cilia. On the addition of formalin, they contracted and contorted within the lorica.

The relative numbers in the three classes, killed, narcotized, and alive but not narcotized, were counted.

The effect of various drugs was examined throughout ranges of concentration depending on the activity of the particular substance under investigation. The first compound examined was acetylsalicylic acid, and as the *p*H value of the solution was *c*. 3·3, the other substances were used at approximately this degree of acidity, except in the cases of sodium salicylate, the calcium salt of aspirin, phenobarbitone and barbitone. The results obtained are shown in the accompanying table.

It is interesting to observe the peculiar effect of aspirin. When pure acetylsalicylic acid is added in requisite amount, the infusoria show perfect evidence of narcosis; but they appear to be killed at the same time, since on transferring to fresh water they show no signs of recovery. If the aspirin be converted into calcium acetylsalicylate and employed at *p*H 6·0, the narcotized Rotifera recover when transferred to fresh water. If the calcium salt be decomposed by the addition of acetic acid, so that the *p*H value is about 3·5, then no recovery takes place. Since salicylic acid appears to be fairly lethal and the Rotifera do not recover from treatment with a dilution of 1 : 1,500, it would seem that the peculiar effect of aspirin may be connected with the breakdown of the molecule into its component moieties. So far as is known, aspirin decomposes in aqueous solution of *p*H 3·3 at 20° C., at the rate of about 1 per cent per hour, a speed which is too slow to account for the rapidity of kill. It may be, however, that the acetylsalicylic acid is decomposed at a much greater rate when it is in the internal fluid of the Rotifera and where *in vivo* factors are operating.

Compound	Concentration of drug producing		Recovery from narcosis
	Kill	Narcosis	
(1) *Analgesics* :			
Hyoscine hydrobromide	1 : 200	1 : 1,500	+
Amidopyrine	1 : 1,000	1 : 40,000	+
Aspirin	1 : 1,000	1 : 2,000	–
Calcium aspirin (*p*H 3·5)	1 : 200	1 : 450	–
Calcium aspirin (*p*H 6·0)	1 : 40	1 : 70	+
Salicylic acid	1 : 1,000	1 : 1,500	–
Sodium salicylate (*p*H 6·4)	1 : 20	N.N.	–
Phenacetin	1 : 1,500	1 : 2,000	+
(2) *Local Anæsthetics* :			
Cocaine hydrochloride	N.K.	1 : 7,000	+
(3) *Anæsthetics* :			
Ethyl alcohol	1 : 10	1 : 10	
Chloroform	1 : 500	1 : 1,600	+
(4) *Hypnotics* :			
Morphine	1 : 400	1 : 500	
Codeine	1 : 30	N.N.	–
Barbitone (*p*H 9·2)	1 : 20	N.N.	–
Phenobarbitone (*p*H 9·0)	1 : 14	N.N.	–

N.K.: up to a concentration of 1 : 750, cocaine did not kill.

N.N.: narcosis could not be produced by sodium salicylate nor with the hypnotics codeine, barbitone or phenobarbitone. With morphine, some 60 per cent of the Rotifera showed evidence of narcosis, while with ethyl alcohol at a concentration of 1 : 10 less than 50 per cent were narcotized, the remainder being killed.

We have found that the larger animalcules, such as *Cyclops* and *Daphnia*, do not lend themselves to this type of experimentation. The experimental results suggest, however, that the Rotifera are excellent experimental animals for the assay of drugs which have analgesic and anæsthetic properties.

R. H. Marriott
S. Morris
Y. Larthe

Beecham Research Laboratories, Ltd.,
Brockham Park,
Betchworth,
Surrey.
March 25.

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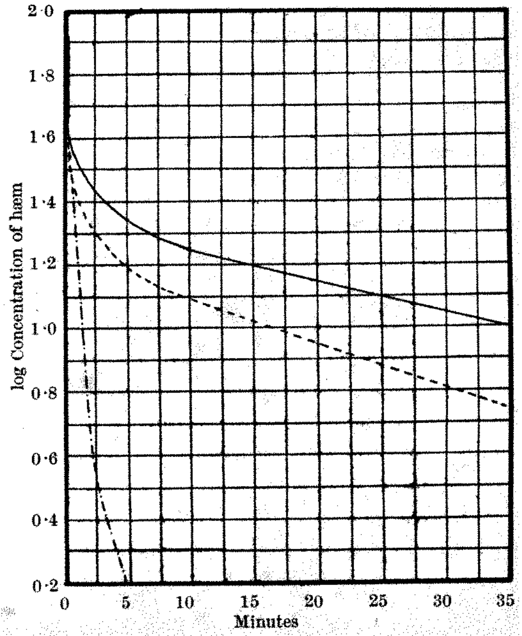
Fœtal Hæmoglobin and Erythroblastosis

In a recent communication, Jonxis[1] repo quantitative estimations of alkali-resistant and lab hæmoglobin in cases of hæmolytic disease of the ne born. He comes to the conclusion that after bir only hæmoglobin of the labile, adult type is forme and that in hæmolytic disease of the new-born the is a selective destruction of red blood corpusc containing fœtal hæmoglobin. We carried out the years 1939–42 a great number of similar estim tions; these have been briefly reported previous elsewhere[2,3].

Our results were at variance with those of Jonx The method applied was a modification of that Haurowitz[4], adapted to the use of Evelyn's phot electric step-photometer. The investigations we carried out before the *Rh* factor and its relationsh to the hæmolytic disease of the new-born was know and it is significant that the study of denaturati curves after blood transfusions revealed two typ one indicating a selective destruction of the bab cells and one showing indiscriminate destruction. the accompanying figure the abscissa represents t time in minutes after addition of *N*/4 sodi hydroxide, the ordinate the logarithms of the co centration of oxyhæmoglobin at each time. T concentration of the original solution, which w always approximately 0·1 gm. per 100 ml., was tak as 100. The percentage of alkali-resistant hæm globin was calculated by extrapolation of the secon gentle slope to time 0. The case was that of hæmolytic disease of the new-born and had a hi reticulocyte count indicating a rapid regeneration erythrocytes. The graph shows a complete repla ment of the fœtal hæmoglobin by the adult ty after blood transfusion, and yet 24 hours later the is already 16·5 per cent alkali-resistant hæmoglob Further curves illustrating selective and indiscri inate destruction of erythrocytes after blood tra fusions in cases of hæmolytic disease of the ne born are given in an earlier publication[3].

Where a few days after a blood transfusion t denaturation curve returns to the pre-transfusi type in the presence of a high destruction- a



egeneration-rate, it is obvious that fœtal hæmolobin has been formed in extra-uterine life. Cases ith an indiscriminate destruction of patient's and onor's cells show that there is no relationship whatver to the type of hæmoglobin present in the red lood corpuscles. In full agreement with these findngs are the results obtained by Mollison[5], who tudied the survival of transfused erythrocytes in æmolytic disease of the new-born by the method of ifferential agglutination. In almost all cases where *Rh*-positive red blood cells have been transfused hey were eliminated within ten days. The detruction of erythrocytes in hæmolytic disease of he new-born depends on their sensitization by *Rh* ntibodies and shows no relationship to the chemical onstitution of the globin component of their hromoprotein.

H. S. Baar

Department of Pathology,
The Children's Hospital,
Birmingham.

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Carbonic Anhydrase in *Arenicola marina*

Several years ago, Brinkman and his collaborators eported that carbonic anhydrase is present in the lood of *Arenicola*[1]. This observation was confirmed y Florkin[2]. Recently, through the kindness of Prof. H. Munro Fox, I have had an opportunity of tudying the distribution of the enzyme in this nnelid in more detail than was done in these two apers, and some interesting points have come to ight.

The determinations of enzyme activity were made y the 'boat' method of Meldrum and Roughton[3], recautions being taken to ensure that diffusion did ot constitute a limiting factor. All the experiments ere carried out at 0° C., the Meldrum – Roughton nit of activity being calculated for that temperature. issues were cut into small pieces, washed with several hanges of sea water and then weighed. After being ound with a little sand, they were extracted for ne hour at room temperature with distilled water the proportion of 1 ml. to each 25 mgm. of tissue. he catalytic effect of the tissue extracts was always mpared with the activity of blood diluted to give he same final hæmoglobin concentration. Hence ny errors due to traces of blood remaining in the ssues were reduced to a minimum. Hæmoglobin as determined directly with a Hilger – Nutting pectrophotometer.

Table 1 gives the figures obtained for blood samples ken from five individuals, together with figures for uman blood (A. M. C.) to serve as a comparison. will be seen that the mean activity of *Arenicola* ood is about the same as that of human blood, though there is considerable individual variation.

Table 1

Enzyme (units per c.mm.)	Hæmoglobin (gm. %)	Activity : hæmoglobin
4·0	2·9	1·38
3·6	3·5	1·03
4·5	4·1	1·10
3·4	2·6	1·31
2·6	1·8	1·44
Mean : 3·6	Mean : 3·0	Mean : 1·25
3·7 (A. M. C.)	15·3	0·024

The ratio of enzyme activity to hæmoglobin concentration, calculated as units of enzyme per cubic millimetre of blood and grams of hæmoglobin per hundred c.c., is much higher in *Arenicola* than in human blood and tends to be fairly constant. The presence of such a large amount of carbonic anhydrase is of considerable importance, for *Arenicola* blood, like that of most annelids, contains very few corpuscles. Of four samples of blood centrifuged for thirty minutes at 3,200 r.p.m., only one showed any signs of a slight deposit of cellular material. Thus the enzyme must be free in solution, an exception to the generalization that carbonic anhydrase is never found outside cells[4].

The enzyme is also present in appreciable amounts in many of the tissues of *Arenicola* (Table 2) but is absent from the cœlomic fluid, as was noted by Florkin.

Table 2

Tissue	Units of enzyme per 50 mgm. wet weight
Œsophageal pouches	71–110
Chlorogenous tissue of stomach	15–38
Gills	5–15
Œsophagus	6–14
Nephridia	3–12
Intestine	1–4
Ep dermis	1–3
Muscles	Traces
Proboscis	Traces
Nerve cord	Nil
Cœlomic fluid	Nil

Of all the tissues examined, the œsophageal pouches showed the highest concentration of carbonic anhydrase. Although these diverticula have a very rich blood supply from several large sinuses situated beneath the inner epithelial lining, it seems rather improbable that they play an important part in the direct elimination of respiratory carbon dioxide from an animal so well equipped with external gills as *Arenicola*. On the other hand, it is difficult to see what other function they could have. The secretion is only slightly acid (pH about 6·4), so the glands can scarcely be similar to the gastric glands of vertebrates. It might be worth while considering whether the pouches represent a primitive respiratory organ which was of importance in annelids lacking external gills. In this connexion it is interesting to recall the work of Eisig[5] on some of the smaller polychætes. He made a careful study of the œsophageal diverticula in syllids and hesionids and concluded that they act as reservoirs of water and air, from which oxygen can be obtained when the supply from the external medium is insufficient to meet the organism's requirements. Eisig compared the pouches with the swim bladder of a fish. It would be interesting to examine the catalytic activity of the tissues of *Arenicola assimilis*, a form which possesses several pairs of œsophageal pouches.

This investigation is being carried out during the tenure of an 1851 Exhibition Science Research Scholarship. My thanks are due to Prof. D. Keilin for suggesting the problem and for his interest in its progress.

A. M. Clark

Molteno Institute,
Cambridge.
April 22.

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LOCALIZATION OF ALKALINE PHOSPHATASE IN YEAST

By Dr. WALTER J. NICKERSON
(Guggenheim Memorial Fellow)

EDITH J. KRUGELIS
(Donner Foundation Fellow)

AND

NILS ANDRESEN
Carlsberg Laboratorium, Copenhagen

THE Gomori technique[1] for alkaline phosphatase localization has been extensively employed with animal and plant material; but it does not appear to have been employed with yeasts. The presence of acid and alkaline phosphatases in yeasts is well known[2,3,4]; but the location of these enzymes in the cell has not previously been described. We have applied the Gomori technique to preparations of *Saccharomyces cerevisiæ* (strain 'Yeast foam', Carlsberg No. 237). Cells were grown in pure culture in 10 ml. of 8 per cent Pilsner wort in Freudenreich flasks at 25° C. for 24 hr. At the end of this time the medium was poured off and 10 ml. of sterilized distilled water was added to the cells sedimented at the bottom of the flask. The cells were suspended in the water by shaking, and drops of the suspension placed on microscope slides. The cells were allowed to dry in air for 10–30 min. and then incubated in one of the several phosphate compound substrates in a veronal buffer solution containing magnesium and calcium at pH 9·2 for 16–40 hr. at 37° C. The cobalt sulphide method of staining[1] was then applied.

Under these conditions we found phosphatase reactivity was shown by a general darkening, and also by more intense localization as a dark spot within the cell (Fig. 1). This spot localization was obtained with hexose diphosphate, sodium glycerophosphate, and sodium pyrophosphate as substrates. With sodium hexametaphosphate as substrate, the spot did not appear; but the reaction resulted in a more intense general darkening and in the appearance of some granules, located in the peripheral layers (see Fig. 2). No spot or darkening was obtaine in the controls (no substrate) or after heating th cells (for 3 min. in boiling water). Fig. 3 shows th negative reaction after heating. In the absence magnesium, there was some decrease in activit detectable with sodium glycerophosphate and hexos diphosphate, and almost no activity with sodiu pyrophosphate or sodium hexametaphosphate substrates.

Concerning the spot localization, there is som independent evidence that such a structure exis as a morphological entity. This evidence was obtaine by use of the Feulgen stain (Feulgen-positive boc observed in an approximately similar position) an by observation of living cells in the phase-contra microscope. It is not unlikely that this spot can b interpreted as the nucleus of the yeast cell. The boc observed by us agrees well with the cytological pictu of the yeast nucleus as presented by Nagel[5]. Sh demonstrated in the yeast cell the presence of tw distinct bodies which she labelled 'parvicorp' (nucle of most earlier authors) and 'companion body'. W have also encountered a structure comparable to th 'companion body'. This was a smaller and light area adjacent to the darker area of the spot. Wit hexose diphosphate, sodium glycerophosphate, an sodium pyrophosphate, it seems that alkaline pho phatase activity is localized with a Feulgen-positi structure and thus may be associated with desox ribose nucleic acid. (However, ribose nucleic aci may also be present.) This finding of phosphatas within the Feulgen-positive material is in accord wit those for the localization of alkaline phosphatas activity on the salivary gland chromosomes *Drosophila*[6,7], and for the general association phosphatase activity with desoxyribose nucleic ac as discussed by Jeener[8].

The general darkening within the cell suggests possible association of enzyme activity with ribo nucleic acid. Such an association has been describ previously for other tissues[9]. We treated cells wi ribonuclease (10 mgm. per cent) as employed b Brachet[10] and Brachet and Jeener[11] for the remov of ribose nucleic acid from the yeast cells. Th reagent was used as an aqueous solution on wash air-dried films of cells. Yeast cells were allowed remain in contact with the enzyme solutions

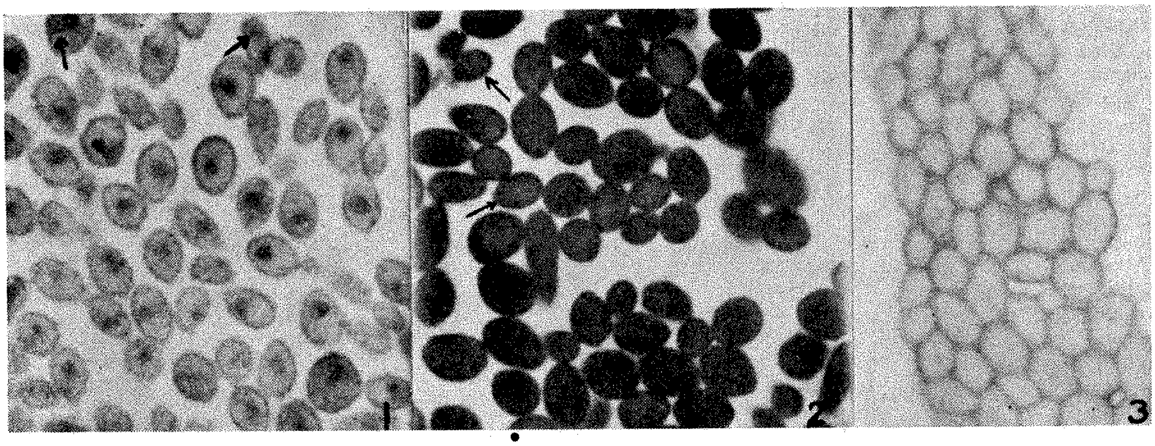

Fig. 1. Yeast cells exhibiting dark precipitate obtained by the Gomori phosphatase reaction using pyrophosphate as a substrate. Magnification, × 900; arrows to 'companion body'

Fig. 2. Yeast cells after the Gomori phosphatase reaction using hexametaphosphate as substrate. Magnification, × 900; arrows to ● cells with peripheral granules

Fig. 3. Yeast cells heated for 3 min. before incubation with pyrophosphate as substrate. Magnification, × 900

0° C. and 35° C. for several hours, during which ime samples were taken at intervals and examined r phosphatase activity with each substrate. There as a decrease in the general darkening; but a shrink-ge of the cytoplasm within the cell made cytological valuation very difficult. The usual homogeneous ark Gram staining reaction of yeast thus treated ith ribonuclease was reduced to stippled surface reas, and a fair proportion of the cells were Gram-egative. Henry and Stacey[12] have shown that the roperty of Gram positivity is associated with surface agnesium ribonucleate. This might be interpreted s indicating that in addition to the Feulgen-positive calization some alkaline phosphatase in yeast may lso be associated with ribonucleic acid at the cell rface. Recent investigations[13] on P^{32} exchange by east implicate a surface nucleic acid – riboflavin mplex in the uptake of inorganic phosphate by lls from the medium. Furthermore, Brachet and eener[14] and Chantrenne[15] have established that dimentable cytoplasmic granules in mammalian lls comprise an association of ribonucleic acid, hosphatase, and other enzymes. Brachet[16] and rugelis[17] find that there is a correlation between e localization of ribonucleic acid and alkaline hosphatase activity in the developing embryo amphibians. The surface darkening and the anulation obtained with hexametaphosphate sug-est the possibility of another enzymatic reaction, though we are aware of the protein precipitant ature of metaphosphate and the possibility of an tefact being produced during the reaction. The ependency on magnesium ion and heat lability of is reaction are in favour of its being enzymatic; ith this substrate we have also used a reaction mperature of 20° C. in view of the apparent in-tability of the hexametaphosphate under our con-itions at 37° C. This reaction with metaphosphate, enzymatic, may be involved with ribose nucleic cid, since Macfarlane[18] has isolated metaphosphate om yeast as an iron – nucleic acid complex.

One more line of evidence points to the association ggested above of nucleic acid and alkaline phos-hatase in yeasts. Cells raised in a medium deficient magnesium ions were stated by Henry and Stacey[12] exhibit greatly reduced Gram positivity. We ew yeast in a synthetic medium with known low oncentrations of magnesium and ferrous ions nedium first purified by 8-hydroxyquinoline-chloro-rm extraction following Waring and Werkman[19] and e ions afterwards added). Cells grown in this edium exhibited the lessened Gram staining roperties described above and showed a reduced arkening of the phosphatase reaction, accompanied y obvious changes in the general morphology of e cell.

The positive cytochemical reaction obtained with yrophosphate and the monophosphate esters as ubstrates suggests the presence of two enzymes (a yrophosphatase and a phosphomonoesterase) local-ed in the spot or nucleus of the yeast cell and resent more diffusely in the cytoplasm as well. The xtreme dependency of the pyrophosphatase activity n magnesium ions as contrasted with a lesser depend-ncy of the phosphomonoesterase activity strengthens he contention that two different enzymes may be resent. The literature contains convincing chemical vidence[20,21,22] for the existence of a pyrophosphatase istinct from a phosphomonoesterase, although the wo are often associated together in a variety of lant forms. The appearance of a somewhat different localization of the reaction with hexametaphosphate as substrate may mean a third enzyme, for which there is some evidence from the work of Schäffner and Krumey[2].

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APPLICATION OF DYNAMIC SIMILARITY TO METAL STRUCTURES WITH ELASTIC AND PLASTIC FLOW

By M. W. THRING
British Iron and Steel Research Association

IN the attempt to attain dynamic similarity for fluid flow systems, different dimensionless criteria appear according to whether momentum and viscosity, or momentum and gravity, are the dominant factors in deciding the flow pattern. The purpose of this communication is to show that a similar argument applied to the attempt to attain dynamic similarity for the flow of a metal structure gives also two alternative dimensionless criteria according to whether momentum and elasticity or elasticity and plasticity are the dominant factors.

For the purpose of dimensional analysis, it is sufficient to consider one dimensional movement, and the fundamental equation governing the motion of an element of the metal structure can be written in the simplified form

$$m\,\frac{\partial v}{\partial t} = P_x + \frac{\partial}{\partial x}\left\{f\left(\varepsilon, \frac{d\varepsilon}{dt}, \int_{\theta=\infty}^{\theta=t} K(t-\theta)\,.\,\sigma(\theta)\,.\,d\theta\right)\right\}, \qquad (1)$$

where m is mass of metal per unit length (gm./cm.); v is velocity of movement of volume element (this is related to ε, but it is not necessary to express the relation for the purposes of dimensional analysis) (cm./sec).; P_x is external force acting on unit length of metal (dynes/cm.^{2}); ε is normal strain (dimensionless); θ is parameter expressing the previous time at which a stress $\sigma(\theta)$ was applied (sec.); $K(t)$ is 'remembrance function' expressing the effect upon the present strength of previous application of stress[1].

The expression in the bracket on the right-hand side represents the difference between the stress acting upon the element of volume and the internal forces (elastic and plastic) resisting this stress. Its exact form is open to doubt; as expressed here it is equivalent to the assumption that these internal forces depend on the extent of the deformation, the rate of the deformation and on previous history. Orowan[2] has pointed out that even an equation of this form cannot express fully the behaviour of a metal, since it is possible to wipe out the entire influence of the past by a sudden extension of a few per cent. Even this statement implies, however, that the past history affects the present strength in a definite way although difficult to express mathematically. It is possible, therefore, for dimensional purposes to write equation (1) in the form

$$m\frac{dv}{dt} = P_x + \frac{d}{dx}\left\{E\varepsilon + \eta\dot{\varepsilon}\right\}, \qquad (2)$$

where both E (the instantaneous value of Young's modulus) and η (the instantaneous 'viscosity') are to be regarded as complex but definite functions of past history, having the dimensions of dynes/cm.^{2} and dyne-sec./cm.^{2} respectively.

When dimensional analysis is applied to equation (2), the condition for static similarity is the usual one; $N_1 = P/E$ must be the same in model and original, so that the forces per unit area in model and original must be the same if the same material is used (same value of E).

In flow systems where the inertia of the material itself and the elastic forces are the important factors, for example, in elastic oscillations of a clamped bar or in impact testing, the condition for dynamic similarity is that

$$N_2 = \rho\,\frac{V}{T}\Big/\frac{E}{L} = \frac{\rho}{E}\cdot V^2 \text{ or } \frac{\rho}{e}\cdot\frac{L^2}{T^2}.$$

Hence when the same material is used in model and original, the usual similarity condition applies, that velocities must be kept constant, that is, the time-scale must be shortened in proportion to the reduction of linear dimensions.

Where, however, plastic or viscous forces are important as well as elastic forces but the inertia of the material can be neglected, a different criterion for dynamic similarity appears. In general, it is now essential to use the same material for model as for original, and it then follows that the condition for similarity is that *the time-scale is the same in the model as in the original.* It follows that it is not possible to obtain dynamic similarity on a reduced scale where both inertial and rate-dependent plastic forces are important.

In the general case it is not possible to construct a suitable dimensionless criterion for this condition —if a Kelvin solid[3] could be found for which E and η of equation (2) were definite fixed quantities one could define a Kelvin Number:

$$N_K = \frac{\eta}{T}\Big/E = \frac{\eta}{E.T}.$$

The condition of equality of time-scale implies that the material of the model has been carried through the same past treatment of stress and heating on the same time-scale as the material of the original. The fundamental assumptions on which similarity is based when this condition is satisfied are those implied in the presentation of most experimental data on the engineering properties of metals, namely, (1) σ and ε are connected in the same way for specimens of different sizes; (2) if the metal is subjected to the same treatment over the same length of time internal condition is changed in the same way; which must be added the condition which separa the use of K_K from N_2; (3) the inertial forces m be negligible compared with the rheological ones

These three conditions enable the limits of app ability of the plastic criterion of dynamic similar to be defined as in the case of the R_e and F_r crite for fluid flow. Brittle fracture[4] and fatigue do satisfy the first condition because there is an absol scale of size inherent in each of these processes, that no similarity is possible with scale chan Fibrous fracture may in some cases not satisfy third condition and impact testing certainly d not. On the other hand, most cases of creep, inter damping, rate of loading effects, elastic after-effe and plastic flow in the work-hardening range sati the three conditions. In such cases similarity can attained even though external forces are of the imp type, provided the latter are suitably scaled as Similarly, in studying the effect of self-oscillations a structure upon permanent set, external loadi of the model structure to give the same period oscillation satisfies the conditions. The reproducti of joints in a structure on the model scale necessar gives rise to failures of similarity[5], which mak unsuitable the use of models of systems where t flow primarily takes place at joints.

This similarity criterion is very much easier satisfy than that of the Reynolds number, where t use of the same material implies that the time-sc must be shortened by n^2 if the length-sc is reduced by $1/n$; and may therefore have use applications in connexion with the laboratory stu of rate of loading and damping effects in such stru tures as wire ropes, ship or car hulls and girders.

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CHOLINESTERASES

By Dr. KLAS-BERTIL AUGUSTINSSON
Biochemical Institute, University of Stockholm

IT is known that the cholinesterases from vario animal tissues are not identical, and it has bee proposed that two types of acetylcholine-splitti enzymes exist. This 'type theory' does not expla fully some of my recent observations[1].

Substrate specificity depends probably on the pr tein character of the enzyme molecule, which m vary from tissue to tissue. In blood serum, t enzyme is probably an albumin; in the red bloc cells, where it has been shown to be bound to t cell membrane, it is probably a lipoprotein. This also true for the cholinesterase of the nervo system, where the enzyme is bound to the ce structure. Hence, the red-cell esterase would expected to be related to the nerve esterase rath than the serum esterase, and this has, in fact, bee demonstrated. The enzymes from brain and re cells are said to be 'specific' cholinesterases, and i addition a 'non-specific' cholinesterase is said t exist, for example, in human serum, which hydrolyse etylcholine as well as aliphatic esters, for example, ibutyrin.

The use of acetyl-β-methylcholine and benzoyl- oline for distinguishing between these two types cholinesterase may sometimes be of value, but it not sufficient for a classification of these enzymes. comparing the activities of an esterase towards rious esters, the substrate concentrations must be nsidered. For example, the 'specific' cholinesterase lits both acetyl-β-methylcholine and acetylsalicyl- oline at a lower rate than acetylcholine at low sub- rate concentrations, but at a higher rate when bstrate concentrations are high. Bodansky[2] has own that the red-cell esterase acts on triacetin, d I find that this enzyme hydrolyses the acetyl- ter linkage in acetylsalicylcholine; the term pecific' is therefore not adequate.

In agreement with Richter and Croft[3] and with odansky[2], I regard the cholinesterases as a 'family' related enzymes with widely divergent properties. he following classification is based on the activity- bstrate concentration relationship for acetylcholine substrate. This classification leads me to distin- uish two groups. Group I contains enzymes which e inhibited at high concentrations of acetylcholine ptimum at $3 \times 10^{-3} M$). The enzymes of Group II llow the Michaelis–Menten formulation, which eans that the maximum rate occurs with infinite bstrate concentrations. Enzymes within each oup differ in certain other respects. There is no bsolute specificity to choline esters in either group.

Group I includes the cholinesterases of the nervous stem, of red blood cells, of *Helix* blood and of *epia* 'liver'. The red-cell and brain esterases are entical, but differ from the *Helix*-blood and *Sepia*- iver' esterases. Differences are seen in the action inhibitors such as choline, caffeine and quinine, d in the ability to split various esters. For ex- mple, the *Helix*-blood esterase is characterized by s high activity with acetylaneurine as substrate. he cholinesterase of shark plasma also belongs to is group.

Group II includes the cholinesterases of certain ra (for example, man, horse) and of the dart sac *Helix pomatia*. The serum esterases show inhibition y excess of benzoylcholine (optimum concentration $\cdot 0 \times 10^{-3} M$); this is not the case with the dart- c esterase, which hydrolyses benzoylcholine rather owly. The serum esterases are competitively in- ibited by choline, but not the dart-sac esterase.

Acetylcholine is the only choline ester found in nimal tissues, and this is why I define as a cholin- sterase an esterase which, under conditions optimal r the hydrolysis of acetylcholine, splits this ester ore rapidly than any other ester. Consequently e rapid hydrolysis of benzoylcholine by guinea pig ver is not due to a cholinesterase; this reaction not due to specific 'benzoyl-choline esterase'.

The optimum substrate concentration is increased the presence of the strongly basic clupein. The egatively charged gum arabic is known to have the pposite effect[4]. I was unable to confirm the finding Mendel and Rudney[5] that the addition of potassium loride caused a shift of the optimum substrate con- ntration. The affinity of the positively charged etylcholine ion for cholinesterase may be directly roportional to the negative charge of the enzyme. ence, with increasing negativity, optimum con- itions are shifted towards lower acetylcholine con- ntrations, that is, towards more physiological con- itions. I am inclined to think that such a change in cholinesterase activity occurs during nervous activity. In depolarization, the neuronal surface becomes more negative, and since cholinesterase is concentrated at this surface[6], enzymic activity becomes optimal at lower concentrations of acetylcholine.

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CLAY MINERALS AS CATALYSTS AND ADSORBENTS

A WHOLE-DAY meeting of the Clay Minerals Group of the Mineralogical Society, held in the apartments of the Geological Society on January 23, was largely devoted to a discussion on the use of clay minerals as catalysts and industrial adsorbents; in the later part of the afternoon some general papers were also given.

Mr. R. H. S. Robertson (Glasgow) introduced the subject with a highly condensed account of the catalytic uses of clays, which could not adequately be summarized. He pointed out that so long ago as 1915, Gurwitsh studied the catalytic polymerization of unsaturated compounds by floridin, and this clay (the active element in which is attapulgite) has since been used in a wide variety of other reactions. Another clay about which much data are available is Japanese acid clay (montmorillonitic). Every type of organic reaction has been shown to be catalysed by one or other of the available types of clay.

Dr. F. E. Salt (Distillers' Co., Ltd.) described experiments on polymerization of α-methyl-styrene. This substance is not polymerized by heat alone, as styrene is; but in the presence of suitable clays it reacts at a low temperature to give low molecular weight polymers ('Polymeth') which may find uses as plasticizers or extenders, or (when mixed with castor oil) as microscope immersion media. The clays used were activated montmorillonites of German and English origin. In the discussion, Mr. Armitage (Lewis Berger and Sons) mentioned the use of such clays for polymerizing indene, coumarone and styrene.

An account of the uses of clays in cracking petroleum was given by Mr. J. N. Haresnape (Anglo-Iranian Oil Co.). Here again, activated montmorillonites are used, and they have to compete with the more effective, but more expensive, artificial products (silica–alumina gels), which were largely used during the War, when cost was a secondary consideration. The clay catalysts tend to alter during use, with production of excessive gas and carbon. This has been attributed to hydrogen sulphide adsorption, though the Anglo-Iranian workers have found that clays of high iron content show this type of activity even with low-sulphur feedstocks.

In practical operations with clay catalysts, difficulty arises from the very large quantity of catalyst which has to be put through a cycle of use and regeneration by heat. One successful practical method of doing this is the fluidizing technique, which was described by Dr. T. H. Blakeley (Esso Development Co., Ltd.), and illustrated by a film and demonstration. In this method small granules (20–40 μ) of catalyst are agitated by an upward stream of oil vapour, in which state they show many of the properties of a liquid, and may be dealt with in a continuous process. Plants working on this principle which are in use or on order (excluding the U.S.S.R.) are capable of dealing with 60,000,000 tons of feedstock per year.

In a discussion on the process of activation of montmorillonites, Dr. B. S. Emödi (Fullers' Earth Union, Ltd.) explained that, by means of acid treatment, the crystalline structure appears to be partly broken down. The improved catalytic activity may be associated with the presence of free colloidal silica, or with the greater effective surface of the mineral, or with both factors.

The afternoon session contained papers on topics connected with adsorption. It was opened by Mr. A. Ibison (W. Bibby and Sons, Ltd.), who dealt with the adsorption of colours from oils and solvents. He stressed the importance of fixed conditions of temperature, moisture, acidity, etc. Adsorption isotherms, corresponding to maximum percentage colour adsorbed at each colour concentration, are then found to be of the Langmuir type with non-activated clays, and steeper with the activated type.

Dr. G. W. Nederbragt (Bataavsch Petroleum Mij, Amsterdam) described the use of floridin for separating long-chain from branched-chain hydrocarbons. The technique used is essentially that of chromatographic analysis with pentane as the solvent. The author suggested that the selective adsorption of normal hydrocarbons is due to the channels present in the structure, as described by Bradley[1].

Experiments on the adsorption of basic dyes by calcium montmorillonite were described by Dr. Emödi. It was observed that while the dye adsorbed is nearly equivalent to the base-exchange capacity of the clay (104 m. equiv. per 100 gm.), usually only 30–80 m. equiv. of calcium are released, the discrepancy increasing with the number of benzene rings in the molecule. From calculations of the frequency of calcium ions between the montmorillonite sheets and the area of the dye molecules, the theory was advanced that the latter are adsorbed between the unit plates, but mainly near the edges, thus blocking the outlet of many exchangeable calcium ions. The clay particles thus become positively charged and can adsorb negative ions.

Dr. D. M. C. MacEwan (Rothamsted Experimental Station) suggested that the mechanism of formation of organic complexes by montmorillonite may be closely connected with surface adsorption on such minerals as mica, the tendency of the clay mineral sheets to gather one or more adsorbed layers of molecules providing a repulsive force between them, while the balancing attractive force may be electrostatic in nature. Using Bangham's data[2] on mica adsorption, it is possible to get a potential curve for methanol showing a minimum in the right position.

Two general papers, descriptive of work done under a programme of research for the British Iron and Steel Research Association, were given by Dr. J. White and collaborators of the University of Sheffield. The substance of the paper by B. Vassiliou has already appeared in *Nature*[3]. The second (with P. Murray) dealt with an attempt to measure reaction constants and activation energies for the thermal dissociation of structural water in different types of clay, using both constant and steadily increasing heating rates. Good results were obtained with kaolinitic and micaceous clays enabling the form of thermal analysis peaks to be reproduced from the calculated data; but with a montmorillonitic clay the values obtained for the constants depended on the conditions of heatin a point which is now being investigated.

Comparison of the papers given in the mornin and afternoon sessions suggested that phenomena adsorption tend to be better correlated with what known of the clay mineral structures than those catalysis. Meetings such as this should therefo serve a useful purpose by bringing together cla mineralogists with chemists working on the proble of catalysis, and enabling them to exchange inform ation.

D. M. C. MacEwan

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ELM DISEASE

ELM disease has been a serious pest in Britai during the last score of years. The Forestr Commission has issued Leaflet No. 19 (London H.M. Stationery Office, 1947), which is an up-to-dat account of what is known at present about thi disease, the life-histories of the associated bar beetles, and control measures.

The attack in most parts of England and Wales i by now pretty well known, and the trees eithe die down from the top, or they may die from th top down one side. Usually the cause of the die back is the fungus *Ceratostomella ulmi* Buism. workin in association with *Scolytus* elm bark beetles. Whe this disease was first discussed, it was known as th Dutch elm disease, having come into Britain from, i was thought, Holland. Its connexion at that tim with the bark beetle was not generally appreciate The fungus is a member of the *Ascomycetes*. It exist in the tree mainly in the form of small yeast-lik bodies, which multiply rapidly by budding, and ar carried along in the water-conducting vessels wit the sap. The fungus produces a toxic substanc which not only poisons the affected branch, but als stimulates the vessel walls to produce gum-containin bodies. These tend to block the vessels and thus lea to death from lack of water, as well as from direc poisoning.

As is well known, bark beetles are especiall dangerous to a tree when anything has occurred t stop or to lessen the upward flow of sap. In the cas of elm disease, when the sap flow becomes restricte the well-known elm bark beetles, *Scolytus scolytu* (*destructor*) and *Scolytus multistriatus*, can make thei breeding grounds in the bark with comparative eas The grubs hatching from the eggs thus have a cam bium layer, with a restricted flow of sap but sufficien to keep it fresh, upon which they feed.

The fungus can only produce its minute an delicate fructifications in very sheltered situation such as under loosened bark or in the beetle gallerie The fructifications are of two kinds, black flask shaped bodies (asci) and thin black stalks (coremia) both are about 1 mm. in length, and both bea microscopic spores at the top in round drops c mucilage. Although they are visible to the naked ey when produced in mass, they are hard to find, an of little value, therefore, in early diagnosis.

Ceratostomella ulmi is not the only cause of diseas in elms; but in the south of England, at any rat it outweighs all other diseases in importance. I Scotland the wych elm is subject to a dieback les rapid and usually less severe than that caused by true elm disease; the cause is as yet unexplained. Elms in towns may be killed by gas leakages, and those in unfavourable situations are often injured by drought or excessive water in the soil; but these causes of death are easily distinguished from the elm disease proper.

Bull. 841, Cornell University Agricultural Experiment Station (September 1947) also deals with elm disease; it is entitled "Log Treatments for Bark Beetle Control in connection with the Dutch Elm Disease". The bulletin is devoted to the assembly of the principal data from a series of long-treatment experiments carried out at the Dutch elm disease esearch laboratory of the New York State College of Agriculture. The War stopped a number of the experiments which were in hand, and others which had been planned were not begun. It was therefore decided to publish all the results of the work so far arried on, so that this information might be available for the continuation of research, and the determination of control programmes.

The fungus is the same as that mentioned above, but the beetles working in conjunction with the fungus in the United States are *Scolytus multistriatus* and *Hylurgopinus rufipes*. The disease organism is described as harbouring in bark beetle galleries made in wood from healthy trees, as well as from diseased rees, and is carried out and distributed by the beetles which emerge. The proper disposal of dead and dying elm wood which is suitable for bark beetle breeding, even if it is not from diseased trees, is herefore an essential feature of a local Dutch elm disease programme.

It is not possible to deal more closely with the ontents of this most interesting bulletin, which is well worth studying, with its interesting illustrations. t is, however, a matter of considerable interest that the so-called Dutch elm disease has now become very widespread, and it certainly requires intensive investigation. The present writer has himself been watching infested trees of his own during the past twenty years, and as one outcome of the observations carried out, considers it does not follow that a tree attacked will die, for it may throw off the disease. In this there is possibly some connexion between the vigorous state of the tree, and the fact that the *Scolytus* beetles do not get the upper hand; in fact, quite possibly they are unable to make their reeding galleries, owing to the flow of sap being too strong.

E. P. STEBBING

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

THE annual report of the National Institute of Economic and Social Research for 1946–47 records no change in the financial situation; grants rom the Rockefeller Foundation, the Leverhulme Trustees and the Nuffield Foundation continuing to e the mainstay of the Institute's finances, and a pecial grant of £1,000 was made by the Nuffield Foundation for the support of a book to be published under the title "Lessons of the British War Economy", which is intended to form a professional symposium on British war economics. With funds of the Garton Foundation, transferred to the Institute in 1942, it has been decided to establish an annual Garton Prize, probably of the value of 100 guineas, which was to be offered for competition in 1948. It is intended to publish the prize-winning essay in a special Garton Monograph Series. Experience with the Senior Research Fellowship scheme which terminated during the year showed the value of the scheme in assisting university research during the transition period; but the increased funds becoming available for research in the social sciences in the universities of Great Britain have diminished the need for special awards for experienced research workers, and there is already difficulty in finding persons of sufficient maturity and experience for the programmes planned.

A grant was made to Bedford College in support of the research project entitled "An Enquiry into the Social Factors Determining Earned Income" being carried out by Mrs. Barbara Wootton, another to the Department of Applied Economics, University of Cambridge, for a senior research worker for the output section of the inquiry into expenditure, output and income, 1920–38, and another to provide Prof. E. Victor Morgan, at University College, Swansea, with part-time research assistance for the project "Studies in British Financial Policy, 1914–25". It was expected that the report of the Joint Advisory Sub-Committee with the Institute of Chartered Accountants on the meanings and uses of terms commonly employed by both accountants and economists would be ready for submission to the Joint Exploratory Committee early in 1948. The Institute has also agreed to co-operate in the provision of bibliographical service with the International Association for Research in Income and Wealth.

The fourth issue of the "Register of Research in the Social Sciences" was circulated in the spring of 1947, and the "Register" is in future to be published as an annual available on a subscription basis only. In regard to research programmes, the major task of fact-collecting for the "Distribution Enquiry" has been completed, and work on each of the three main parts of the "Building Enquiry" progressed steadily. Work has continued on the "National Expenditure, Output and Income, 1920–38, Enquiry", and a new investigation, to be called "The Social Accounts of Local Authorities", has developed out of work on the Public Authority section. The report on international comparisons of productivity in British and American manufacturing industry has been circulated privately to a limited number of research centres, Government departments and other organisations.

The contribution of the independent research institute is discussed at some length in the report, which points out that such organisations are the natural complement of the universities, with which, and Government departments, the report of the Clapham Committee was solely concerned. They can undertake investigations which are unlikely to be developed under university conditions, and apart from providing a common meeting-place for representatives of different interests and different approaches to the social sciences, they can take risks in opening new ground or trying expensive new methods which an individual scholar or university might not be able to afford. Among the ancillary functions of the independent research institute, special emphasis is laid upon that of providing a clearing house for information.

The Institute in March 1947 called an informal conference of some forty persons responsible for the conduct or organisation of research. As a result of this conference, a report was published entitled "Social and Economic Research and Government Departments" which has been given a wide circulation. The conclusions of the conference are embodied in a set of practical proposals which go far towards providing means for unravelling the difficulties of the research worker in the social sciences in his dependence on official sources of data. For example, the conference urged that it is a matter of first importance that general principles governing the confidential character of official material should be formulated. It also recommended that in drawing up the departmental schedules governing the preservation and destruction of records, outside experts should be consulted. Other pressing problems such as the automatic release of certain collections, the setting of time-limits to the inaccessibility of documents, the publication of material by Government departments in signed articles, the development of research bulletins and the need for outside expert advice on new collections of data were also considered by the conference ; an appendix to the report lists twenty-four major collections, tabulations and analyses of data known to exist in Government departments or which can readily be compiled and are of basic importance to research workers. The report, however, is only a first step, and the conference can be convened again when there is work for it to do.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

CHIEF ANIMAL HUSBANDRY OFFICER, Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (August 5).

SENIOR CHEMISTS to take charge of small research teams on physical and chemical problems of coal tar and its processing, an ANALYST to take charge of Analytical Department, RESEARCH CHEMISTS to work on the constitution of coal tar and refining processes, an INTELLIGENCE OFFICER AND LIBRARIAN to take charge of a Technical Library, etc., and ABSTRACTORS (male or female graduates in chemistry with a working knowledge of French and/or German)—The Director of Research, Coal Tar Research Association, 9 Harley Street, London, W.1 (August 7).

RESEARCH AWARD IN THE DEPARTMENT OF ZOOLOGY—The Registrar, University College, Hull (August 7).

ASSISTANT LECTURER (Grade III) IN GEOGRAPHY—The Secretary, The University, Edmund Street, Birmingham 3 (August 7).

ASSISTANT ADVISORY OFFICER IN AGRICULTURAL BOTANY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 7).

LECTURER IN ELECTRICAL ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (August 10).

EXPERIMENTAL OFFICER at the Forest Products Research Laboratory, Princes Risborough, to assist in research work in connexion with woodworking machinery and sawmill problems—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2206 (August 11).

HEAD OF THE HORTICULTURAL DEPARTMENT of the Kent Farm Institute, Sittingbourne, and a LECTURER IN HORTICULTURE AND RURAL STUDIES at the Kent Horticultural Institute, Swanley—The County Education Officer, Kent Education Committee, Springfield, Maidstone (August 14).

RESEARCH ASSISTANT IN THE DEPARTMENT OF MINING—The Registrar, The University, Sheffield (August 14).

LECTURER with special qualifications IN PURE MATHEMATICS (or ASSISTANT LECTURER)—The Registrar, University College, Hull (August 14).

SENIOR LECTURER (temporary) and LECTURERS (2) IN MATHEMATICS at Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 15).

LECTURER IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Liverpool (August 23).

SENIOR LECTURER IN PRODUCTION ENGINEERING—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Senior Lecturer in Production Engineering' (August 23).

CHEMISTS (men and women) for unestablished appointments in the grades of SCIENTIFIC OFFICER Class and EXPERIMENTAL OFFICER Class, for analytical work in connexion with atomic energy development—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.78/48A/2 (August 24).

ENGINEERING INSPECTOR IN THE FIRE SERVICE DEPARTMENT of the Home Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2208 (August 24).

SENIOR PROFESSIONAL OFFICER FOR CERAMIC AND REFRACTOR RESEARCH, Government Metallurgical Laboratory, University of th Witwatersrand, Johannesburg—The Director, Government Meta lurgical Laboratory, c/o Victor Reid, South Africa House, Trafalg Square, London, W.C.2 (August 31).

LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS, Universit of the Witwatersrand, Johannesburg—The Secretary, Universiti Bureau of the British Empire, 8 Park Street, London, W.1 (Augu 31).

PROFESSORSHIP OF ECONOMIC AND MINING GEOLOGY in the Un versity of Adelaide—The Secretary, Universities Bureau of the Britis Empire, 8 Park Street, London, W.1 (August 31).

READERSHIP IN BIOCHEMISTRY at the Royal Cancer Hospital-The Academic Registrar, University of London, Senate House, Londo W.C.1 (September 1).

RESEARCH FELLOWSHIP and a RESEARCH ASSISTANT IN THE DEPAR MENT OF ECONOMICS of Natal University College—The Secretar Universities Bureau of the British Empire, 8 Park Street, London, W (September 1).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS, Universit College of the West Indies, Jamaica—The Secretary, Inter-Universit Council for Higher Education in the Colonies, 8 Park Street, Londo W.1 (September 15).

PROFESSOR OF ZOOLOGY at Makerere College, Kampala, Uganda-The Secretary, Inter-University Council for Higher Education in t Colonies, 8 Park Street, London, W.1 (September 15).

LABORATORY STEWARD IN THE DEPARTMENT OF SCIENCE AN TECHNOLOGY—The Principal, Cambridgeshire Technical Colleg Collier Road, Cambridge.

LECTURER IN BOTANY, and a DEMONSTRATOR IN GEOLOGY—Th Registrar, University College, Exeter.

ASSISTANT LABORATORY STEWARD IN THE DEPARTMENT OF ZOOLOG —The Head of the Department of Zoology, University College, Hul

DIRECTOR OF THE WEST AFRICAN FISHERIES RESEARCH INSTITUT Sierra Leone—The Under-Secretary of State, Colonial Office, Researc Department, Sanctuary Buildings, Great Smith Street, London, S.W.

LECTURER IN THE MATHEMATICS DEPARTMENT—The Principa Northampton Polytechnic, St. John Street, London, E.C.1.

LABORATORY ASSISTANT (woman) at Aylwin School, Southwar Park Road, S.E.16—The Education Officer (Estab. 2), London Count Council, The County Hall, London, S.E.1.

LECTURER IN PHYSIOLOGY up to B.Sc. standard—The Clerk to th Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

ENTOMOLOGIST IN THE RESEARCH DIVISION of the Department Agriculture and Forests, Sudan Government—The Sudan Agent London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist Agriculture'.

CHIEF MECHANIC to take charge of workshop attached to medic research unit—The Director, Radiotherapeutic Research Unit, Medic Research Council, Hammersmith Hospital, Ducane Road, Londo W.12.

PHOTOGRAPHIC TECHNICIAN with experience in photo-micrography for M.R.C. Biophysics Research Unit—Prof. J. T. Randall, King College, Strand, London, W.C.2.

TECHNICIAN (with considerable experience in routine investigatio IN THE DEPARTMENT OF CHEMICAL PATHOLOGY, and a TECHNICIA to be responsible for preparation of teaching classes in Organic Chemistry, Biochemistry and Chemical Pathology—The Secretary, Charin Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

SENIOR SCIENTIFIC OFFICER (G. 224/48A) to take charge of Biolog and Chemistry Section, a SENIOR SCIENTIFIC OFFICER (A.185/48A) t take charge of Physics and Electronics Section, a SCIENTIFIC OFFICE (F.429/48A) for investigation of deterioration of materials and complete equipment exposed under tropical conditions, a SENIOR EXPER MENTAL OFFICER (A.186/48A) to lead a team working on Electronic EXPERIMENTAL OFFICERS AND ASSISTANT EXPERIMENTAL OFFICE for work in the following Sections : Chemistry (F.430/48A), Biolog (G.225/48A), Physics and Electronics (A.187/48A), General Engineeri (C.415/48A), at the Ministry of Supply Tropical Testing Establis ment, Port Harcourt, Nigeria—The Ministry of Labour and Nation Service, Technical and Scientific Register (K), York House, Kingswa London, W.C.2, quoting the appropriate Ref. No.

METALLURGIST to work in the Mechanical Testing Section—T Secretary, British Non-Ferrous Metals Research Association, 81- Euston Street, London, N.W.1.

SENIOR LABORATORY ASSISTANT—The Headmistress, Maidsto Grammar School for Girls, Maidstone.

THEORETICAL PHYSICIST or MATHEMATICIAN (preferably with knowledge of matrix and tensor calculus), and an EXPERIMENTAL PHYSICI (if possible with some experience in instrument design) for researc on the rheological properties of materials, an ELECTRONICS PHYSICI for fundamental research in applications of microwaves, and PHYSICIST with experience of high vacuum and interferometry techniques—The Secretary, British Rayon Research Association, Bridg water House, 58 Whitworth Street, Manchester 1.

ANALYST IN THE DEPARTMENT OF CHEMISTRY of the School Agriculture, Sutton Bonington, Loughborough—The Registra University College, Nottingham.

ASSISTANT LECTURER IN GEOGRAPHY, a LECTURER IN PHARMACOLOGY, a DEMONSTRATOR IN PHARMACOLOGY, an ASSISTANT LECTUR IN PHARMACEUTICS, and a DEMONSTRATOR IN PHARMACEUTICS—T Registrar, University College, Nottingham.

PHYSIOLOGIST to obtain experience for from 1 to 2 years in Americ teaching and research—Prof. H. C. Bazett, Department of Physiolog University of Pennsylvania, Philadelphia, Pa., U.S.A. (write by a mail).

PHYSICIST—The House Governor, Royal Hospital, Wolverhampto

ASSISTANT GAME WARDEN—The Sudan Agent in London, Wellin ton House, Buckingham Gate, London, S.W.1, endorsed 'Assista Game Warden'.

ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Registra University College, Singleton Park, Swansea.

INSPECTOR OF AGRICULTURE, Department of Agriculture and Forest Sudan Government—The Sudan Agent in London, Wellington Hous Buckingham Gate, London, S.W.1, endorsed 'Inspector of Ag culture'.

NATURE

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DISTRIBUTION OF SCIENTIFIC MAN-POWER

FROM the national point of view, a proper balance must be struck between productive effort and research effort, as in any successful private business ; it is the task of management to secure that the appropriate balance is achieved, and that it is achieved without diverting too many creative and fertile minds to the equally essential task of administration. This is the point of view from which the present organisation of scientific and industrial research in Great Britain must be considered. As Sir John Anderson rightly said in his lecture to the Society of Chemical Industry when he received the Messel Medal on July 14, Great Britain has been a pioneer among the nations in the organisation of scientific research ; but nevertheless we must have the organisation of science in the public service constantly under review. In particular, it is essential that we should consider whether, by any changes in the existing organisation or by more careful use of our limited scientific man-power, we can rectify admitted weaknesses in the development of research results, and in the supply of trained scientific men and technologists.

It seems clear from its first report that the Advisory Council on Scientific Policy is concerning itself with this broad question ; but it is equally important that the scientific and industrial world should be provided with adequate data on which to base a sound and independent judgment of the correctness of Government organisation and policy. That is the fundamental reason why early resumption of the publication of full reports from the Department of Scientific and Industrial Research is so important. Moreover, since a sound judgment cannot reasonably be made on the results of any one year, it is the more important that there should be available as early as possible a full account of the war effort, and especially before the Department is irretrievably committed to any schemes of expansion which involve large drains on man-power or equipment.

Admirably as the recent report from the Chemistry Research Board (see p. 228 of this issue) fills the need from one point of view—and there can be nothing but praise for much of the work done and also for the special attention being given to the development of new techniques for the benefit of both industry and science—a striking feature of the report illustrates the necessity for completing the picture. This is the way in which the work of the Chemical Research Laboratory is linked up with that of other Government institutions and departments. The Corrosion of Metals Section, for example, has collaborated with the Light Division of the National Physical Laboratory and with the British Iron and Steel Research Association, as well as with the Water Pollution Research Laboratory, the British Cast Iron Research Association and the British Non-Ferrous Metals Research Association, and has carried out work for the Ministry of Supply and the Ministry of Works. The High Polymers and Plastics Section has worked with the Engineering Division of the National Physical Laboratory and the Forests Products Research Laboratory, and the Coal Tar Section with the Heat Section of the Physics Division and the Metrology Division of the National Physical Laboratory. The Chemistry Research Board itself directs attention to contacts maintained with other departments and to field trials by the Colonial Office on the control of nagana in Africa by the use of phenanthridinium compounds prepared in the Laboratory, as well as the development of the production of food yeast in Jamaica.

There can be no question as to the value of such collaboration in achieving economy of effort and equipment, and whatever doubts are entertained as to the value of the research association movement, there are *a priori* reasons for believing that the work of such institutions as the Chemical Research Laboratory is thoroughly sound, and that under the Chemistry Research Board it is making an important, and possibly a vital, contribution to the advancement of science and to industrial development, apart from the study of the specific scientific problems which arise in the public service. The very way in which it is interlocked with the work of other bodies, however, makes it important that we should consider the Government organisation of research as a whole. Otherwise there is danger that justifiable expansion at one point may have serious and undesirable repercussions on activities elsewhere which it is vital to maintain or even expand.

It was noticeable that, in his address at Edinburgh, Sir John Anderson was purely descriptive and neither commended nor condemned what he described, though those who followed his survey closely might perhaps have gained from his inflexions some idea of the general trend of Sir John's own mind. Neither can it be said that the Advisory Council on Scientific Policy has in its first report addressed itself to the broadest aspects of the question. The Council was asked by the Government to make recommendations on the specific questions, *inter alia*, of the appropriate organisation for scientific research within the Government, with special reference to research on building and on fuel and power, and the appropriate form of research effort to assist the maximum increase in national productivity during the coming decade. In regard to the former of these problems, the Advisory Council was asked to consider, in particular, what should be the respective functions of Government departments, of the research councils and of outside bodies (including the boards of socialized industries) in carrying out research.

The Advisory Council recognizes that on one hand research of the highest quality depends on a freedom which is difficult to reconcile with the normal conditions of Government work, and on the other hand, that close contact between the research worker and the user of the results of applied research is essential in order that the results obtained may be of practical value and supply data and a satisfactory foundation for the research itself. It therefore devoted considerable time at the outset to discussion of the general principles which should apply to the organisation of Government research and its applicatio and as a result reached agreement on two genera principles. First, the executive department shoul be responsible for identifying problems requirin research, settling their order of priority, decidin where the various investigations should be carrie out and applying their results. Secondly, the researc councils, and particularly the various branches of th Department of Scientific and Industrial Researc should continue to be free to initiate backgroun research where they think fit, free from administrativ control of the executive departments and consequently from considerations of day-to-day expediency

Like Sir John Anderson in his lecture, the Advisor Council rejects the idea of a Ministry of Science an agrees that no attempt should be made to concentrate responsibility for carrying out all Governmen scientific research on the Lord President of th Council. It considers that this would intensify rathe than diminish the old cleavage between science administration and policy; although the Lor President should assume a particular concern fo such branches of scientific research as have a wide application than to the problems of a particula department.

While there will probably be much general suppor for these views, it will be noted that the Advisor Council does not discuss in the present report th effectiveness or adequacy of the general structure, o whether its disposition as between Government an industry could be improved with advantage to th public welfare. This is the more important in vie of the next conclusion, that if the executive departments are to discharge their considerable scientifi and technical responsibilities thus defined, they wi require to employ considerable scientific staff corresponding to the operational research unit attached to the Service Ministries and Command during the War. The appointment of a 'chief scientifi officer' by the departments, provided with an adequat staff, however admirable in principle, may well b open to question on practical grounds at the presen juncture. Can we really afford to withdraw suc men from production while we are still awaiting th increase in scientific and technological man-powe recommended by the Barlow Report ?

The recommendation, it is true, is in line with th observations in the report of the Select Committe on Estimates, which in its third report for th Session 1946–47, dealing with expenditure on researc and development, referred to the absence of sufficien provision for the identification of scientific problem in day-to-day administration as one of the greates weaknesses in the Government organisation. Th Select Committee itself recommended the appoin ment in all executive departments of scientifi advisers who should have a high standing and direc access to the policy-forming level. There can only b welcome for any proposal which will give the scientifi man more influence in guiding the formulation a well as the administration of policy, and for th recommendation that executive departments to th work of which science can contribute should assum a more positive role than hitherto in the organisatio and direction of research required for their own purposes and in supervising the application of its esults. Nevertheless, however urgent and essential may be the appointment of chief scientific officers or the planning of the present Government research programme in the best way to meet national needs, the question must still be asked where the men are to be found, and whether there are not other activities which could be curtailed or discontinued to release men for such work.

These recommendations were submitted by the Advisory Council in a general report on May 22, 947, and two such appointments have since been made, to the Ministry of Food and to the Home Office respectively. The same principles have been applied to the Council's consideration of the special requirements of building research. Here it recommends that the Department of Scientific and Industrial Research should retain full responsibility for scientific research and initial development in building, as well as its freedom to initiate research and undertake investigations at the direct proposal of the building industry. The Ministry of Works should retain the broad responsibilities indicated for executive departments in general, including that of keeping the technical development of the building industry under review, promoting the final stages of development, and encouraging the use by industry of the results of research. For the discharge of these scientific functions the Advisory Council recommends, in addition to the appointment of a 'chief scientific officer', a scientific advisory council of scientific men and representatives of the building industry in equal proportions, and such a Council on Building and Civil Engineering and Development was established on December 8, 1947. Under these proposals, the responsibility for identifying the problems requiring research and determining their priority, as well as for initiating research in the sociological or economic field, rests with the Ministry of Works. In like manner he Advisory Council recommended that the scientific and engineering staff of the Ministry of Fuel and Power should be substantially strengthened, and that a 'chief scientific officer' should be appointed with adequate status and with responsibility for making a broad strategic survey of the problems on which to base a general research problem for the fuel and power industries. He would be assisted by an advisory council including not only scientific men but also economists, administrators and men of wide practical experience in the nationalized industries. The Advisory Council has rejected a suggestion to transfer he Fuel Research Station to the Ministry of Fuel and Power; but advised that the Station should continue to act as an agent in carrying out such research as the Ministry may decide to allocate o it.

There can be no doubt that, under its terms of eference, the Advisory Council on Scientific Policy is discharging important functions not hitherto provided for, and its first report encourages the hope hat the Council will go much more closely into such mportant questions as the appropriate pattern for he scientific organisation of Government departments in general as well as that of the general structure of the organisation of scientific and industrial research in Britain, the principles on which research in the nationalized industries should be organised and the overall requirements of scientific man-power and the appropriate measures for its recruitment and training. Meanwhile, its report should reassure those who fear that the conduct of scientific research by Government departments or the research councils will be over-planned. Its pronouncements on the status of 'chief scientific officers' will be welcomed by those who have urged, as has been done in these columns for many years, that the scientific man should be given the status which will enable him to make his voice heard effectively in the determination of policy where scientific factors are involved; and that the possession of scientific qualifications should not constitute a bar to advancement to positions of the highest administrative responsibility when the requisite administrative talent is joined to such qualifications.

Nevertheless, the report will inevitably cause some misgivings. As is rightly emphasized, to meet the urgent requirements of the economic situation the direction in which scientific research and development should be promoted cannot be determined solely from the point of view of science itself; and its gravity makes it essential to develop quicker and more efficient application of the results of fundamental research, demanding in turn an efficient scientific organisation in executive departments and a better supply of the type of technologist who can effectively apply the results of fundamental research. It is no easy task to strike the right balance between long-term and short-term interests, between the needs of academic and industrial research, between the requirements of science and Government; and however valuable the Advisory Council may prove in future in deciding such issues in terms of an overall scientific and economic policy, the present report will not satisfy those who believe that an excessive proportion of the general as well as the scientific man-power of Britain is being diverted from productive to non-productive occupations.

This is not to suggest that research is non-productive; but as we have already stressed, if too large a proportion of scientific workers is employed on research or the dissemination of its results, there will not be enough available to apply those results. The Advisory Council does not entirely ignore this question of production; but the special Committee on Research and Productivity appointed by the Advisory Council, with Sir Claud Gibb as chairman, and the functions of which have now been transferred to a new and independent Committee on Industrial Productivity, was concerned more especially with the human factor in production, and such matters as nutrition and production and the improvement of technical information services. The fundamental question of the proper distribution of the scientific man-power of Britain between defence and civil requirements is only touched upon in that part of the Advisory Council's report which deals with scientific man-power, and even here the vital issue of the distribution between productive industry and other civil requirements, including services of all kinds, is not adequately examined. This, however, is really the most important section of the Advisory Council's report, and requires fuller discussion in the light of the revised estimates of university expansion and the prospective demand for scientific man-power which have appeared since the Barlow Committee reported in 1946.

CHEMICAL SYNTHESIS MADE EASY

Synthetic Methods of Organic Chemistry

A Thesaurus. By W. Theilheimer. Vol. 1: 1942–1944. Translated from the German by Hans Wynberg. Pp. x + 254. (New York and London: Interscience Publishers, Inc., 1948.) 30*s*.

THIS is a new type of organic chemical publication. The volume under review is a translation of a German version published in Basle in 1946, and purports to cover the original literature of the period 1942–44. In fact, references to earlier publications are frequently given. Volume 2, covering the literature of 1945–46, has now been published in German, and presumably an English translation of this will appear in due course. If there is to be a series of volumes appearing at two-year intervals, then steps should be taken to reduce this time-lag between publication of the original Swiss edition and the appearance of its translation. The work is described as a "Thesaurus", a word which is defined by the Shorter Oxford English Dictionary as meaning a 'treasury' or 'storehouse' of knowledge. This savours somewhat of grandiosity, and it remains to be seen whether organic chemists will regard the work so highly as the description implies. For the present, they will be content to accept the commendation of Prof. Reichstein in the foreword which he contributes, and to give the volume a conspicuous place on their shelves of reference works.

The author's intentions are admirable. The present volume summarizes more than seven hundred reactions, with literature references, and the information collected will be of value not only to those who are interested in synthetic methods but also to those who have a general interest in organic reactions and their current applications. As Prof. Reichstein points out in his foreword, the actual methods of organic chemistry are not classified and recorded in such a highly systematic way as are new compounds. Until recently the best available reference book for methods was "Houben", which is now a little out of date, and although there are excellent newer books on methods, such as "Organic Reactions" and "Newer Methods of Preparative Organic Chemistry", these deal only with reactions in strictly circumscribed fields.

Dr. Theilheimer has attempted to give a systematic survey of reactions likely to be of value in organic synthesis. This has of necessity meant making a selection, based on personal preference. The supreme difficulty of the project has been to devise a system of classification sufficiently simple to enable the entries relating to the desired reactions to be found readily; and sufficiently elastic to allow for an increase in the range of reactions to be included in future volumes. To meet this difficulty the author has devised a new form of symbolism, based on the system of classification used by C. Weygand in his "Organisch-chemische Experimentierkunst" (also available in an
English translation). Probably familiarity with
system will enable the user to find at once the ref
ences to the reaction in which he is interested ;
until he has acquired this familiarity the novice
be inclined to flounder rather helplessly, and
probably tend to rely on the index which, althou
good, is by no means perfect. It would have been
assistance if a table of contents could have be
included, with page numbers of the main headin
such as "Formation of C–C Bond".

For the most part, the methods enumerated do
appear to be new, but are examples of reactio
already known, taken from the literature of t
period under review. It is doubtful whether the ide
system of classification has been found. The syste
used results : (*a*) in the grouping together of reactio
which have very little in common except the natu
of the linkage which appears in the product, and (*b*)
the wide dispersal of very similar reactions. As
example of the latter we find that reactions number
652 and 768 are of precisely the same type, namel
union of aromatic nuclei by elimination of hydrog
halide by means of potassium hydroxide. There a
some inconsistencies. Aromatic rings are sometim
shown with Kekulé double bonds and sometimes no
it is curious to find potassium alcoholate listed in o
place as a reagent for the preparation of α-*iso*nitros
ketones and in another place sodium nitrite. Also,
is a little odd to find acetic acid and sulphuric ac
among the reagents used for nitration. The formul
appear to have been transcribed exactly from th
Swiss edition, even to the errors which have bee
detected in the formulæ given under numbers 192 an
695. In some cases translation has been accompanie
by the appearance of new errors. Thus, in sectio
No. 147 the name of an author is spelt incorrectl
and in section No. 152 2-acetylfluorene is erroneousl
given as 8-acetylfluorene. These, however, are mino
matters, and the author is to be congratulated on
courageous attempt to fill a serious gap in the literature of organic chemistry.

J. W. COOK

BIOLOGICAL STANDARDIZATION OF VITAMINS

The Biological Standardisation of the Vitamins

By Dr. Katharine H. Coward. Second edition. Pp
vii+224. (London: Baillière, Tindall and Cox
1947.) 16*s*. net.

SINCE the early 1930's, Dr. Katharine Coward ha
worked untiringly to popularize sound method
of biological standardization of vitamins. The firs
edition of her book appeared in 1938. In bringin
out the second she has the satisfaction of preachin
to the almost converted. The last ten years hav
seen no spectacular change in the principles o
biological assay of vitamins, but much refinement o
technique and broadening of scope. Dr. Coward ha
catered for both, but has followed her original pla
of discussing only those tests of which she has per
sonal experience and only those vitamins for whic
international standards are available. This strictl
orthodox approach is perhaps too harshly restrictive
of the whole gamut of the B vitamins now known i
the pure form, vitamin B_1 is the only one considered
a mention of riboflavin, pyridoxin and pantotheni
acid, for which reliable tests are available, would
certainly have been useful.

The presentation of the statistical methods has been considerably revised and improved. The treatment is very sound and comprehensive, though perhaps, for a beginner, some parts are too condensed, and scarcely enough stress is laid on criteria of significance.

Dr. Coward might well consider amplifying some of these useful statistical chapters; she could gain space for it by cutting out unnecessary repetition in he description of biological technique. To quote only one example of redundancy, the formula of one salt mixture is given in full no less than three times, on pp. 32, 135 and 155.

Most misprints of the first edition have been corrected; but by a strange fluke 'ingestation' has again escaped unscathed, to appear repeatedly on pp. 17–19.

In too many branches of science the standard monograph is a dry-as-dust compilation by scissors and paste. Vitamin workers in the field of biological standardization are fortunate to have in Dr. Coward a mentor who knows and loves the land through which she guides them. We wish her well in the task of charting for her third edition the discoveries of the next ten years.

S. K. Kon

P. White

VEGETATION OF THE ARGENTINE

La vegetación de la Argentina

By Profs. L. Hauman, A. Burkart, L. R. Parodi, and A. L. Cabrera. (Geografía de la República Argentina, Vol. 8.) Pp. 350. (Buenos Aires: Gaea, Sociedad Argentina de Estudios Geográficos, 1947.)

Up to the present, the botanist or agriculturist desiring information on the plant cover of the Argentine has been obliged to seek it among a large number of scattered publications, some in rather obscure periodicals, many out of print. Assistance has been given in recent years by Castellanos and Perez-Moreau's valuable classified bibliography of South American botany, published in *Lilloa*, volumes 6 and 7, 1941, and by the reprinting of some of the older works, such as, for example, Hieronymus' "Observations on the Vegetation of the Province of Tucumán", 1874, republished in 1945 by the University of Tucumán; but no compact account of the plant resources of this extremely varied country has yet been available. The appearance of the volume now published by the Argentine Society of Geographical Studies and written by botanists of authoritative position is, therefore, much to be welcomed. It is concise and so far as possible complete, although as Cabrera, writing of the Patagonian shrub steppe, notes, there is still much room for botanical and sociological investigation. The material was ready for publication in 1939; but printing had to be deferred until 1947.

The work has a geographical bias, and the subject-matter is arranged in accordance with the natural regions into which the Argentine is divisible. These are mapped by Parodi. Hauman, the senior author, has written the introduction and the sections which deal with the forests of Misiones and those of the 700-km. long narrow strip running from north to south through the provinces of Salta, Jujuy and Tucumán; with the Gran Chaco; with the enormous scrub or thorn woodland area known as the *Monte*; and with the sub-Antarctic forests and the Andean regions. Burkart describes the Mesopotamian region lying between the Rivers Paraná and Uruguay, in which forest alternates with savannah, the latter predominating. L. R. Parodi contributes the account of the great grass steppe of the pampas, and A. L. Cabrera that of the Patagonian shrub steppe.

The reader is impressed by the wealth of plant resources of the Argentine and by the great diversity of the material described. The influence of cultivation and stock-raising is perceptible principally in the pampas, not always to the detriment of the plant cover. Where, however, the exploitation of light lands in dry, wind-swept areas is excessive or even is practised at all, there is grave risk of wind erosion. This is so in a very large part of the middle west, where shifting sand dunes 30–40 m. in height, practically denuded of all vegetation, are to be seen.

G. M. Roseveare

GUSTAV FECHNER

Religion of a Scientist

Selections from Gustav Th. Fechner. Edited and translated by Walter Lowrie. Pp. 281. (London: Kegan Paul and Co., Ltd.; New York: Pantheon Books, Inc., 1946.) 17*s*. 6*d*. net.

Dr. Lowrie's biography of Fechner and selections from his writings make an interesting book. Fechner was a remarkable and most unusual kind of man, as unlike the standard nineteenth-century German professor as can be imagined; a poet, humorist and above all a Romantic. He is remembered chiefly in connexion with the Weber–Fechner law. His work was certainly a landmark in the study of sensory response. But the range of validity of the Fechner law is restricted; it states the value of a ratio between two physical quantities (total stimulus and least discernible increment), and what it signifies psychologically is doubtful. The assertion on the dust cover of this book, that through Fechner "psychology developed into an 'exact' science susceptible of mathematical treatment", is, to put it mildly, misleading. Dr. Lowrie himself says nothing of the sort.

There is a legend that Fechner was a physicist who was afflicted in middle life by an illness which affected his sight and probably his reason, and he thereafter gave up science and took to religious mysticism. Dr. Lowrie's narrative explodes the legend. Fechner's best-known religious work, "Life after Death", was published four years before his illness, and the work on Fechner's law was done several years after. All his life he found the mechanistic view of physical science intellectually stifling, and fought against it; first with parodies and jokes, afterwards more seriously and constructively. He took a pan-psychic or pan-theistic view of the natural world rather characteristic of the Romantics of his period. Unlike most of them, however, he did not turn his back on science; instead he tried to enlarge the scientific insight.

Fechner was rash in speculation and perhaps entirely mistaken in thinking that scientific thought could transcend its traditional limits. The mistake was not that of a man who is just stupid or ill-informed. The illness he had still remains mysterious, but does seem to have originated in mental conflict of some kind. Physiologists should note the strange diet of raw lean ham soaked in wine and lemon juice which initiated Fechner's recovery from his digestive troubles (p. 38).

A. D. R.

PHYSICAL AND CHEMICAL ASPECTS OF RUBBER TECHNOLOGY

THE Rubber Technology Conference, held in London during June 23–25 under the auspices of the Institution of the Rubber Industry, provided the first opportunity since the War for scientific workers and technologists in this field from many countries to meet for a general discussion of their problems. The papers presented covered a very wide range of subjects, from purely scientific to highly technical; this short article is an attempt to review only the more scientific aspects of the matters discussed.

Physical Aspects

It has been known for a long time that natural rubber crystallizes on stretching, and it is generally supposed that this phenomenon has an important bearing on such mechanical properties as tensile strength and resistance to tearing. In a paper on the degree of crystallization in natural rubber, Dr. J. M. Goppel discussed his recent X-ray studies of the absolute amount of crystallization as a function of the degree of extension of the rubber. For a highly extended vulcanized rubber, the fraction of crystalline material was found to be only 29 per cent, which is very much lower than figures given by the earlier work of Field (60–80 per cent). Correspondingly low figures were obtained for frozen raw rubber (unstretched), for which the degree of crystallization was found to increase with time of storage. The highest figure obtained was 38 per cent for crepe rubber which had been stored for twenty-nine years. It was shown also that estimates of crystallinity from density changes reported in the literature led to values of the same general magnitude.

Papers dealing with the design of engineering components in rubber were contributed by Mr. R. S. Rivlin, who dealt with the theoretical basis of this subject, and by Mr. H. L. Jenkins and Mr. H. D. Cooper, whose approach was from the experimental side. Mr. Rivlin referred to the inherent limitations of the classical theory of elasticity—particularly the restriction to small deformations—and gave an outline of recent developments in the theory of large elastic deformations, with particular reference to incompressible materials, that is, materials like rubber, the volume of which is substantially constant on deformation. Rivlin's theory is centred on the existence of a unique work of deformation or stored-energy function corresponding to a specified state of strain; from this stored-energy function the generalized stress-strain relations are readily derived. The theory has been applied to a number of problems of practical interest, among which shear mountings and torsional couplings were particularly considered.

From experiments on the axial compression of cylindrical blocks between lubricated plates (to allow free lateral expansion), Mr. Jenkins and Mr. Cooper showed that the properties of rubber in compression can be adequately represented by the formula derived from the statistical theory of James and Guth. This formula, which had previously been applied mainly to rubber in tension, involves only one physical constant k, which is analogous to the modulus of rigidity in the classical theory. The experimental values of k are nearly independent of the ratio of length to diameter of the cylinder. In the case of shear, the theoretical linear relation between stress and strain was found to be inadequate; but the experimental results can be represented by the use of the same constant k together with an empirical 'shape function'. It was pointed out, however, that the values of k are dependent on the time of loading or 'load history' adopted, and a machine was described which has been designed to facilitate the application of different load-history patterns.

Another aspect of the mechanical properties of rubber, the rate of retraction from the stretched state after release of the tension, was examined by Dr. B. B. S. T. Boonstra. The technique employed depends on the breaking of electrical contacts by the motion of the rubber, the time between successive breaks being measured by the fall in potential of a condenser discharging through a resistance. Differences were found both in the rates of retraction, and in the residual temporary 'set', between the various rubbers (natural and synthetic) examined. The speed of retraction did not appear to be correlated with rebound resilience; for example, butyl rubber, though showing very low rebound resilience, gave a retraction-rate only slightly below that for natural rubber.

The two sessions devoted to the discussion of compounding ingredients included a number of papers dealing with the effects of fillers, particularly carbon black, on the physical properties of rubber. Although carbon black is regarded as the outstanding 'reinforcing' filler for rubber, there appeared from the discussion to be no general agreement as to what constitutes reinforcement, though tensile strength, stiffness and abrasion resistance were the most frequently quoted criteria. In view of this lack of definition of the concept, it is not surprising to find that the mechanism of reinforcement is still but imperfectly understood. A new and interesting fundamental approach to this problem was provided by Dr. W. R. Smith and Mr. W. D. Schaeffer, who have attempted to evaluate the surface activity of various carbon blacks by measurements of the heats of adsorption of gaseous hydrocarbons. Their results reveal a marked variation in heats of adsorption with degree of surface covering (up to 1·5 molecular layers), which points to a selective adsorption at specially active sites. How far these conclusions are directly applicable to the carbon-rubber system has yet to be established; but the evidence suggests that there is a rather close correlation between the initial heats of adsorption and the reinforcing power of the black.

A general physical approach was adopted in the paper by Dr. E. Guth on the theory of filler reinforcement. Guth's theory concentrates attention on the effect of included rigid particles on the modulus of an elastic medium. This theory leads to an expression for the modulus in terms of the volume concentration of the filler which may be regarded formally as an extension of the well-known Einstein relation for the viscosity of a liquid medium containing solid particles in suspension. By means of this equation it should be possible to distinguish between approximately spherical particles, and particles possessing marked geometrical anisotropy. The experimental evidence quoted by Dr. Guth indicated that non-reinforcing fillers like calcium carbonate correspond to the case of spherical particles, while reinforcing fillers require the assumption of highly elongated particles. Since individual carbon particles are roughly spherical in shape, this is regarded as evidence for the formation of elongated chain-like agglomerates of particles, such as have frequently been observed in the examination of blacks under the electron microscope. Indeed, by a suitable modification of the theory it is possible to include the effect of non-sphericity in terms of a 'shape factor'; the shape factors thus derived are found to agree reasonably well with the shapes observed in the electron microscope. This conclusion received further support from Dr. L. H. Cohan, who presented electron microscope evidence for the existence of chain-like structures, which appear to be of characteristic form for any particular mode of preparation of the black. A large number of measurements on a particular black yielded an axial ratio of 6, and this value was found to account for the observed increase of modulus, on Guth's theory, up to 25 per cent concentration.

This theory of reinforcement, as the subsequent discussion showed, is not without its difficulties. According to Dr. L. Mullins, the stiffening effect of carbon black 'wears off' after a small number of repetitions of the extension of the rubber, and gradually reappears on resting, suggesting a breakdown of the chain structures due to stressing. This aspect was further discussed by Mr. A. F. Blanchard and Dr. D. Parkinson, who made use of measurements of electrical conductivity, which is directly related to a net structure of the carbon particles, to throw light on the breakdown and re-formation of these structures. Their conclusion is that the degree of breakdown of structure on extension is relatively of a minor character, certainly not sufficient to account for the observed reduction of stiffness, which they attribute rather to the rupture of the bonds between the carbon particles and the rubber.

A contribution to the study of the optical properties of rubber was presented by Dr. L. A. Wood and Mr. L. W. Tilton, who described an accurate method of measuring refractive indices, in which the specimen was moulded into prismatic form between glass plates. Data were obtained at five different wave-lengths, and over a range of temperature, and compared with various theoretical formulæ for optical dispersion. An interesting result which emerged is the disparity between the isoprene unit and normal mono-olefins, which suggests that the middle C—C bond may partake of the properties of a double bond. A corresponding abnormality in bond-length was found from an X-ray analysis by Jeffrey of the closely comparable low-molecular crystalline compound, geranylamine hydrochloride.

The curious luminescence which may sometimes be observed on tearing rubber in a dark room was the subject of a paper contributed by Dr. A. van Rossem. From numerous experiments it has been shown that the emission of light is related to the type of filler with which the rubber is compounded. The effect was observed only in the presence of non-reinforcing fillers. The suggestion was made that the phenomenon is due to a discharge of electricity through the vacuoles which are known to be formed in such filled rubbers under tension.

On an entirely different subject, Prof. H. W. Melville and Mr. C. R. Masson reviewed recent techniques for the measurement of very small osmotic pressures, as encountered in the determination of molecular weights of high polymers. The difficulty of such measurements arises from the length of time required for the attainment of osmotic equilibrium. It was shown that this may be greatly reduced (*a*) by the use of bacterial cellulose as a semi-permeable membrane, and (*b*) by the use of a dynamic method involving the measurement of the rate of approach to equilibrium. Another technique described was the 'osmotic balance' method, in which the diffusion of liquid into the cell is determined by weighing instead of by measurement. This method was claimed to give remarkable sensitivity, and should prove useful for the determination of molecular weights hitherto considered to be beyond the range of investigation by osmotic methods.

Among a number of papers dealing mainly with the technical evaluation of the properties of rubbers, many questions of interest to the physicist were touched on. Particular mention may be made of two papers on the resistance of rubber to tearing, by Dr. J. M. Buist and Dr. H. A. W. Nijveld, respectively, and one by Dr. J. R. Scott and Mr. R. W. Whorlow on the interpretation of plasticity measurements.

Chemical Aspects

Although most aspects of the chemistry of elastomers were implicit in the many matters discussed from a technological point of view, the actual contributions to rubber chemistry were limited to the three main topics of oxidation, vulcanization and rubber halides. There were also some subsidiary advances in chemical knowledge in the more technical discussions on synthetic rubbers and on latex.

On the subject of oxidation, papers presented by Dr. R. L. Stafford and by Dr. J. Le Bras and Mr. A. Salvetti were both primarily concerned with the mode of action of inhibitory substances. It has been suggested that in rubber chemistry the latter fall into two distinct classes, termed antioxidants and deactivators respectively, typical examples being phenyl-β-naphthylamine and mercapto-benzimidazole. The former fulfil the normal function of retarding oxygen attack, whereas the latter reduce the deleterious chain-scission reactions associated with oxidation of rubber without lessening the overall combination of oxygen. Much of the earlier work on the autoxidation of rubber and allied substances has been carried out with strong sources of light (for example, ultra-violet), thus giving a reaction which proceeds at a rate many times that of the dark reaction and which is unretarded by the usual antioxidants. No fundamental change in the nature of the reaction or of the effect of antioxidants was encountered by Dr. Stafford when the oxidation was effected with a weak light source with the object of obtaining a rate of photo-activated absorption of the same order as that of the dark thermal reaction.

However, although neither phenyl-β-naphthylamine nor mercapto-benzimidazole (the antioxidant and deactivator studied) was effective against light-activated absorption, a mixture of the two was found to possess considerable efficacy. The precise mechanism of this effect, which is in accord with earlier work of Le Bras, is still unsolved.

For the study of these oxidation effects with rubber, Dr. Le Bras has designed an improved type of manometric apparatus in which the oxygen is generated as required by electrolysis of a concentrated solution of copper sulphate.

The chief difficulty in this type of work is the fluctuation in results occasioned by the variability of composition of crude natural rubber. Assistance in this direction was given by Mr. G. Martin, who described a simplified method of preparing pure rubber hydrocarbon for oxidation studies. The method involves addition, to the ammonia-preserved latex, of a soap, which displaces the protein from the rubber particle surfaces, followed by repeated creaming, coagulation with acetic acid and extraction with acetone.

Considerable interest was shown in a paper by Dr. W. T. Chambers on the direct determination on a micro-scale of oxygen in rubbers. His method is an application of that of Unterzaucher involving reduction of the oxygenated compound with carbon, the resulting carbon monoxide being oxidized by iodine pentoxide and the liberated iodine estimated after oxidation to iodate. The ability to determine small percentages of oxygen directly, instead of by difference from the carbon and hydrogen figures, will be of great value in rubber oxidation studies. The accuracy of this method is of the order of ±0·01 in the range 0–0·5 per cent oxygen and ±0·04 in the range 1·0 to 2·0 per cent oxygen. This precision was not sufficient to show conclusively that the molecular breakdown of rubber on milling is always associated with oxidation, but Dr. Chambers was able to demonstrate this effect in one run with pale crepe rubber.

In his presidential address to the Conference, Sir Robert Robinson mentioned the advances that had been made in the knowledge of polymerization and the importance of the introduction of intermolecular cross-linking into natural and synthetic polymers. Dr. G. F. Bloomfield was able to present more evidence on the nature of the cross-links arising in the vulcanization of rubber with sulphur. In this connexion methyl iodide has proved a useful reagent for determining the type of C—S link present. Earlier work has shown that methyl iodide at 25° C. removes the sulphur from diallylic sulphides to form trimethyl sulphonium iodide, and since the latter is obtained from the reaction of methyl iodide with rubber/sulphur vulcanizates, it has in the past been assumed that diallylic groups must be present in appreciable numbers. The unreliability of this conclusion (which is, in any event, at variance with other vulcanization evidence) was made apparent by Dr. Bloomfield's demonstration of a similar formation of trimethylsulphonium iodide from compounds containing the sulphur atom between one allylic and one tertiary grouping. It is known that the reaction of polyisoprenic compounds with sulphur leads to the formation of cyclic and cross-linked sulphides, and the evidence presented in this work is consistent with the view that the allyl-tertiary sulphide grouping is a characteristic of both.

The importance of the non-hydrocarbon constituents of natural rubber in the process of vulcanization was demonstrated by Mr. G. Martin in his work on highly purified rubber. The catalytic effect of these other constituents, the absence of which was found markedly to reduce the vulcanizing efficiency of sulphur, is a subject requiring further careful investigation.

A study of the hydrochlorination of rubber in latex by Dr. G. J. van Veersen had theoretical as well as practical significance. The reaction of hydrogen chloride with rubber in solution shows an induction period, the length of which is proportional to the solubility of the hydrogen chloride in the solvent. It was suggested that a solution of rubber in dioxane (for example) represents a system of two electron donors competing for the hydrogen chloride to form co-ordination complexes. During the induction period, the speed of the reaction would be dependent on the affinity of the solvent for hydrogen chloride, but after saturation the rate would be independent of the nature of the solvent. In the reaction of hydrogen chloride with rubber latex it is necessary to prevent coagulation by reversing the charge on the rubber globule with a cationic soap. Under these conditions a ver clean addition takes place with a minimum o cyclization.

It is difficult in a substance of high molecula weight like rubber to determine the nature of artificially introduced chemical groups. A contributio to this subject was made by Dr. G. Salomon, who rea a paper by himself and Drs. C. Koningsberger an A. J. Ultée on the kinetic analysis of rubber halides The method is based on the marked differences i reactivities of the various classes of aliphatic halide with organic bases. In the case of monohalides this order is allylic>primary>tertiary (with som exceptions) > secondary > secondary monocyclic > vinylic. Polyhalides are more difficult to distinguis unambiguously, but their identification is rendere possible in many cases by comparison of the speed of reaction with various bases. Using this kineti method, evidence was found, for example, for th formation of secondary allylic chloride groupings i the chlorination of rubber under conditions favourin substitution, and of a series of polychlorides, th constitution of which has yet to be settled, b conventional chlorination.

The papers and discussion on synthetic rubber were mainly technological in nature, although ther were some points of chemical interest. Dr. R. F Dinsmore directed attention to the fact that *GR–* requires less combined sulphur than natural rubbe to give a satisfactory vulcanizate, a point that ma well be connected with the tendency of the $\Delta^{1:}$ polyene system of rubber to give cyclic sulphide which contribute little to the strengthening of th molecular network. Mention was made of some o the physical and chemical properties associated wit the characteristic structures of silicone, 'Buna-N and butyl rubbers and of condensation rubbers of th type of 'Vulcaprene' (a di-isocyanate-modified poly esteramide).

An important contribution to our knowledge o the constitution of natural rubber latex was made b Miss L. N. S. Homans and Dr. G. E. van Gils. B centrifuging fresh unammoniated latex they wer able to separate a yellow fraction which was suspension mainly of non-rubber particles and whic contained 6–8 per cent of the total solids of latex These globules (termed 'lutoids') were easily visibl under the microscope as transparent masses considerably larger than the rubber globules and wer shown to consist of 80–85 per cent of water, with th solid content made up of proteins, salts and acetone soluble substances, in the form of lipoids. Additio of ammonia brought the lutoids into solution, an dilution with water caused shrinking; but they wer quite stable towards 0·1 *N* sodium chloride in aqueou solution. Removal of the lutoids resulted in marke changes in properties of the latex; for example greater susceptibility to photoxidation, lower mechanical stability, greater thermal stability.

This new knowledge may have interesting biologic implications in that it brings the constitution of late more into line with the complexity of other physiological liquids.

A further attraction of the conference was a exhibition, arranged by the Dunlop Rubber Company which included demonstrations of some of the mor striking of the properties of rubber and methods b which they have been studied.

It is intended that the *Proceedings* of the Conference shall be published in a single volume. There is no doubt that this will prove a worthy companion to the *Proceedings* of the first conference, held in 1938, and a valuable source of reference to all interested in rubber science.

L. R. G. Treloar
R. F. Naylor

NUTRITION OF ATHLETES

A WHOLE-DAY meeting of the Nutrition Society on July 17 was devoted to the subject of the 'Nutrition of Athletes". The first papers dealt with the physiology of muscular effort, and the meeting took a more practical turn later in the morning and in the afternoon session.

The meeting opened with a paper by Dr. Philip Eggleton of Edinburgh on "The Neuromuscular Mechanism". Physiological studies, he said, fall into three clear-cut categories. The first of these is the work on animals (including dog and man) which comprises measurements of work done, respiratory measurements, urine and blood analyses, nutrition studies and so on. The second category includes work on isolated muscles and nerves, which has been carried out mainly on cold-blooded animals because of the difficulty of using such preparations from mammals. Thirdly, there is work on the muscles of marine shell-fish. These last two methods have certain disadvantages in that it is difficult to apply the results obtained from them to the mammal, and particularly to the human being. Nevertheless, results from the three fields combine to produce a picture of the neuro-muscular machine which, according to the author, comes nearest to the physiologist's ideal—a description of physiological phenomena in terms of chemistry and physics—than has been achieved in respect of any branch of physiology, save perhaps the transport of gases by the blood.

Experiments in the first field have shown a simple relation between work done and food intake required; and there is also considerable evidence that manual labourers do not choose to eat carbohydrates but prefer fat and protein. This preference for a high protein diet by both manual labourers and athletes may be a survival perhaps of sympathetic magic; yet it may have as a basis the fact that meat is a good source of some of the B complex of vitamins. The preference for fatty food is more understandable, since it is an economical source of energy.

Dr. Eggleton went on to discuss A. V. Hill's work on the oxygen consumption during exercise, and said that in Hill's experiments the consumption of oxygen was about 4 litres a minute for men engaged in running at a pace which did not give them undue respiratory distress. However, these experiments only lasted for minutes, and Eggleton pointed out that the heart cannot pump 4 litres of oxygen into the body indefinitely; if the exercise has to be maintained for some time, an oxygen consumption of 1 litre per minute is nearer the upper limit. In this connexion Dr. Eggleton remarked that an athlete can build up an oxygen debt for events such as the 100-yd. sprint, and that in this event the rate of output of energy of the runner is 10–13 horse-power, which corresponds to an oxygen intake of 23 litres a minute—six times anything the heart can achieve. This debt is financed partly by the breakdown of glycogen to lactic acid and partly by the reserve of non-oxidative energy represented by the creatin phosphate content of muscle.

Dr. Eggleton discussed some of the aspects of the evolution of the neuro-muscular mechanism, and pointed out that one of the differences between invertebrate and vertebrate muscle is the presence of arginine in the muscles of the former and of creatine in muscles of the latter. Also vertebrate muscles contain considerable amounts of two di-peptides—β-alanylhistidine and β-alanyl-methyl-histidine—which are not present in invertebrate muscle.

In conclusion, Dr. Eggleton commented upon the apparent increasing athletic abilities of the human race, which he felt were more apparent than real, and upon the view that the decreased performances of British athletes recently is due to the changes in diet and habits engendered by the War, a problem which he felt should be left to later speakers.

Dr. Dorothy Needham spoke on chemical aspects of chemical contraction. In this field, Dr. Needham said that two lines of work, followed independently for about half a century, had only recently come together. One of these was the nature of the muscle machine, and the other was the nature of the essential fuel. Dr. Needham discussed the early work of Fletcher and Hopkins and of Meyerhof on the energy liberated by the formation of lactic acid in muscle, and of Lundsgaard's work on creatine-phosphate breakdown as a source of energy. Lohman's work in 1934, she said, suggested that adenosine triphosphate hydrolysis supplied the first energy-yielding reaction in muscular contraction.

The old idea that lactic acid production is an inevitable accompaniment of contraction has had to be discarded since it has been shown that much work can go on without any lactic acid formation. The most important constituent of the muscle machinery is the protein, and the modern phase began with the work of Edsall and von Muralt in 1930. Solutions of myosin showed the property of double refraction in flow, and this suggested some relation with the anisotropic bands of myo-fibrils. It appears that the contractile fibrils of muscle consist of polypeptide chains of myosin showing the α-fold, and owe their elasticity and contractility to their power of straightening out to the fully extended chain or folding up still further. The link between the machinery and the fuel comes from the observation that myosin has adenosine triphosphatase activity, so that myosin is not only the chief structural entity of muscle but is also the enzyme catalysing the chemical processes which lead to its own contraction. Szent-Györgyi has shown that another fibrous protein, 'actin', can be extracted from muscle, and that actin and myosin may unite to form fibrils of much greater length; this compound of the two proteins is called actomyosin.

It seems possible that some of the symptoms of fatigue may be due to the breaking of inter-molecular links which hold the partly folded polypeptide chains in place. If contraction is too severe and prolonged, too great a distortion may take place and unusual breaking of links or the formation of new and inconvenient ones may take place.

There are at the moment two main views on muscular contraction. One is that the contracting fibrils are made up of actomyosin. If adenosine triphosphate comes into contact with actomyosin fibrils, there is a rapid change of the protein with loss of water. Szent-Györgyi regards this as synonymous with contraction; on the other hand, Astbury has suggested that in resting muscle the fibrils are made more rigid and stable by combination in parts with a parallel *actin*-system, and that upon stimulation this combination is loosened by the action of adenosine triphosphate. When this happens the myosin can take up a shortened form of folding.

Group Captain C. A. Rumball described the practical uses to which investigations on the neuromuscular mechanism have been put in the choice of air-crews by the R.A.F. Pulse-rates while sitting, standing and under stress gave useful information. Diastolic blood pressures of more than 90 mm. were not acceptable, though up to 90 mm. was. However, it was pointed out that fifty-five marathon runners examined in 1909 had an average diastolic pressure of 93 mm. of mercury. One test which gave information of considerable value was that designed by Flack in 1920, in which a subject was asked to sustain a 40-mm. column of mercury in a U-tube manometer by a single expiration for as long as possible, and the pulse response examined. There are four main types of pulse response to this test; but only two of them, namely, a rapid and sustained rise to 10 or more beats per 5-sec. interval and a rapid rise followed by an abrupt fall to a low figure, indicated low functional efficiency.

Nutritional aspects of muscular activity were introduced by Dr. G. H. Bourne in a paper entitled "Vitamins and Muscular Exercise". Dr. Bourne pointed out that vitamins of the B complex play an important part in the reaction chains concerned with carbohydrate metabolism, and the demand for them might be expected to be increased in muscular exercise. A figure of fifteen times the normal requirement for vitamin B in severe exercise has been quoted. This would mean a daily intake of 22·5 mgm. (based on a normal daily requirement of 1–5 mgm. of vitamin B_1). To obtain this amount of vitamin B_1, one would need to consume 6½ kilos of National wheatmeal bread, ¾ kilo of commercial wheat germ or 90 gm. of dried brewers' yeast. One should consider, therefore, if these greatly increased demands for vitamins of the B complex do exist, and if they do, whether it would be possible for an athlete to obtain them from natural foods, with the possible exception of dried yeast. Perhaps, then, an athlete's performance is limited by his vitamin B complex intake, and this is itself limited by the amount of natural food he can eat. The consumption of quantities of meat, liver, eggs, etc., by athletes may be related not to the protein content of these foods, but to the relatively high amounts of various members of the vitamin B complex they contain.

If supplementation of athletes' diets is undertaken, it should be remembered that there is some evidence that certain vitamins may have a supra-physiological or pharmacodynamical action, which may or may not be related to their normal nutritional function. Inspection of the literature on the effects of supplementing the diet with various vitamins of the B complex shows no uniformity of results; but on the average there does seem to be a bias in favour of the beneficial effect of these vitamins on muscular exercise.

Attempts to show that extra doses of vitamin C increased resistance to fatigue have also been equivocal; but there seemed to be some evidence in favour of its use.

There is little doubt that deficiency of most vitamins seriously affects muscular effort; but the difficulty is in deciding just at what level of intake deficiency exists.

Dr. Bourne felt that the subject of nutrition o athletes, with its obsession with calories and proteins is lagging considerably behind modern advances in nutritional science.

In the afternoon, Sir Adolphe Abrahams asked what indication there was for a high calorie diet fo athletes, what foodstuffs should predominate in it and thirdly, what part, if any, alcohol should play in the diet of athletes ?

On the question of calories, Sir Adolphe said tha the figures published of the calorie intake of athlete at the Berlin Olympiad in 1936, which were said to have been compiled from observations on 4,700 competitors, were extraordinary. They quoted a daily average intake of 800 gm. of meat, 150 gm. o sugar, 150 gm. of butter, 1–1½ litres of milk, vegetables and fruit *ad lib.*, making a grand total o 7,300 calories. Such an intake is really equivalent to the requirements of a 24-hr. walking race, or daily violent physical exercise of six hours duration. In fact, no athlete in training undertakes six hours violent physical exercise a day. Most athletes visi the track twice a day. The sprinter does a few bursts from the start and a run through of 150 yd. each time, and few of even the long-distance men do really hard work during their training period. Events such as the annual Oxford and Cambridge boat race only use up about 500 calories per man. Athletes, therefore, do not need vast quantities of food; but a generous diet is desirable from a psychological point of view.

Discussing the role of meat in the diet, Sir Adolphe pointed out that athletes who claimed to be vegetarians invariably consumed milk, cheese and eggs, containing animal protein. He felt that extra sugar is not of particular benefit to athletes. The men of to-day are not better physically than the men of fifty years ago, and Sir Adolphe felt that the explanation of improved records is partly due to improved technique and partly to the increasing growth of the cult of athleticism.

The final paper of the day was given by Dr. Nevil Leyton on "Some Practical Aspects of the Training of Athletes". Dr. Leyton made the important point on the difference in individual calorie requirements for the performance of the same task, and the difference in the times before events that individual athletes require to eat. The actual calories for the Oxford and Cambridge boat race may be as much as 600 per man; this figure may be compared with that for a Marathon race, when 2,000 calories may be used. A five-set tennis match may use 1,200 calories. In addition, the body may continue to expend energy at a higher rate than normal for 24–48 hours after the event. A good training diet should nourish the athlete adequately during this period and should include fruit and vegetables, the function of these being partly to provide vitamins. Some consideration must also be given to the possibility of assisting the athlete during the contest. A 20-min. all-out effort uses about an ounce of sugar. So a marathon runner may use nearly 5 oz. in a race. Four ounces of sugar may be absorbed from the gut in about two hours. Some benefit should accrue to performance if an athlete is given sugar an hour or two before an event. Even if calories can be provided in sufficient amounts, it is often difficult in Britain to-day to provide an athlete with just the food he feels he wants, and this may have an adverse psychological effect.

The day's discussions were ably summed up by the chairman, Prof. J. R. Marrack.

SHORTAGE OF SCIENTIFIC TEXT-BOOKS IN CAMBRIDGE

A SURVEY carried out in Cambridge during March–April among teaching staffs and booksellers shows that nearly half of the scientific books the average student is recommended to buy are not vailable for him to buy new. It also shows that American books cover 33 per cent of all books students re recommended to buy, as opposed to 10 per cent before the War.

Teachers from twelve scientific departments of the University supplied lists of recommended text-books nd also indicated the annual number of students kely to require each book. 145 titles were listed in ll, 97 being of British origin and 48 American. Some books were, of course, alternatives to others, but the 145 titles covered 128 separate 'topics'.

The availabilities of American and British books depend upon different factors and were, therefore, stimated by different methods. Booksellers stated that the *number* of American books demanded has pproximately doubled since 1939, whereas their average *price* has risen by about 50 per cent. Thus the current demand is about 300 per cent by value of the pre-war demand. Since permitted imports are now 200 per cent by value of pre-war imports, it is estimated that approximately two-thirds or 67 per cent of the American books now required are available. n other words, a student requiring an American book has, on the average, a two-thirds chance of obtaining it; a particular student may, of course, do better han this, either by good luck or by his own efforts. The above estimate neglects the possibility that an American book is out of print. The number of such books is small, and, in any event, should affect neither the total imports of American books nor the average availability in Great Britain. Also, no account is taken of books imported as single copies direct from the United States to the British purhaser; this factor is not thought to be important o far as students are concerned.

With the co-operation of booksellers, the British books were classified as: (1) available for immediate ale; (2) reprinting or new edition in preparation; 3) out of print. The data thus obtained referred to a particular date (early April 1948); but it seems probable that the percentage availability of a large ample of books at any one time will give a fair measure of their average availability over a period, individual fluctuations cancelling one another out. In fact, the availability found for the particular date agreed with the booksellers' own independent mpression of the general position. Further, unless major changes in policy occur, of which there is no indication, the estimates should also hold for the near future. The student may, of course, be able to get second-hand copies, but this factor also does not seem to be of major importance, especially since students now finishing their courses are stated to have a greater tendency than formerly to keep their books. The data obtained refer to a wide range of subjects, but analysis showed that the position is not signiicantly different as between (1) physical and biological sciences, (2) books required by a large number of students (more than fifty copies a year) and those required by fewer.

Of the 128 'topics' analysed, 55 were available in British books. 48 were unavailable in British books and no American alternative was mentioned (of the 48 'topics', 33 books were reprinting and 15 were out of print). For the remaining 25 'topics', only American books were in print and it was assumed that 17 of these were actually available and 8 not available (that is, a 67 per cent availability as stated in a previous paragraph). Hence only 72 (55 plus 17) out of the 128 'topics' were available in any form, that is, 56 per cent.

As stated above, 97 of the 145 titles were British, and 56 per cent of these were available. It will be noted that this compares unfavourably with the percentage availability of American books (67 per cent). It is of further interest that about 50 per cent of the American books were listed as alternatives to British books, and about 20 per cent of the British books were given with American alternatives. Both booksellers and teachers confirmed that the demand for American books has considerably increased since before the War and now represents about 33 per cent of the total demand, as opposed to 10 per cent before the War.

The survey comments that the advantage that American books have over their approximate British alternatives is due primarily to the paper shortage and other obstacles to British book production, coupled with the lack of priority as to subject-matter in the allocation of paper to British publishers. This lack of discrimination at home stands in marked contrast to the complete discrimination in favour of learned, scientific and technical books when imported from abroad. The supplies of British text-books are affected both by low production and high export. Out of a total value of more than £30 million for books of all types produced in Britain in 1947, 24·5 per cent was exported (*The Bookseller*, March 20, 1948). The proportion of British book production (all types) exported was as high as 35 per cent in 1940 and 29 per cent in 1941 (*The Bookseller*, March 20, 1948). The much-enhanced position of American scientific books in the British market dates from that time. It has not been seriously affected by the short period in which imports were cut to 100 per cent of pre-war value. American publishers are continuing to press their advantage, arising from Britain's production difficulties and her need to export.

Many of the newer American books are, of course, invaluable, and no British alternative exists. This is especially true of up-to-date scientific and technological works of reference. In this respect American books have an advantage over British ones, quite apart from Britain's immediate production difficulties and need to export. In great part, of course, the advantage arises from the larger scale of American industrial and scientific activity generally, and hence the greater number and variety of specially qualified authors. Nevertheless, there are other, less unavoidable, reasons for the relative paucity of new British advanced works. Delays in publication put British books at a disadvantage by increasing the chances that a new American book will have arrived and satisfied the demand in a subject before an already-written British book on that subject appears. Furthermore, inquiries in Cambridge indicate that new British works are not being *written* in numbers commensurate with our supply of qualified authors. An important deterrent mentioned was lack of time and (not so important) lack of financial inducement. Increased teaching pressure leaves little time for the writing of new books and makes it difficult for those who fell behind in their reading while on war-work to catch up again. The direct financial inducement to write advanced scientific works was never great; but to-day it is smaller than ever. Publishers try to share out their limited paper among the most needed titles, and the consequent small impressions mean correspondingly small royalties. The survey suggests that official encouragement should be given to the writing of new books by British specialists.

It is stated that a good case can be made out for the large percentage of book production which goes to export. It is emphasized, however, that this trade and, even more important, this reputation, are in danger unless our total volume of 'learned, scientific and technical' book production is increased both in number of copies of existing standard works and in new titles. The value of American exports of books (all types) to all countries had not in 1947 quite equalled Britain's; but 1947 was the year in which the import of America's books was artificially restricted by two of her best customers, Britain and Australia. In spite of that, American exports rose more steeply than our own. With British import restrictions relieved, American exports may be expected to surpass Britain's. Moreover, America can, as Britain cannot, increase the exported fraction of her total production without serious consequences for the home consumer. America's exported fraction was only 7 per cent of the total (in 1946) as against Britain's 25 per cent. The conclusion is drawn that it is essential that British scientific book production should be increased by giving priority in material allocation to the publication of such books, so that both the home and export markets may be better supplied.

This survey was carried out by the Cambridge Branch of the Association of Scientific Workers, and copies of the complete survey are available from the Head Office of the Association (15 Half Moon Street, Piccadilly, London, W.1).

R. Innes

NEWS and VIEWS

Physiology at the London Hospital Medical College: Dr. John L. D'Silva

Dr. John L. D'Silva, reader in physiology at St. Bartholomew's Hospital Medical College, who has been appointed to the chair of physiology at the London Hospital Medical College, was born and educated in southern India. He graduated with first-class honours in chemistry at King's College, London, in 1929, and remained there for a further three years doing research on the chemistry of disulphides. In 1932 he went over to physiology, still at King's College, carrying out investigations on the effect of adrenaline on the metabolism of potassium. After a short period with Messrs. British Drug Houses, Ltd., spent on research into the molecular distillation of fish oils in connexion with the study of vitamin A, he went in 1936 to St. Bartholomew's Hospital Medical College, where he was demonstrator in physiology and in biochemistry, and continued his work on the metabolism of adrenaline and potassium. He was awarded the degree of D.Sc. for his published work. During the Second World War, Dr. D'Silva qualified as a medical practitioner and also continued teaching. After work at St. Bartholomew's Hospital, in 1944 Dr. D'Silva was appointed to the Medical College again and has remained there since, lecturing and carrying out research on the physiology of the visual process.

Jöns Jakob Berzelius (1779–1848)

When he died a century ago on August 7, 1848, Berzelius was not only the most famous chemist of the world, but also the autocrat of the world of chemistry. The son of a schoolmaster, he was born near Linköping on August 29, 1779. After studying medicine and chemistry at Uppsala, at the age of twenty-three he was appointed assistant professor of botany and pharmacy at Stockholm, and full professor in 1807. During 1815–32 he held the chair of chemistry in the Caroline Medico-Chirurgical Institution. In 1818 he became perpetual secretary of the Stockholm Academy of Sciences, and received a title of nobility, with permission to retain his name. Seventeen years later, on the occasion of his marriage, he was made *Freiherr*. Berzelius spent some ten years determining with great accuracy the atomic and molecular weights of more than two thousand chemical substances; he isolated selenium, thorium, silicon, titanium and zirconium, and also prepared and examined many organic compounds. He devised the present system of chemical symbols. His "Lehrbuch der Chemie", begun in 1808, went through five editions and, in various translations, spread his fame over Europe. His dualistic electrochemical theory exerted a profound influence on the progress of chemistry. Though Berzelius worked in the simplest of laboratories, his reputation attracted students from many countries. In his hands the blow-pipe became the symbol of qualitative dry analysis. Distinguished in appearance, inclined to be portly, neat in attire and habits, cordial and unassuming, Berzelius was vigorous in body and mind, though essentially conservative in his outlook. Of his characteristic sayings the following may serve as a sample: "The devil may write text-books of chemistry, for every few years the whole thing changes".

Australian Journal of Scientific Research

The Australian Council for Scientific and Industrial Research, in collaboration with the Australian National Research Council, has decided to take responsibility for the establishment in Australia of a new scientific journal, the *Australian Journal of Scientific Research*, as a medium for the publication of research papers of outstanding merit. This journal is open to receive contributions from research workers, irrespective of country or of the organisation to which they are attached. Dr. N. S. Noble has been appointed as editor of the new journal. Editorial policy will be determined by an editorial board under the chairmanship of the editor and comprising as members: Prof. W. J. Dakin (Department of Zoology, University of Sydney), Prof. E. J. Hartung (Department of Chemistry, University of Melbourne), Prof. L. H. Martin (Department of Physics, University of Melbourne), and Prof. J. G. Wood (Department of Botany, University of Adelaide). The Board aims at achieving a high standard of quality in papers accepted and a strict refereeing system has been instituted. The *Journal* will be printed in two series: Series A (Physical Sciences) and Series B (Biological Sciences). Initially each series will be issued quarterly and will cost 30*s*. a year.

Birkbeck College Research Laboratory

By the aid of a gift from the Nuffield Foundation, Birkbeck College (University of London) has been enabled to equip and staff two houses in Torrington Square, London, W.C.1, as a Biomolecular Research Laboratory under the direction of Prof. J. D. Bernal. The main work of the Laboratory will be the application of physical methods, particularly X-ray analysis, to the understanding of the structures and reactions of molecules in biological systems. X-ray methods are being used in two ways, namely, the study of the mutual relations in space of virus molecules in solution and in solid phases by low-angle diffraction; and the investigation of the internal structure of the molecules themselves by high-angle diffraction. In addition to the study of molecules directly connected with proteins, others of more general biological interest are also being examined by modern X-ray analytical methods, as well as other structures chosen to develop methods of X-ray crystal analysis. To make the fullest use of existing techniques and to develop further experimental and theoretical tools for this purpose, two sections devoted to electronics and computation respectively have been added to the Laboratory. The design has already been completed of an electronic computing machine of such speed that complete analysis of complex structures by the method of 'steepest descents' can be carried out in a reasonable time. Another section of the Laboratory is working on the fundamental structure of the active constituents of Portland cement, and the nature of their reaction with water; this investigation is being financed by the Department of Scientific and Industrial Research. The work is not so isolated from the main interests of the Laboratory as may at first sight appear; for already it has been found that the properties of hydrated cements are closely related to those of many biological gels and are strongly influenced by the same long-range forces. Part of the two houses now taken over by Birkbeck College to provide for these investigations is being devoted to chemical research under Prof. W. Wardlaw and will also furnish facilities for chemical work in connexion with the biomolecular studies.

The new Laboratory was formally opened by Sir Lawrence Bragg on July 1. Sir Lawrence welcomed the initiation of a new Laboratory which is to study biomolecular substances, because such borderline subjects between physics, chemistry and biology are becoming so very important. There is always a difficulty in attracting first-rate young research workers into borderline subjects, because they tend to classify themselves as physicists, chemists or biologists and take up research accordingly. Probably the best way of overcoming this difficulty would be to provide first-rate centres of research, directed by well-known scientific workers, for such subjects.

Rubber Technology Conference

Elsewhere in this issue (p. 204) an account is given of some physical and chemical aspects of the contributions to the Rubber Technology Conference held in London during July 23–25. The Conference was attended by no less than 609 members, including 119 from abroad. This compared very favourably with the previous Conference in 1938, when 553 members attended. On the occasion of the 1938 Conference more than a hundred papers were presented, and this necessitated two simultaneous sessions. This year there were only forty-three papers spread over eight sessions running consecutively. An outstanding feature of the Conference was a demonstration of physical and chemical properties of rubber on June 23 arranged by Mr. E. F. Powell and certain members of his staff from the Dunlop Rubber Co., Ltd. The Conference closed with a dinner at the Connaught Rooms, London, on the evening of June 25; Mr. F. D. Ascoli, president of the Institution of the Rubber Industry, presided. During the evening, the Colwyn Medal of the Institution was presented to Dr. R. P. Dinsmore of the Goodyear Tyre and Rubber Co. of the United States. This is the sixteenth award of the Medal and the first time that it has gone to an American.

Earthquakes during May

During May ten strong earthquakes were registered at observatories throughout the world, and there were numerous smaller shocks and tremors. The greatest earthquake which was registered at Kew gave ground amplitudes of 110 μ at Kew on May 14 and came from a focus the epicentre of which was south of the Alaska Peninsula (lat. 54½° N., long. 161° W.). A world-shaking aftershock of this came on May 17 from a focus the epicentre of which was perhaps slightly to the north of the original. The second most intense shock of the month was the one which occurred on May 11, starting from a focus with epicentre near lat. 17° S., long 71° W. in southern Peru. The focus of this earthquake was a little deeper than normal; the instrumental strength of the shock was almost 7½, and casualties and damage were caused at Moquegua in southern Peru and at Arica and Tacua in northern Chile. The third greatest earthquake shock of the month happened on May 25 from a focus having an epicentre near lat 30° N., long. 99½ E. in Sikang Province in China. A much less intense earthquake on May 28 from a focus with epicentre at lat. 12° S., long. 77° W. did damage to property and caused the deaths of five people in Peru. The deepest focus earthquake of the month occurred on May 23 from a focus some 200 km. deep with epicentre near lat. 18° S., long. 169° E. More feeble shocks occurred on May 23, doing damage to property in both islands of New Zealand; on the morning of May 24, throwing people out of bed at Palermo in Sicily; and on May 25, off the west coast of Oregon. Data for the month have been received from the U.S. Coast and Geodetic Survey, the International Seismological Bureau at Strasbourg, and observatories at Beograd, De Bilt, Durham, Kew, Stuttgart, Toledo and Uccle.

Cleveland Seismological Observatory

In 1946 gifts from the Louis D. Beaumont Trust and the Cleveland Foundation financed the purchase of three electromagnetic seismographs of the Sprengnether type for the Cleveland Seismological Observatory, which is situated at lat. 41° 29′ 27·90″ N., long. 81° 31′ 52·22″ W. (geographic co-ordinates) at an altitude of 1,070 ft. on University Heights, Cleveland, Ohio. The geocentric latitude is 41° 18′ N. The staff at present consists of the Rev. Henry F. Birkenhauer, *S.J.* (director), Rev. Joseph S. Joliat, *S.J.* (associate director), Dr. Edward J. Walter (assistant director), Mr. Richard Becka and Miss Jeanne Carrabine. The publication of monthly teleseismic bulletins and monthly microseismic reports has already begun.

New Tropical Fungi

THE various regions of Central Africa are a territory which has not been studied mycologically in any detail. It is therefore not surprising that, in a second paper on tropical fungi, G. B. Hansford (*Trans. Linn. Soc. Lond.*, 159, pt. 1, pp. 21; 1947), in describing thirty-four species, includes no less than twenty-eight new ones. The genus *Meliola* is well represented with eight new species, and it has been found necessary to create two new genera, *Phragmodiscus* and *Dictyoasterina*, to accommodate some of the new findings. The collections are from Uganda, the Belgian Congo and Sierra Leone.

University of Leeds

THE Council of the University of Leeds has announced that the Wool Industries Surplus Cloth Corporation, Ltd., has given a sum of £40,500 for the establishment in the University of a research chair of wool textile engineering within the Department of Textile Industries. Other gifts include £10,000 from the International Wool Secretariat (in addition to a similar amount already received) for the purpose of completing the cost of equipping the new Wool Research Laboratories; 1,000 dollars from the Ella Sachs Plotz Foundation for the purchase of equipment for the Department of Biochemistry; £250 from Messrs. J. and J. Crombie of Aberdeen, for the Textile Department; £2,126, handed over by the Leeds Public Dispensary and Hospital, being the balance of the Research Appeal Account, which the Council agreed to earmark for rheumatism research; £300 a year from Sandoz Products, Ltd., of Bradford, to provide a scholarship for a male candidate to take the form of three consecutive two-year awards; 500–600 plastic mouldings for experimental research in speech training, presented to the Department of Education by Messrs. Birkby's, Ltd., of Liversedge.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. D. V. Glass, reader in demography at the London School of Economics and Political Science, to the University chair of sociology tenable at the School; Mr. E. P. Sharpey-Schafer, physician and senior lecturer at the Postgraduate Medical School of London, to the University chair of medicine tenable at St. Thomas's Hospital Medical School; Dr. D. S. Bertram, lecturer in the Department of Entomology and Parasitology in the Liverpool School of Tropical Medicine, to the University readership in entomology tenable at the London School of Hygiene and Tropical Medicine; Dr. F. L. Warren, senior lecturer in biochemistry in the Physiology Department of St. Mary's Hospital Medical School, to the University readership in biochemistry tenable at University College. All these appointments take effect on October 1, 1948.

The titles of emeritus professor in the University have been conferred on the following: Prof. A. B. Appleton, on his retirement from the chair of anatomy at St. Thomas's Hospital Medical School; Prof. O. L. V. de Wesselow, on his retirement from the chair of medicine at St. Thomas's Hospital Medical School; Prof. F. E. Fritsch, on his retirement from the chair of botany at Queen Mary College; Prof. D. T. Harris, on his retirement from the chair of physiology at the London Hospital Medical College; Prof. T. Baillie Johnston, on his retirement from the chair of anatomy at Guy's Hospital Medical School; Prof. W. Neilson Jones, on his retirement from the Hildred Carlil chair of botany at Bedford College.

The following doctorates have been conferred D.Sc.: J. R. Busvine (Imperial College of Science an Technology); D.Sc.(Eng.): D. G. Tucker (externa student).

Beit Memorial Fellowships for Medical Researc

THE following elections have been made by th Beit Memorial Trustees: *Senior Fellowship* (£900 a year): Dr. F. Sanger (Cambridge), to study the structure of proteins with special reference to insulin, a the Department of Biochemistry, University of Cambridge. *Junior Fellowships* (normal value £600 a year): D. A. Darcy (Dalhousie, Canada), to study the role of the lymphocyte and plasma cell in homo graft breakdown, at the Department of Zoology and Comparative Anatomy, Oxford; R. M. C. Dawson (London), to study biochemical changes in the brain associated with different forms of functional activity at the Biochemical Laboratories, Cardiff City Menta Hospital; F. N. Fastier (New Zealand), to study the nature of the musculotropic action of basic amidine derivatives, at the Department of Pharmacology Oxford; Dr. L. J. Haynes (London), to study the synthesis of the coenzyme, cozymase, at the University Chemical Laboratory, Cambridge; Dr. A. T. James (London), to study the relationship between structure and biological activity in naturally occurring substances, at the Lister Institute of Preventive Medicine, London; A. McCoubrey (London), to study analgesic and addictive tendencies from a chemical point of view, at the Departments of Organic Chemistry and Pharmacology, University of Leeds S. W. Stanbury (Manchester), to study the effect of changes in nervous activity, induced by narcosis and sleep, on the renal circulation and blood pressure in normal and hypertensive individuals, at the Department of Medicine, University of Manchester; D Verel (Cambridge), to study the postural hypotension which may follow prolonged rest in bed, at the Clinical Research Unit, Guy's Hospital, London.

Announcements

THE Joint Committee consisting of representative from the Royal Society of Edinburgh, the Roya Physical Society, and the Royal Scottish Geographica Society have awarded the Dr. W. S. Bruce Memorial Prize to Dr. W. A. Deer, Department of Mineralogy and Petrology, University of Cambridge, for his work in East Greenland during 1935–36, especially in regard to the petrology of the Skaergaard gabbro intrusion.

THE Faraday Society is arranging a general discussion on "The Physical Chemistry of Proces Metallurgy" to be held at Ashorne Hill, near Leamington Spa, by permission of the British Iron and Stee Federation, during September 23–25. Further particulars can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, London, W.C.1.

THE postgraduate lectures for 1948 of the London Section of the Oil and Colour Chemists' Association will be delivered by Prof. H. J. Emeléus, on September 30, October 7 and 14 at 6.30 p.m., at the Royal Institution. Prof. Emeléus will speak on "The Impact of Radioactivity on Inorganic Chemistry". Admission will be by ticket (price 10s.) obtainable from the honorary secretary of the London Section of the Association, H. C. Worsdall, c/o Messrs. Plastanol Ltd., Crabtree Manorway, Belvedere, Kent.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Properties of a Hypothetical di-Neutron

THE question of the possibility of obtaining experimental evidence for the existence of a neutral particle of mass 2 has recently been raised by Kundu and Pool[1]. These authors suggest that certain features of nuclear transformations produced by bombardment by tritium (^{3}H) ions favour the conclusion that a di-neutron having at least transient existence may be captured as a single entity in a nuclear process of an Oppenheimer – Phillips type.

It is the object of this note to point out that the β-active species ^{6}He, though stable against the spontaneous emission of neutrons of normal mass (stable, that is, against the process $^6\text{He} \rightarrow {}^5\text{He} + {}^1n$), is unstable against the emission of a di-neutron which has more than a relatively small energy of binding, so that the presumption that a di-neutron is not, in fact, emitted by ^{6}He (based on the evidence of its 'long' life-time) sets an upper limit to the binding energy of this hypothetical particle. In deducing this limiting energy, we may consider the reactions:

$$^9\text{Be}\ (+\ h\nu) \rightarrow {}^8\text{Be} + {}^1n + Q_1$$

$$^8\text{Be} \rightarrow 2{}^4\text{He} + Q_2$$

$$^9\text{Be} + {}^1n \rightarrow {}^6\text{He} + {}^4\text{He} + Q_3.$$

Obviously we have

$$^6\text{He} \rightarrow {}^4\text{He} + 2{}^1n + Q_1 + Q_2 - Q_3\,;$$

and inserting experimental values, $Q_1 = -1 \cdot 63$ MeV.[2], $Q_2 = 0 \cdot 12$ MeV.[3], $Q_3 = -0 \cdot 8$ MeV.[4], we obtain

$$^6\text{He} \rightarrow {}^4\text{He} + 2{}^1n - 0 \cdot 7\ \text{MeV}.$$

This last figure ($0 \cdot 7 \pm 0 \cdot 2$ MeV.) is the upper limit to the binding energy in question—a very much smaller binding energy than that of the deuteron (2·17 MeV.).

In terms of these last two binding energies, we can proceed to set limits to the energy available for the β-disintegration of a quasi-stable di-neutron $({}^2_0n)$. Clearly we have

$$^2n - {}^2\text{H} + Q_4 = {}^1n - {}^1\text{H} + 2 \cdot 17\ \text{MeV.}\,;$$

where $^1n - {}^1\text{H} = 0 \cdot 76$ MeV. and, as above obtained, $0 < Q_4 < (0 \cdot 7 \pm 0 \cdot 2)$ MeV. Thus $(2 \cdot 2 \pm 0 \cdot 2) < ({}^2n - {}^2\text{H}) < 2 \cdot 93$ MeV. This estimate allows us to predict the life-time (τ) of the di-neutron on the reasonable assumption that the transition

$$^2n \xrightarrow{\beta} {}^2\text{H}$$

is super-allowed[5]. In this way we obtain $1 < \tau < 5$ sec.

From the fact that ^{6}He is sufficiently long-lived to exhibit β-activity, we have thus deduced quite narrow limits for the radioactive constants of the hypothetical di-neutron. It might be added that, if such a particle should exist, it would be expected to be produced in (^1n, ^2n) reactions over a small range of neutron bombarding energy, in each case just below the absolute threshold energy for the corresponding (n, $2n$) reaction—and even at energies somewhat above these absolute thresholds, because of the requirement that the first neutron emitted in an (n, $2n$) process shall be emitted with finite energy. But, above all, search for the di-neutron might most conveniently begin with beryllium under neutron bombardment, not only because the (n, $2n$) threshold is lowest with this element (which makes possible the use of a D—D neutron source, which is free from γ-radiation), but also because the possibility of producing ^{6}He in an excited state in this case opens the further possibility (see above) that the di-neutron may be obtained as a secondary disintegration particle following upon the reaction ^{9}Be (^1n, ^{4}He) ^{6}He*. This possibility is unique just because the mass number 5 is the only mass number for which a neutron-stable species does not exist; thus the excitation necessary to render ^{6}He unstable against the successive emission of two neutrons of normal mass is correspondingly increased.

As regards possible methods of detecting a di-neutron, it is perhaps out of place in this note to offer detailed suggestions. But apart from its spontaneous radioactivity (the half-value period of which is reasonably short) a quasi-stable di-neutron might be expected to produce nuclear transformations which in certain cases might be sufficiently characteristic to be used for its identification. Thus activities might be induced in effectively simple elements (such as ^{6}He in helium, ^{25}Na in sodium, ^{105}Rh in rhodium, ^{211}AcC in bismuth, for example) for some of which large capture cross-sections might apply. It might even be possible, investigating suitable substances under deuteron or α-particle bombardment at energies in the neighbourhood of the (d, $2n$) or (α, $2n$) thresholds, to work under conditions in which the flux of di-neutrons was comparable with the normal neutron flux. In such circumstances comparison of the pulse-size distributions due to the recoil particles in hydrogen- and deuterium-filled ionization chambers might be used to effect a clear-cut identification.

N. FEATHER

Department of Natural Philosophy,
University, Edinburgh.
June 15.

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[1] Kundu and Pool, *Phys. Rev.*, 73, 22 (1948).

[2] Myers and Van Atta, *Phys. Rev.*, 61, 19 (1942). Wiedenbeck and Marhoefer, *Phys. Rev.*, 67, 54 (1945).

[3] Hemmendinger, *Phys. Rev.*, 73, 806 (1948).

[4] Allen, Burcham and Wilkinson, *Proc. Roy. Soc.*, A, 192, 114 (1947).

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Propagation of Pulses of Second Sound in Liquid Helium II

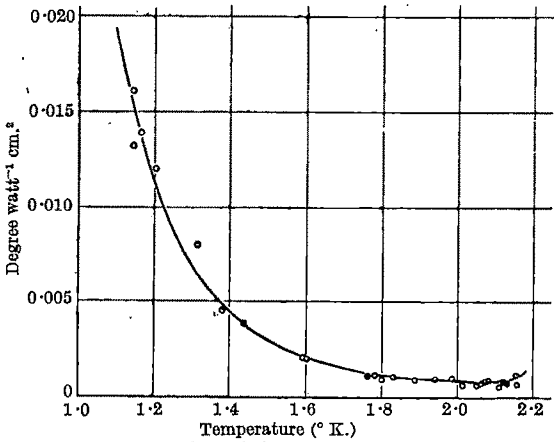
PRELIMINARY measurements of the velocity of second sound in this Laboratory using a resonator of fixed length and signals of a variable frequency have given results in good agreement with the resonance measurements of Peshkov[1] and of Lane, Fairbank and Fairbank[2]. In the course of these experiments it became apparent that if measurements were to be extended below 1° K., some method would be necessary which used a smaller mean power input. It can be shown, too, that the amplitude of temperature oscillation obtained in a resonance experiment is governed entirely by damping, and provides little information about the propagation of travelling waves in the medium.

With these considerations in view, a technique has been developed for transmitting and receiving pulses of second sound. The signals are generated by applying a direct current pulse of 0·1–1 millisecond duration to a fine wire heater. The second sound pulse travels down an ebonite tube about 5 cm. long filled with liquid helium II, and is received by a phosphor bronze resistance thermometer which carries a steady direct current. The change of resistance causes a voltage pulse to appear across the thermometer and, after suitable amplification, this is displayed on a cathode ray tube. Using standard radar techniques, it is a simple matter to time the pulse on its journey and hence to measure its velocity. The velocity results, which cover the range 1·1°–2·16° K., are in good agreement with those of earlier workers using the resonance method, and need not be reproduced here.

The more interesting feature of this method is the information which it provides about temperature amplitudes. It can be shown very simply, by considering the propagation of a unit step of temperature, that the power flow per unit area, W_1, must be connected with the temperature amplitude, T_1, by the relation

$$\frac{T_1}{W_1} = \frac{1}{\rho c u_2},$$

where ρc is the specific heat per unit volume of liquid helium and u_2 is the velocity of second sound. This relation is independent of any special theory of second sound and assumes only the propagation of a unit step without change of shape. The temperature amplitude ($\sim 10^{-3}$ ° K.) can be deduced experimentally from the size of the output signal, the gain of the amplifier and the calibration of the thermometer wire. The power fed in during the pulse ($\sim 0 \cdot 1$ watt cm.$^{-2}$) can be deduced from measurements of the voltage applied to the heater and of the heater resistance. The full line in the accompanying diagram gives $1/\rho c u_2$ (calculated from the known values of ρc and u_2) as a function of temperature, while the points are the experimental values of T_1/W_1. The agreement is well within experimental error.



Curve plotted from values of $1/\rho c u_2$; experimental points, values of T_1/W_1

Experiments are in hand to study the possible dispersion and absorption of second sound and to extend the velocity measurements to the range below 1° K. A combination of such velocity measurements with amplitude measurements may, on the basis of the above equation, provide a convenient method of determining the specific heat of liquid helium below 1° K.

D. V. OSBORNE

Royal Society Mond Laboratory,
Cambridge.
June 22.

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[1] Peshkov, V., Phys. Soc. Camb. Conf., 19 (1946).

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Emission Schumann – Runge O_2 Bands

FOLLOWING on a recent contribution in *Nature*[1], it seems desirable to report briefly some work carried out in this laboratory and shortly to be published elsewhere in detail. Lalji Lal[1] has produced the Schumann – Runge bands of O_2 from 2450 A. to 4490 A. using a high-frequency discharge. He reports new bands which he has identified from small glass and quartz spectrograms.

I have photographed the Schumann – Runge system from 2000 A. to 5000 A. on a quartz Littrow (Hilger *E*.1) spectrograph, and this dispersion has been found sufficient for adequate resolution of the rotational structure of the bands. The spectra were excited by a high-voltage low-current arc in oxygen at atmospheric pressure. This source emits the bands so well that they occur even when the arc chamber is filled with air. In addition to the bands measured by earlier workers, the following bands have been found: (2, 22), (1, 12), (0, 11), (1, 11), (0, 10), (1, 10), (2, 10), (0, 9), (1, 9), (2, 9), (1, 8), (2, 8), (2, 7), (3, 7), (2, 6), (3, 6), (3, 5). Though some of these bands fall in the region investigated by Lalji Lal, his analysis does not correspond to that given here. However, bands of high v' will be more easily excited in the low-pressure source since collision damping will be active at high pressures, and this may account for some of the differences. The present analysis seems to give the Franck – Condon parabola suggested by previous work, whereas Lalji Lal's bands are rather widely scattered in the $v' v''$ array.

On comparing Lalji Lal's wave-numbers with those calculated from the data of previous workers, some rather large discrepancies are found. An attempt was made to identify Lalji Lal's bands both on *E*.1 and small quartz (*E*.3) spectrograms, but no good coincidences were found; the same result was obtained when examining the *E*.2 photograph obtained by Wulf and Melvin[2]. Obviously the difficulty can only be removed either by photographing the high-frequency discharge at larger dispersion for a more accurate analysis or by direct comparison of high-frequency discharge and high-voltage arc spectrograms. The heads are so weak on the present spectra that analysis has been made by identification of the rotational structure of each band, and 'heads' that seem present with small dispersion are found, with higher dispersion, to be merely due to chance overlapping of structure from several bands.

It will be seen that the present interpretation of the bands shows that Flory's[3] suggestion of predissociation for $v' > 2$ is incorrect (this also follows from Lalji Lal's analysis). In the detailed publication referred to above, Flory's arguments are critically examined, and it is found that there is no difficulty in abandoning the predissociation hypothesis.

The bands are found to be very sensitive to pressure changes and are strongly emitted only at a pressure near atmospheric, unless specially pure gas is used to allow long exposures without the appearance of impurity spectra. This may be explained by the fact that normal O_2 molecules are dissociated by electronic collisions into $O(^3P)$ and $O(^1D)$ atoms, since a Frank – Condon transition from the ground-state $(^3\Sigma_g^-)$ leads to a molecule in the $^3\Sigma_u^-$ state which is excited 3·5 volts above the dissociation limit of this state. For the emission of a band system, recombination to the excited state must occur, and this becomes more probable at high pressures where rapid diffusion is prevented. Results obtained by various authors using high-voltage arcs, ozonizers and glow discharges all support this result.

These investigations were undertaken in connexion with work in progress here on the spectrum of the night sky, and from the spectra measurements are being made which will enable the O_2 Herzberg bands, believed present in the night sky spectrum, to be more accurately predicted than previously.

I am indebted to Prof. R. W. B. Pearse for suggesting the work and for his constant advice.

M. W. Feast

Astrophysics Dept.,
Imperial College of Science and Technology,
London.
April 16.

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[1] Lalji Lal, *Nature*, 161, 477 (1948).

[2] Wulf, O. R., and Melvin, E. H., *Phys. Rev.*, 55, 687 (1939).

[3] Flory, P. J., *J. Chem. Phys.*, 4, 23 (1936).

A Simple Result in Quadrature

In calculating the intensity of light scattered by a transparent homogeneous medium, one comes across the infinite series[1]

$$\alpha \sum_{n=-\infty}^{+\infty} \frac{\sin^2 (n\alpha + \theta)}{(n\alpha + \theta)^2}, \qquad (1)$$

in which θ is a constant and n an integer. α is a positive number, which under the conditions under which light-scattering is generally studied is very small, and hence the sum of the above series is usually replaced by the corresponding integral

$$\int_{-\infty}^{+\infty} \frac{\sin^2 x}{x^2}\, dx, \qquad (2)$$

which evidently is equal to π.

It can be shown[1], however, that the equality of (1) and (2) holds not only in the limit when $\alpha \rightarrow 0$, but for any value of α in the range $0 < \alpha \leqslant \pi$. An obvious interpretation of this result is that the area subtended between the curve $y = \sin^2 x/x^2$ and the x-axis can be obtained by taking the sum of the ordinates at equal intervals α, $0 < \alpha \leqslant \pi$, and multiplying by α, that is, by simple rectangulation, just as well as by integration. In erecting these ordinates at equal intervals, we may start from any value θ of x.

The main purpose of this note is to direct attention to this property, namely,

$$\alpha \sum_{n=-\infty}^{+\infty} f(n\alpha + \theta) = \alpha \sum_{n=-\infty}^{+\infty} f(n\alpha) = \int_{-\infty}^{+\infty} f(x)\, dx, \qquad (3)$$

where $0 < \alpha \leqslant$ a certain constant α_0, which characterizes $f(x) = \sin^2 x/x^2$, and to show that numerous other functions can be constructed that have this property. A method of evaluating (1) given by Prof. Wiener, and quoted in the paper referred to[1], suggests the criterion by which to construct such functions.

Consider an even function $F(x)$ [$= F(-x)$] the Fourier transform of which,

$$g(v) = \frac{1}{\sqrt{(2\pi)}} \int_{-\infty}^{+\infty} F(x) \exp\,(ivx)dx, \qquad (4)$$

has non-zero values when $| v |$ is less than a certain constant v_0, and is zero otherwise. Then by Poisson's summation formula[2]

$$\alpha \sum_{n=-\infty}^{+\infty} F(n\alpha + \theta) = \sqrt{(2\pi)} \sum_{N=-\infty}^{+\infty} \exp\,[-i2\pi N\theta/\alpha] . g(2\pi N/\alpha), \qquad (5)$$

where n and N are integers and $\alpha > 0$. If now α is chosen to be $\leqslant 2\pi/v_0$, then all the terms on the right-hand side of (5) except the one corresponding to $N = 0$ vanish, and we obtain

$$\alpha \sum_{n=-\infty}^{+\infty} F(n\alpha + \theta) = \sqrt{(2\pi)}\, g\,(0),$$

which can be seen from (4) to be equal to $\int_{-\infty}^{+\infty} F(x)\, dx$; and hence the function F satisfies (3).

Since the Fourier integrals of a large number of functions have been tabulated by Campbell and Foster[3] and by others, it is easy to select, or construct, examples of functions F the Fourier transforms of which satisfy the above criterion, and which satisfy (3). $F(x) = \sin^m x/x^n$, where m and n are positive integers, $m \geqslant n$, both of them odd or both of them even, is one such function with $v_0 = m$; when $m = 1$, the range of v over which $g(v) \neq 0$ includes $v = 1$. A few other examples are given below.

$F(x)$	$\sqrt{(2\pi)} . g(v)$	v_0
$\dfrac{\sin\,[a(x^2 + \lambda^2)^{1/2}]}{(x^2 + \lambda^2)^{1/2}}$	$\pi\, J_0\,[\lambda(a^2 - v^2)^{1/2}]$	a
$\cos\,[a(x^2 + \lambda^2)^{1/2}] - \cos ax$	$-\dfrac{\pi a\lambda J_1\,[\lambda(a^2 - v^2)^{1/2}]}{(a^2 - v^2)^{1/2}}$	a
$\dfrac{1}{\Gamma(a + x)\, \Gamma(\beta - x)}$	$\dfrac{(2 \cos 1/2v)^{\alpha + \beta - 2} \{ - \frac{1}{2} \exp iv(\alpha - \beta)\}}{\Gamma(\alpha + \beta - 1)}$	π [4]

A more detailed account will be published shortly in the *Journal of the Indian Mathematical Society*.

K. S. Krishnan

National Physical Laboratory of India,
Delhi. June 6.

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[2] See Titchmarsh, "Introduction to the Theory of Fourier Integrals", 60 (Oxford, 1937).

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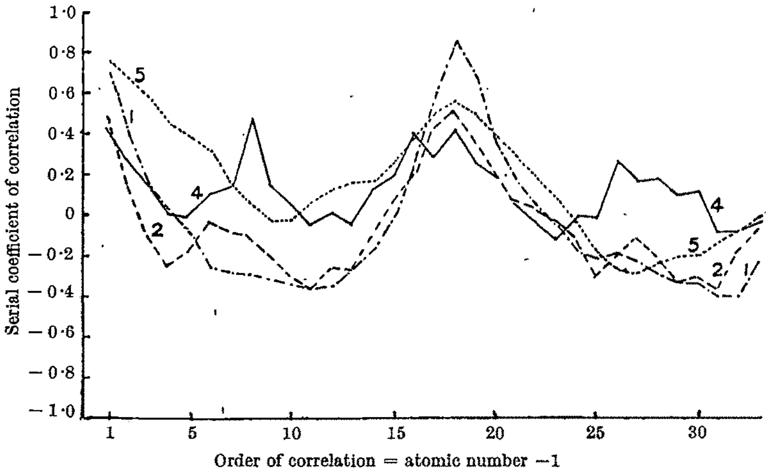
[4] From Ramanujan, "Collected Papers", 216.

Physical Periodicity of the Periodic Table of the Elements in the Light of Statistical Theory

The periodic system of the elements, arrived at originally from the collation of facts of a chemical nature, has since been most strikingly reflected by most of the physical properties of the elements. The melting points, boiling points, coefficients of thermal expansion, atomic volumes, compressibilities, densities, ionization potentials, to mention only a few properties, undergo periodic variations with increasing atomic weight or atomic number.



1, Atomic volumes; 2, melting points; 4, ionization potentials; 5, densities

It seemed of interest to inquire whether the generating mechanism of the physical periodicity was the same for all the physical properties to which it applied, or whether there existed characteristic differences between the periodicities of different physical properties. With the view of obtaining an answer to that question, some of the series were subjected to the statistical analysis called correlogram analysis[1]. The correlogram is the plot of the serial correlation coefficient against the order of correlation. For example, in the correlogram for atomic volume, the points are the correlation coefficients between the series of atomic volumes 1, 2, 3 . . . *n* times apart in the series of the elements arranged according to their atomic numbers, plotted against the atomic number minus one.

The series subjected to the analysis were those of the atomic volumes (1), melting points (2), compressibilities (3), ionization potentials (4) and densities (5) of the first sixty elements. Series 1 to 4 are based upon Tables 2 and 16, Chapter 5 of "Physical Chemistry" by E. A. Moelwyn-Hughes; Series 5 is taken from Table 3, "Physical Chemistry" by Gucker-Meldrum, based upon the International Critical Tables, supplemented by Landolt – Börnstein tables. The first thirty-three serial correlation coefficients were calculated and plotted against the order of correlation; the curve for compressibilities has been left out of the diagram so as to avoid overcrowding.

On the basis of the correlogram it appears that what was hitherto called 'physical periodicity' has a different structure, that is, it represents sums of different cyclical components, for each of the physical characteristics under investigation. So far as the correlograms show similarities, it would seem that they can be classified into two types. The correlograms for atomic volumes, densities and compressibilities show a peak for the correlation of order 18, and a trough for that of order 10 or very near it, which corresponds to the elements 19 (potassium) and 11 (sodium) respectively, and thus reveal a period of length 18, which corresponds to twice the fundamental period of the chemical periodicity of 8, plus the first two elements of the table. The correlograms for melting points and ionization potentials, on the other hand, show, in addition to the period of length 18 (16), a smaller one with peaks at 8 and 26, or very near them, and thus a greater similarity to the chemical periodicity of the elements with its fundamental period of 8.

Since the melting points (the temperature at which the atoms begin to leave the crystal lattice) and ionization potentials (the energy needed for removing an electron from the atom) have this in common, that they both refer to the point where lattice disorder sets in, and thus to the *dynamic* properties of matter, whereas atomic volumes, densities and compressibilities are properties of the *static* atom, it would seem that this difference is faithfully portrayed in the respective types of physical periodicity as revealed by the correlogram.

Investigations of this kind may afford an indication for linking more intimately than has been done so far the mechanism of the various physical periodicities with the periodic system of the electrons constituting the shells and subshells of the atom.

G. HERDAN

C/o Paint Research Station,
Teddington, Middlesex.
June 6.

[1] Kendall, M. G., "The Advanced Theory of Statistics", vol. 2 (1946).

X-Ray Scattering by Thermal Vibrations in Crystals

SIR C. V. RAMAN, in his letter on "X-Rays and the Eigen-Vibrations of Crystal Structure"[1], claims that the elastic vibrations cannot "give rise to any geometric diffraction pattern exhibiting an observable relationship to the structure of the crystal". The reasons given for this statement make it appear that he has fallen into Debye's original error, and supposes that the atomic vibrations are essentially independent, or are markedly dependent on the form of the crystal and on external boundary conditions. This would perhaps be the case for very small crystallites; for crystals of ordinary size the boundary conditions would involve second-order effects only, as they do in the case of Bragg reflexion. It should also be clearly understood that the change of frequency due to the X-ray 'Doppler effect' is so small that the modified wave-lengths still lie well within the width of the monochromatized $K\alpha_1$ line, assuming that to be the incident radiation; the change is of the order of 1 in 10^5.

That the elastic vibrations do indeed give rise to a geometric diffraction pattern has been most conclusively proved by the excellent agreement between theory and experiment for metals such as sodium, lead and tungsten. The theory of eigen-vibrations can offer no explanation whatever of these experimental results, whereas the elastic vibration theory predicts them correctly in every detail[2].

KATHLEEN LONSDALE

University College,
Gower Street,
London, W.C.1.
July 15.

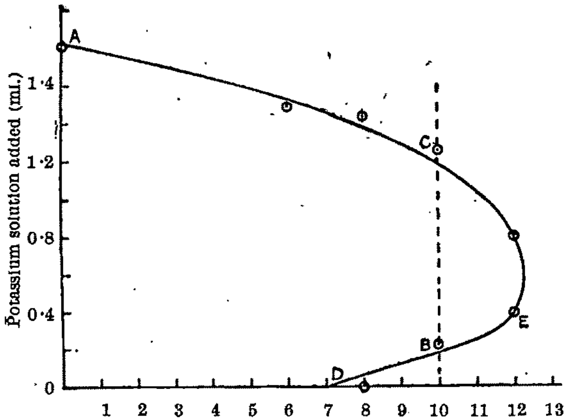
[1] Raman, C. V., *Nature*, 162, 23 (1948).

[2] Jahn, H. A., *Proc. Roy. Soc.*, A, 179, 320 (1942). Lonsdale, K., and Smith, H., *Nature*, 148, 628 (1941); 149, 21 (1942). Lonsdale, K., *Proc. Phys. Soc.*, 54, 314 (1942).

nteraction between Curare and the Potassium Ion at the Motor End Plate

IN a previous paper[1] evidence was presented that here is a relation between the curariform activity f an onium ion and the charge density on its uaternary central atom. A consideration of this heory and of the fact that the paralysing action of urare can be reversed by a fall of temperature[2] led o an investigation of the antagonism between curare nd the potassium ion[3].

By working below 30° C., it has been possible to udy the actions on the rat diaphragm[4] of potassium n concentrations which reduced neuromuscular ansmission while leaving the muscle fibres fully sponsive to direct electrical stimulation. Under ese conditions, it was possible to demonstrate a euromuscular block by high concentrations of the otassium ion alone (point *A* on graph). This block ay be similar to that produced in ganglia by high oses of potassium chloride[5]. The graph also shows at by bringing the muscle into equilibrium with creasing concentrations of curare it has been possible o demonstrate that the addition of curare reduces e concentration of potassium required to cause a 0 per cent block. When the dose of curare which uses a 50 per cent block at normal concentrations f potassium ions is exceeded, the addition of otassium ion has two opposite actions (dotted line). irst it antagonizes and decreases the block, the point B giving the potassium ion concentration which produces a 50 per cent block, and then after reducing he block still further a point is reached when more otassium sums with the curare and causes the block o increase again. The point *C* represents the 50 per ent block produced by adding excess potassium ons. The line *D*—*E* corresponds to the potassium n – curare antagonism observed earlier[3].



Relationship between *d*-tubocurarine chloride added to a 40-ml. bath and the amount of Tyrode solution containing 100 times the normal amount of potassium chloride required to maintain the neuro-muscular conduction of the preparation in a state of 50 per cent block

It appears to us that the interaction between urare and the potassium ion is an ion exchange action (cf. ref. 6 in this connexion), and that the gion of the motor end-plate contains an ion exhanger. Moreover, we would like to suggest that n normal neuromuscular transmission the onium ion roup of acetylcholine liberated by the nerve impulse acts with the exchanger, to which potassium ions re normally bound, and that the potassium ions so isplaced stimulate the muscle fibre, possibly by depolarizing it. The liberation of acetylcholine ions and their displacement of potassium ions from the ion exchanger would give rise to potentials of the liquid junction type. Moreover, the depolarization of the muscle fibre by the potassium ions would set up electrotonic and action potentials. The complexity of end-plate potentials[7,8] is therefore not unexpected. The marked similarity between the actions of potassium and acetylcholine[9] becomes easy to understand; and the continued occupation of the receptors of the ion exchanger by curare, stable choline esters and acetylcholine after eserine[10], by preventing the reoccupation of those receptors by potassium ions in preparation for the next impulse, explains the blocking action of these substances. We can represent the reaction between the receptors of the exchanger and the potassium ion briefly as follows:

$$R^- + K^+ \rightleftharpoons RK.$$

Normally, the acetylcholine liberated by a nerve impulse, by combining with free receptors and blocking the left to right part of the equilibrium, would leave the dissociation of potassium ions unopposed, with a consequent local rise in potassium concentration at the muscle fibre. If we decrease the free receptors by raising the potassium ion concentration, then acetylcholine cannot combine; hence the blocking action of excess potassium and its summation with curare when the number of free receptors is the limiting factor. Curare acting on normal muscle would decrease that potassium bound to the receptor which is available for exchange with acetylcholine. In this case, potassium ions would antagonize curare by increasing the available bound potassium.

P. E. B. HOLMES
D. J. JENDEN
D. B. TAYLOR

Department of Pharmacology,
King's College,
University of London,
Strand, London, W.C.2.

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[1] Holmes, P. E. B., Jenden, D. J., and Taylor, D. B., *Nature*, **159**, 86 (1947).

[2] Holmes, P. E. B., Jenden, D. J., and Taylor, D. B., *J. Physiol.*, **106**, 21P (1947).

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Effect of Drugs on Actin

IN previous work from this laboratory it has been established that the polymerization of actin is influenced by various ions in different ways. In view of the possibility that the change of globular actin into fibrous actin plays an important part in the mechanism of muscle contraction, it is especially interesting that calcium and potassium (or sodium) ions show antagonistic action at some concentrations[1].

When globular actin polymerizes, the reaction-rate can be followed by the rising viscosity of the solution. The reaction is usually of an autocatalytic type; therefore the rate is best measured by the reciprocal value of the time needed to reach 50 per cent polymerization.* Such a study, using 0·001 *M* calcium chloride and varying concentration of potassium

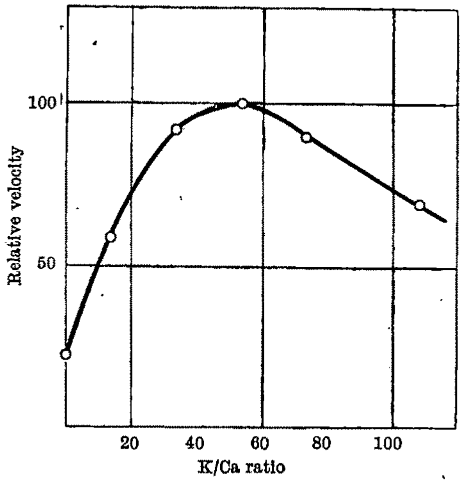

Fig. 1. Variation in the rate of polymerization of actin in presence of calcium (0·0005–0·001 *M*) and potassium (0–0·11 *M*) ions

chloride (pH 7) at 24° C., gave the results represented in Fig. 1. As the rate of polymerization of a given actin preparation is variable, the results are represented as a percentage of the rate obtained at the physiological potassium – calcium ratio. It is seen that in this type of experiment a synergistic action of calcium and potassium is observed, with an optimum at the physiological ratio.

The effect of many of the drugs which act directly on muscle is analogous, and is supposed to be related, to the action of one or other of the cations of the tissue. It was therefore of interest to study the effect of such drugs on the ion-catalysed reaction of the polymerization of actin. We have found that the rate of polymerization was greatly enhanced by adrenaline (0·1 mgm./ml.), whereas it was inhibited in presence of the same concentration of quinine, strychnine and veratrine. The study of these effects at varying potassium – calcium ratios gave the very suggestive curves of Figs. 2 and 3. In both these figures the ordinate represents percentage change in the rate of polymerization when compared with a control experiment in which actin was polymerized in presence of the same ions but without the addition of the drug.

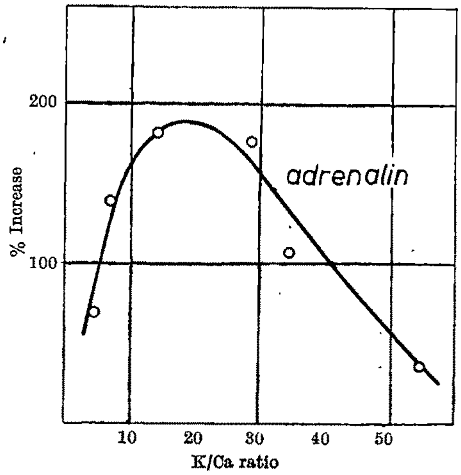

Fig. 2. Change in the rate of polymerization of actin in presence of adrenaline (0·1 mgm. per ml.) in relation to the rate of polymerization in presence of the same salt concentration but in absence of drug

A purified concentrate of the prosthetic group c actin (0·1 mgm./ml.) gave rise to effects similar t that of adrenaline.

Different preparations of actin are influenced b the above-mentioned drugs to a varying degree eve at constant ionic environment. This lends furthe support to the conception advanced in an earlie paper[1] that the process of polymerization is a serie of reactions, any one of which might be the limitin factor in a given preparation. One of these reaction can be catalysed either by the prosthetic group o actin or by calcium and adrenaline.

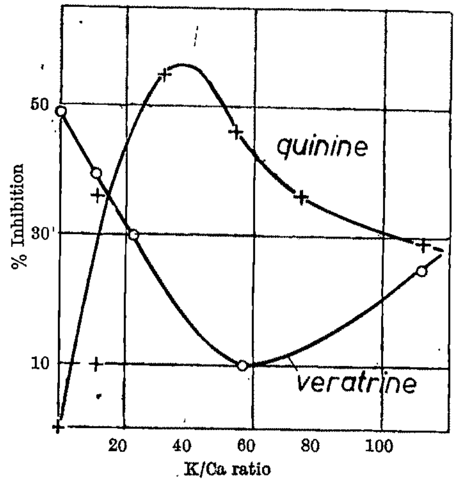

Fig. 3. Effect of quinine and veratrine (0·1 mgm. per ml.) on the polymerization of actin under the same conditions as for Fig. 2

The present results make it very probable that th molecular changes of actin are involved in the contraction mechanism.

A detailed account of this work will appear in th *Hungarica Acta Physiologica*.

F. B. STRAUB
G. FEUER
I. LAJOS

Institute of Medical Chemistry,
Szeged.
April 21.

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Actomyosin Content of the Uterus

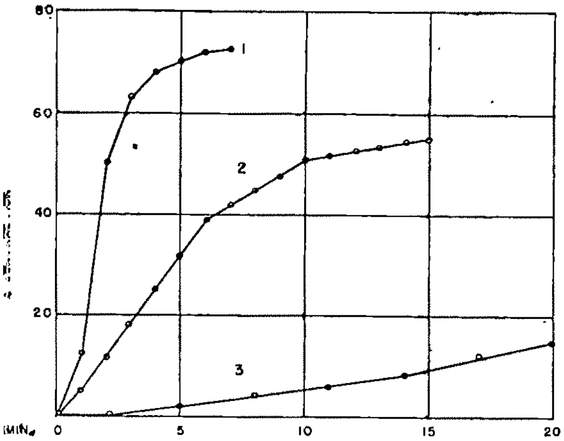
THE methods developed by the Szent-Györgyi school[1] offer a possibility of characterizing and explaining the well-known differences which exis between the pregnant and the non-pregnant uteru I have applied these methods to the study of huma and animal uteri under normal conditions, in differen stages of pregnancy and in certain pathological cases

The actomyosin of the frozen uterus was extracte with 3 volumes 0·5 mol. potassium chloride, in th presence of 2·5 mgm./gm. muscle adenosine triphosphate, by thoroughly grinding it with sand The viscosity of the actomyosin solutions with an without the addition of adenosine triphosphate, an the contraction of the actomyosin thread in th presence of adenosine triphosphate, were measured Both methods show that the extracted material i a mixture of actomyosin and myosin. The data i the accompanying table were obtained from viscosit determinations calculated according to Szent-Györgyi and Straub[2,3].

Material	Amounts of actomyosin and myosin in the solution extracted from 1 gm. material		
	Mixture	Myosin	Actomyosin
Non-pregnant human uterus	16	11	5
Human uterus during labour (Cæsarean sect.)	22	9	13
Human cross-striated muscle	44	18	26

The absolute and relative actomyosin content of he non-pregnant uterus extracts is much lower than hat of cross-striated muscle, and increases with dvancing pregnancy, rapidly reaching its maximum nmediately before parturition.

The contraction of a thread of actomyosin, followed time, clearly demonstrates the differences between ne pregnant and the non-pregnant uterus (see graph).



ntraction of actomyosin threads prepared from human uteri: (1) during labour; (2) from non-pregnant uteri; (3) from uteri after X-ray castration

These observations seem to explain many problems the physiology and even pathology of gravidity and rturition (abortion at too high, and very weak bour at too low, concentrations of actomyosin ?).

More work is planned along this line, and a detailed port will appear elsewhere.

Á. Csapó

Biochemical Institute,
and
No. 2 Women's Hospital,
University of Budapest.

zent-Györgyi, A., "Chemistry of Muscular Contraction" (Academic Press, Inc., New York, 1947).

zent-Györgyi, A., *Acta Physiologica Scand.*, 9, Supp. 25.

traub, F. B., Stud. Inst. Med. Chem., Univ. Szeged, 2, 3 (1942).

Production of Riboflavin and Allied Substances during the Growth of *C. diphtheriæ*

While studying, by paper partition chromatoaphy[1], the utilization of amino-acids during the owth of the Park Williams No. 8 strain of *C. phtheriæ*, we noted a strong yellow fluorescence with tra-violet light of culture filtrates of the organism own on a casein hydrolysate medium prepared sentially according to the method of Mueller and iller[2]. When such culture filtrates were run on romatograms using *n*-butanol-acetic acid as the lvent[3], two strongly fluorescent yellow spots were observed when the dried paper was placed under an ultra-violet lamp. Neither of these spots gave any colour when the paper was sprayed with 0·1 per cent (w./v.) ninhydrin in chloroform. One of them was in a position approximating to that occupied by proline and the other to that occupied by the basic amino-acids.

It was suggested to us by Dr. W. A. Rawlinson that these fluorescing spots might be due to flavins, and we have since learned that Wadsworth and Crowe[4] have shown that a special strain of *C. diphtheriæ*, grown on a synthetic medium, elaborated an unidentified flavin. We found that the faster moving spot had the same R_f value as riboflavin when run with either *n*-butanol-acetic acid or collidine as solvent. Moreover, when these spots were eluted from the chromatogram, both showed riboflavin activity, as did the original culture filtrate, when examined by the usual microbiological technique using *Lactobacillus casei* E. as the test organism. The crude culture filtrate had an activity equivalent to 25 μgm. of riboflavin per ml.

We found, also, that the fluorescent material behaved chemically like riboflavin. It was resistant to the action of potassium permanganate and hydrogen peroxide, would pass through a 'Cellophane' bag, and could be adsorbed on Fuller's earth and 'Super-filtrol', from which it could be eluted with small volumes of 20 per cent (v./v.) pyridine in 2 per cent (v./v.) acetic acid solution. Such an eluate when chromatographed gave two fluorescent spots, in the same position but much more intense than those on the chromatogram of the original culture filtrate. The eluate, when evaporated to dryness and taken up in water, once again showed riboflavin activity when tested by microbiological assay methods.

Therefore there is strong presumptive evidence that the faster moving of the two fluorescent spots obtained on chromatograms of culture filtrates of the Park Williams No. 8 strain of the diphtheria bacillus is riboflavin itself, while the other may possibly be either riboflavin phosphate or flavine adenine dinucleotide, both of which have been reported by Crammer[5] as having R_f values approximating to that obtained by us for this slower moving spot.

A. J. Woiwod
F. V. Linggood

Wellcome Physiological Research Laboratories,
Beckenham, Kent.
April 13.

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Sex and Organ Specificity in the Response of β-Glucuronidase to Extrinsic Agents

It was considered that the correlation shown to exist between the β-glucuronidase activity of a tissue and the amount of cell proliferation in progress[1] could explain the rise in uterine glucuronidase found by Fishman and Fishman[2] to follow œstrogen administration to ovariectomized mice. In a preliminary kinetic study of the enzyme in mouse uterus, the *p*H-activity curve for the hydrolysis of phenol β-*d*-glucuronide was found to be almost symmetrical about *p*H 4·5. This is in contrast to the curves

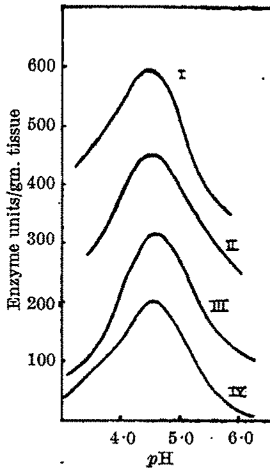

Fig. 1. *p*H-Activity curves for uterine glucuronidase
I, 10-day old mice; II, ovariectomized adults, 3 days after subcutaneous injection of 50 μgm. œstrone; III, normal adult; IV, ovariectomized adults

previously found for liver and spleen glucuronidase in the normal mouse[3], with peaks at *p*H 5·2 as well as at 4·5. Mills[4] has shown that beef spleen glucuronidase can be separated into two fractions, *A* and *B*, with slightly different *p*H optima for the hydrolysis of menthol glucuronide. Since it seemed probable that mouse uterus lacked a glucuronidase fraction present in liver and spleen, it was considered necessary to investigate the possibility that differences between *A* and *B* in distribution and response to extrinsic agents might in some way explain the selective actions of such substances as carbon tetrachloride and œstrone on liver and uterine tissue respectively.

As can be seen from Figs. 1 and 2, the *p*H activity curves for liver and uterine glucuronidase were unchanged in shape during active growth. The high figure for uterine glucuronidase in infant mice supports the view that in this organ, as in others, the activity of the enzyme is a measure of cell divisio The effect of carbon tetrachloride on liver does n suggest any selection between the glucuronida fractions. Carbon tetrachloride is known to have effect on kidney glucuronidase[5], in spite of the fa that the *p*H activity curve has been found to ha the same general shape as that shown for liver.

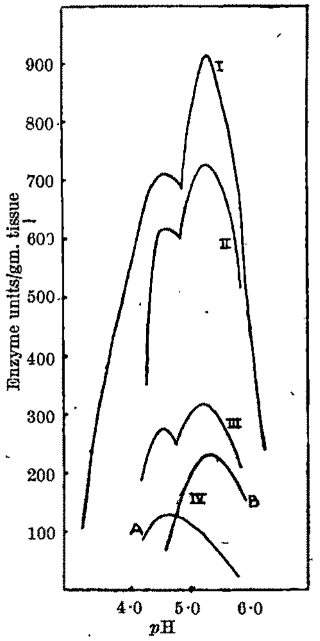

Fig. 2. *p*H-Activity curves for liver glucuronidase.
I, 6-day old mice; II, adult, 1 day after subcutaneous injection of 5 gm. chloroform/kgm.; III, normal adult; IV, the same preparation as III after separation of *A* and *B*

In further experiments, fraction *A* was precipitat by making the preparation 38·5 per cent saturat with ammonium sulphate[4] at *p*H 5·2, and the tw fractions were then determined separately. uterine enzyme was found in fraction *A*. The se aration achieved is illustrated for a liver preparati in Fig. 2. In the response of liver glucuronidase chloroform, and kidney to mercuric nitrate, *A* and were equally affected. Eschenbrenner and Mill found the production of renal necrosis in mice chloroform, seen only in males, to be prevented castration, and noted a correlation between kidn morphology and its susceptibility to chlorofor Morphological differences were confined mainly Bowman's capsule; but this was not involved the necrosis. The response of kidney glucuronida to chloroform observed in the male mouse[5] w abolished by castration. While figures for untreat females, males and castrated males did not sugge any differences in *A* or *B* corresponding to the vari tions in the structure of the kidney, the rise in kidn glucuronidase after injection of normal males wi chloroform was confined to fraction *B*. This could explained on the assumption that the two glucuro idase fractions are unevenly distributed througho the kidney. From the other results quoted abov it appears that the response by glucuronidase to a agent is independent of the 'fraction' present in t cell affected. For the comparative study of t effects of extrinsic agents on organs such as liv and kidney, it would appear adequate to determi the total enzyme activity at *p*H 5·2. The importan of determining the *p*H-activity curve for each n organ examined is, however, emphasized by the fin ings for the uterus.

LYNDA M. H. KERR
G. A. LEVVY

Department of Biochemistry,
University of Edinburgh.
April 8.

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Aneurin-Pyrophosphate Content of Red and White Blood Corpuscles in the Rat and in Man

WE have determined accurately the aneur pyrophosphate content of red and white blo corpuscles in the rat and in man. Rats in a we nourished condition and with slight aneurin deficien were examined, and also human subjects, bo healthy and suffering from various diseases. Deter inations were carried out in two blood fractio obtained by centrifuging, one containing a la number of red cells and very few white cells, the seco containing practically all the leucocytes of the blo sample and relatively few erythrocytes. Centrifuging must be carried out at a low rate, as at high rates the white cells agglutinate and cannot be resuspended for counting. Cell counting[1] must be performed with great care, as it is subject to much larger errors than the aneurin-pyrophosphate determination. The latter was carried out according to Westenbrink *et al.*[2].

Working with seven well-nourished male albino rats, their red cells contained 2·1 ± 0·41 γ aneurin-pyrophosphate per 10^{11} cells, the white cells 340 ± 100 γ per 10^{11} cells; so the average rat leucocyte contains about 160 times as much as an erythrocyte.

For eight normal men the average red cell content was 1·49 ± 0·08 γ aneurin-pyrophosphate per 10^{11} cells; for fourteen normal women the average was 1·28 ± 0·09 γ per 10^{11} cells. This sex difference was significant. Such a difference was not found for the white cells, their average content being 280 ± 45 γ per 10^{11} cells. So for human beings the ratio of the contents of a red and a white cell is about 1 : 200.

Although the aneurin-pyrophosphate content of erythrocytes is low, they contribute most to the aneurin-pyrophosphate of total blood, owing to their very large number.

A ration containing less than 0·15 γ aneurin a day (a rat needs about 10 γ a day) caused a significant decrease of the aneurin-pyrophosphate content of rat erythrocytes from 2·1 ± 0·41 γ to 1·0 ± 0·19 γ per 10^{11} cells in five days; the decrease of the leucocyte content was much less pronounced and only just significant, namely, from 340 ± 100 γ to 240 ± 58 γ per 10^{11} cells. The decrease of the red cell content in the avitaminotic rats runs roughly parallel to the decrease in liver, kidney and muscle, while the decrease of the white cell content is roughly proportional to that of the brain. This shows that differential determination of the aneurin-pyrophosphate content of the blood corpuscles provides conclusive information regarding the aneurin-level of the body.

When seven human subjects (six men and one woman) received an aneurin-poor diet for ten days, the average aneurin-pyrophosphate content of the red cells had decreased to about 1·15 ± 0·08 γ per 10^{11} cells, while the decrease of the white cell content, though distinct, was less pronounced. Human blood cells thus appear to be slower in losing their aneurin-pyrophosphate than rat cells.

In two cases where abnormally high values for the red cell content were found in apparently healthy subjects, this appeared to be due to the abnormally large volume of their erythrocytes, the aneurin-pyrophosphate content being normal when reduced to normal cell volume.

The aneurin pyrophosphate content of the red cells also appeared to depend upon their age; in the nucleated stage they may contain as much as 100–160 γ per 10^{11} cells.

In general, our work on pathological subjects, comprising cases of pernicious anæmia, primary liver carcinoma with extensive hæmorrhagia, erythroblastosis, lymphatic leucæmia, pyloris stenosis, myeloid leucæmia, and of aneurin deficiency, has shown that conclusions regarding the aneurin-level of the body cannot be based upon aneurin-pyrophosphate determination in total blood only. A blood count must always be made and the blood picture studied; for a reduced number of red cells can depress heavily the total content of blood even while the content of each cell may be normal or even increased. Conversely, in a case of leucæmia with a total blood content of 210 γ per 100 cm.^{3} (normal: ± 8 γ per 100 cm.^{3}), this very high value was caused by the extremely large number of white cells.

A full account of our experiments and discussion of the accuracy of the results will appear in *Biochimica et Biophysica Acta*.

This work forms part of investigations on aneurin metabolism being carried out by Prof. H. G. K. Westenbrink and collaborators.

E. Florijn
G. Smits

Laboratory of Physiological Chemistry
of the University, and
Central Institute for Nutrition Research,
T.N.O.,
Utrecht.
April 6.

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A Hyaluronidase Unit

Despite our deficient knowledge of the physical and chemical properties of both hyaluronic acid and hyaluronidase, it seems desirable to have a hyaluronidase unit, which can be used until international standard preparations are available for comparison, in order to be able to correlate the numerous investigations being carried out with this substance. All investigations so far suggest that the viscosimetric method of estimation at present affords the best possibilities for quantitative analysis of a biological material.

By a series of investigations into the individual phases of the viscosimetric estimation, we have obtained a unit for hyaluronidase. We define this unit as the amount of enzyme which at 37° C. in the course of 300 sec., by its action on 1 litre of a solution of roughly purified hyaluronic acid from synovia of recently killed cattle with a time of flow in a special viscosimeter of about 2·5 times that for water, reduces the increase in time of flow due to hyaluronic acid to half that period. We find it more important at present that the conception of a unit should be attached to an easily accessible hyaluronic acid preparation and a viscosimeter of fixed dimensions than to provisional local standard preparations of the enzyme.

The hyaluronic acid preparation applied is prepared from synovial fluid produced by puncture of the hock of cattle immediately after killing. The synovial fluid is diluted with an equal part of distilled water, after which the hyaluronic acid is precipitated by addition by drops of glacial acetic acid. The resulting coagulum is washed with distilled water and dissolved in phosphate citric acid buffer *M*/60, *p*H 7·0 (after McIlvaine) with 3·5 per mille sodium chloride. The solution is adjusted to a relative viscosity of about 3 and *p*H 6 by addition of buffer and 4 *N* sodium hydroxide.

The viscosimeter used is U-shaped with a wide tube of internal diameter 6 mm. and a capillary tube of internal diameter 0·3–0·4 mm., forming the bend and the measurement section. On this latter is a broadened region with a volume of 0·2 ml., delimited above and below by scratch marks. The distance from the lower mark to the bend is 175 mm.

A further account of the procedure of analysis pertaining to a viscosimetric rapid method will be published in the *Acta pharmacol. et toxicol.* (Copenhagen).

Since devising this method, we have been able to examine a sample of hyaluronidase from the Treemond Company, Brooklyn, N.Y. This sample was declared to contain 100 turbidity-reducing units per mgm.; by our method this was found to be equal to 2 hyaluronidase units as defined above. We therefore expect the ratio of the turbidity-reducing unit to our hyaluronidase unit to be approximately 50.

Sv. Dalgaard-Mikkelsen
S. A. Kvorning
Knud O. Møller

Department of Pharmacology,
University of Copenhagen.
April 2.

Indicator Yellow and Retinene$_1$

In their interesting article on the "Chemistry of Visual Processes", Ball, Collins, Morton and Stubbs[1] consider that Lythgoe's indicator yellow[2] is a "fortuitous artefact having no direct relevance to visual chemistry". They base this conclusion on the fact that retinene$_1$ may be extracted from bleached retinæ or from bleached visual purple (rhodopsin) solutions by a mixture of acetone, ethanol and light petroleum ether and that "free or loosely bound retinene$_1$ (the final product of bleaching rhodopsin) may combine with any suitable protein or amino-acid which may be available"[1]. They regard this fortuitous combination as the means of production of indicator yellow in solution.

These facts do not, however, justify their conclusion. Lythgoe[2] was unable to extract retinene from bleached visual purple solutions using petroleum ether alone as solvent. Hecht[3] has pointed out that alcohol must be added to the petroleum ether in order to extract the retinene. Again, if cold acetone is added to a bleached visual purple solution, the precipitate "contains not only the protein but most of the yellow colour. The retinene must therefore still be mainly attached to the protein, since carotenoids are not easily adsorbed in the presence of high concentrations of acetone" (Hecht, *ibid.*).

The inference is plainly that, after bleaching, the altered visual purple chromophores are still attached to the parent protein (this arrangement constituting the indicator yellow molecule), unless an active reagent such as alcohol strips these altered chromophores (retinene) from the protein. Thus by using alcohol, or other active agent, in the solvent, one is extracting a substance retinene, which is *not*, in fact, "the final product of bleaching rhodopsin". The recombination of retinene with a suitable protein (perhaps, indeed, the original protein from which it was detached) to yield 'indicator yellow' could then scarcely be described as 'fortuitous' but rather the restitution of the original state of affairs.

The visual purple molecule consists of a protein 'base' to which are attached about ten chromophores[4]. It is known that when one quantum of light is absorbed one chromophore is altered[5], but there is no evidence for the statement, often occurring in the literature, that the secondary process following activation of the chromophore is a loosening, that is, a dissociation of the chromophore-protein bond. It is just as probable that activation of a visual purple chromophore by a light quantum is succeeded by chemical process resulting in an electron transfe down the conjugated carotenoid chain to the protei base and thence, *in vivo*, to the retinal end-orga to which, in all probability, the visual purple molecules are attached. This gives us a simpler pictur of the genesis of the physiological impulse than doe the usual view that the retinal end-organs are stimulated by a product of the disrupted visual purpl molecule.

H. J. A. Dartnall

Vision Research Unit,
Institute of Ophthalmology,
Judd Street, W.C.1.

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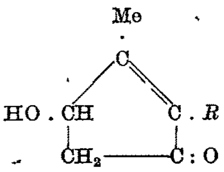
The facts quoted by Dr. Dartnall do not invalidat our conclusions. If under the action of light th retinene is split off, the conditions are such that it available for recombination with any protein to forr new compounds. The spectroscopic evidence indicates that there are three materials in bleache rhodopsin solutions, retinene (or retinene + protei and the acid and alkaline forms of indicator yellow We consider that, although the same protein is concerned in all three compounds, yet the chemica evidence indicates that in indicator yellow, retinen is firmly bound while in neutral bleached rhodopsi solutions it is only weakly bound. We agree wit Dr. Dartnall's final paragraph.

S. Ball
F. D. Collins
R. A. Morton

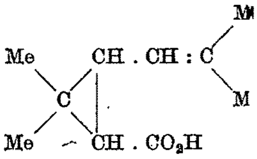
Biochemistry Department,
University of Liverpool.

Total Synthesis of some Pyrethrins

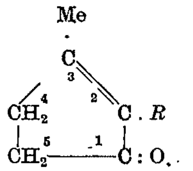
In view of recent publications in the United State it is desirable to record briefly some of the result obtained by us during the past year or so. Followin the demonstration by LaForge and Barthel[1] of th heterogeneity of 'pyrethrolone', the alcoholic component of the pyrethrins, and the revision by LaForg and Soloway[2] of the structures of the constituen alcohols to (I), where *R* is butenyl or pentadieny and the synthesis by Campbell and Harper[3] (—)-*trans*-chrysanthemum monocarboxylic acid (II the enantiomorph of the acidic component pyrethrin I, the total synthesis of various pyrethrin (that is, esters of I with II), the insecticidal constituents of pyrethrum flowers, appeared a mor favourable project than previously.



I



II



III

A convenient route to ketones of type (III) was explored by Harper[4], by the preparation of ketones, in which R = n-butyl and butenyl, the former being identical with dihydrocinerone and the latter isomers of cinerone ; and has since been extended to higher analogues, in which R = n-amyl, pentenyl, etc. If direct substitution could be effected in position 4, then subsequent condensation with chrysanthemum monocarboxylic acid would provide a convenient route to pyrethrins, in which structural and stereochemical variations could be readily made. The 4-position is analogous both to the γ-position of crotonaldehyde and crotonic esters and to the β-position of saturated esters, and might therefore be expected to undergo free radical substitution more readily than elsewhere. Developing this approach, we have been able to effect smooth substitution of bromine, using N-bromosuccinimide in carbon tetrachloride, to give what we believe to be the 4-bromoketone, though we have not yet established this unequivocally. Nevertheless, reaction with silver acetate in glacial acetic acid gives the corresponding acetoxyketone, which is saponified to the hydroxyketone, of the same series, irrespective of the absolute structure, as natural pyrethrolone and cinerolone. When R is n-butyl, the product is (±)-dihydrocinerolone, which has also been synthesized by a similar method by Soloway and LaForge[5]; and when R is n-amyl, the product is (±)-tetrahydropyrethrolone, which has also been synthesized by a similar method by Dauben and Wenkert[6] (see Table 1).

Table 1

	(I), R = n-Butyl	Dihydrocinerolone	Ref.
Alcohol	b.p. 114–117°/0·8 mm.	(+) 115–117°/1 mm.	1
	n_D 1·4946 (19°)	(+) 1·4958 (22°)	1
Semicarbazone	m.p. 184–185°	(±) 185°, 184–185°	1, 8
3:5-Dinitrobenzoate	m.p. 110–110·5°	(±) 111°	5
Acetate	b.p. 100–103°/0·75 mm.		
	97°/0·25 mm.		
	n_D 1·4788 (20°)		
	1·4772 (20°)		
Acetate 2:4-dinitrophenylhydrazone	m.p. 125–126°		
	(I), R = n-Amyl	Tetrahydropyrethrolone	
Alcohol	b.p. 127°/0·4 mm.	(+) 124°/0·6 mm.	9
	n_D 1·4882 (25°)	(±) 1·4892 (28°)	1
Semicarbazone	m.p. 169°	(±) 172–173°, 172–174°	1, 8
3:5-Dinitrobenzoate	m.p. 105–106°		
Acetate	b.p. 103°/0·4 mm.	(+) 117°/1·3 mm.	9
	n_D 1·4747 (25°)	(+) 1·4761 (20°)	9

Having established the relationship of these products to the pyrethrins, we have now submitted the bromoketone in carbon tetrachloride to reaction with the silver salt of synthetic chrysanthemum monocarboxylic acid and isolated by distillation the corresponding pyrethrin. Table 2 lists the synthetic esters we have obtained, and their stereochemistry. These esters have been tested for insecticidal properties, and are of a low order, thereby confirming the low toxicity reported by LaForge and Barthel[7] for tetrahydropyrethrin I.

Table 2

(I), R=	Stereochemistry of alcohol	Stereochemistry of acid	B.p.	n_D^{20}
n-Butyl	(±)	(±)-*trans*	115–116°/1 × 10^{-3} mm.	1·4992
n-Butyl	(±)	(±)-*cis*	117–119°/3 × 10^{-4} mm.	1·5000
n-Amyl	(±)	(±)-*trans*	96°/7·8 × 10^{-4} mm.	1·4970
n-Amyl	(±)	(±)-*cis*	120–124°/2·1 × 10^{-3} mm.	1·4980

Experiments are in progress to establish beyond doubt the position of substitution and to investigate the extension of this method to ketones in which R = butenyl, pentenyl, etc.

L. CROMBIE
M. ELLIOTT
S. H. HARPER
H. W. B. REED

King's College,
Strand,
London, W.C.2.
April 13.

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Alkaloids of the Australian Rutaceæ

IN certain tribes of the family Rutaceæ a relatively high proportion of species has been found to contain alkaloids. Moreover, these alkaloids vary widely in character and include representatives of several of the principal structural groups, for example, quinoline, *iso*-quinoline, carboline and imidazole derivatives.

We are examining the alkaloids of a number of Rutaceous genera of the Australian flora, particularly those of the Queensland tropical rain-forest. This work is part of a general survey of the occurrence and pharmacology of alkaloids in the Australian flora, which is being undertaken by the Council for Scientific and Industrial Research in collaboration with the departments of chemistry and physiology of several Australian universities. At least six unrecorded alkaloids have been isolated from the three rain-forest species, *Melicope fareana* F. Muell., *Evodia xanthoxyloides* F. Muell., and *Acronychia baueri* Schott. Of these, five are certainly related and exhibit a number of novel features. The bark of *Melicope fareana* contains melicopine ($C_{17}H_{15}O_5N$, pale yellow needles, m.p. 178·5–179·5°), melicopidine ($C_{17}H_{15}O_5N$, pale yellow prisms, m.p. 121–122°), melicopicine (yellow prisms, m.p. 131–132°), and acronycidine ($C_{15}H_{15}O_5N$, colourless needles, m.p. 136·5–137·5°). The leaves of this tree also contain melicopine, melicopidine and melicopicine, but acronycidine is absent. There is present, however, a small amount of another colourless alkaloid which has not yet been obtained in a pure form. The bark of *Acronychia baueri* contains acronycine ($C_{20}H_{19}O_3N$, pale yellow needles, m.p. 174–175°), melicopine, melicopidine and acronycidine, while melicopicine has been isolated from the leaves. The bark of *Evodia xanthoxyloides* contains evoxanthine ($C_{16}H_{13}O_4N$, pale yellow needles, m.p. 217–218°), and melicopidine.

Although the structural problems have not yet been completely clarified, it has been established that the five yellow alkaloids are acridine derivatives, actually N-methyl acridones. Acronycidine (colourless) is probably a quinoline derivative related to skimmianine. A number of other species belonging to the same and related genera are under examination, and it is hoped to correlate the nature of the alkaloids with the taxonomy of the groups concerned. Full details of this work will be published elsewhere.

G. K. HUGHES
Department of Organic Chemistry,
University of Sydney.

F. N. LAHEY
Department of Chemistry,
University of Melbourne.

J. R. PRICE
Division of Industrial Chemistry,
Council for Scientific and Industrial Research.

L. J. WEBB
Division of Plant Industry,
Council for Scientific and Industrial Research.

Determination of Mixing of Gas Streams by the Infra-Red Gas Analyser

A TECHNIQUE developed by this laboratory for use in model experiments on the mixing of air and gas in the open hearth furnace has application to any problem of turbulent diffusion between streams of similar gases, in which mean concentrations of one gas in the other are to be sampled. The method used combines high sensitivity and rapidity of response with freedom from poisonous tracer substances.

The technique is at present being applied to the study of mixing in a model of a producer gas-fired open hearth furnace. Both air and fuel gas are replaced in the model by air at room temperature, and the pattern of mixing between the air from the gas port and that from the air ports is studied. This pattern is of great importance in furnace design as it determines shape of the flame and rate of burning. To obtain Reynold's similarity with a 1/12-scale model a flow rate of nearly 7 cubic metres/minute is needed, which necessitates a highly sensitive detector if the flow-rate of the tracer is to be kept low.

Originally, consideration was given to the use of a radioactive tracer such as radon, which has already been used both for full-scale furnace experiments and in the laboratory[1,2]; but the commercial production[3] of the infra-red gas analyser provides a means of obtaining sensitivity without the inconvenience of a tracer which decays with time. Using carbon dioxide, a full-scale deflexion is obtained with a concentration of 0·03 per cent, corresponding to a flow of 2 litres/minute, of pure carbon dioxide. In a well-ventilated laboratory, this may be safely run to waste. At the rate of aspiration used, the speed of response of the instrument, including delays introduced in the tubing, is better than 5 sec. for two-thirds final reading.

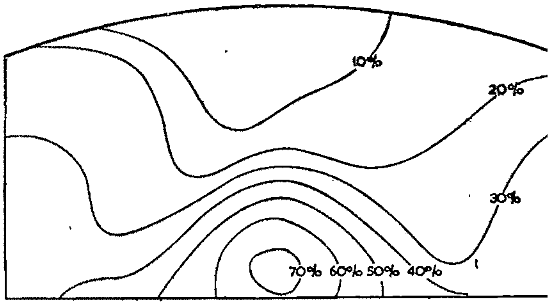
Precautions are necessary to eliminate the effect of changes in the concentration of carbon dioxide in the atmosphere. It has been suggested that the use of methane as a tracer would avoid this. The infra-red gas analyser can be made almost as sensitive to this gas (about 0·1 per cent for full-scale deflexion), so that waste removal should not be too difficult.

In the apparatus used, air is passed into the i takes and ports of the model at measured rates. small quantity of carbon dioxide from a cylinder introduced into the gas port line. Samples are tak from the furnace by a probe connected by rubb tubing to the sample tube of the infra-red gas analys A small pump provides suction at the outgoing en of both sample and control tube. The latter dra air continuously from the duct supplying air to t air ports, and a two-way tap enables the sample tu to be connected at will to the gas port supply li Each of these systems is arranged to be similar length and speed of aspiration.

At the start of the experiment the sensitivity co trol of the analyser is adjusted to correspond wi the calibration curve provided by the makers[4]. T rate of flow of carbon dioxide is then increased un full-scale deflexion is obtained with the sample tak from the gas port line. This is checked betwe each reading. The probe is placed in predetermin positions and the readings taken and plotted as co tours of equal concentration.

The work, not yet complete, from which the ill trations are taken is designed to supplement that do by the Steelmaking Division of this Association, the effect of furnace design on gas and air mixi on heat transfer to the hearth[5].

Fig. 1



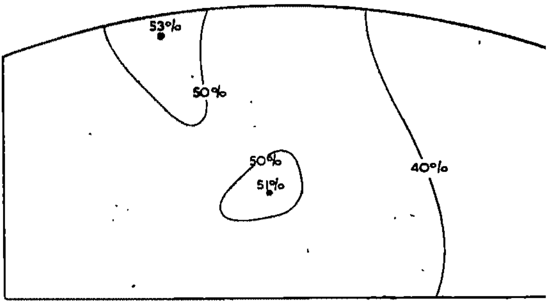


Fig. 2

The accompanying two graphs show the effect o modification of air port design. Both represe vertical sections across basically similar furnaces the first charging door. Fig. 1 represents the co ventional design, in which points to be noted a the slow mixing shown by the high concentration unburnt gas, the position of the flame close to t hearth, and the flow of air down the centre of t roof. Fig. 2 shows a rejected modification. Mixi is very good; but the higher concentration near t roof, especially when compared with similar sectio near the end wall, indicate that the flame has be blown up to the roof, and this in practice would so cause the roof to melt. It is to be noted that t asymmetry with respect to the centre line is in agre ent with the work of Mr. A. R. Philip[6] in visualizing e flow pattern in open hearth furnaces.

R. D. Collins
M. P. Newby

Physics Laboratories,
ritish Iron and Steel Research Association,
40 Battersea Park Road, London, S.W.11.
April 16.

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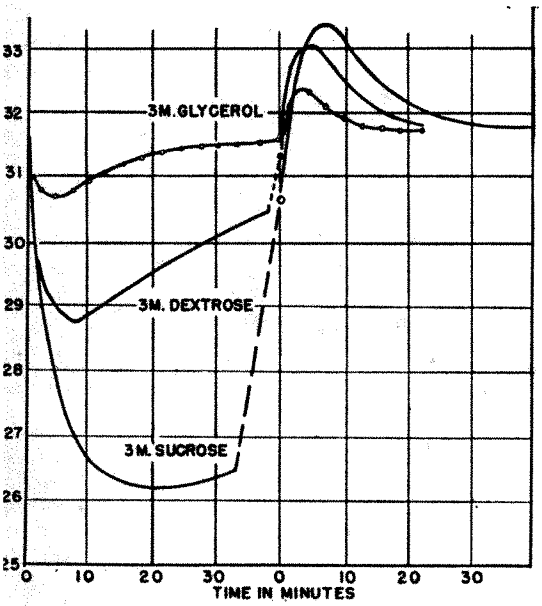
Ionic Exchange and Fibre Contraction

In a communication under the above title, pubhed in *Nature* of May 31, 1947, p. 746, J. L. Mongar d A. Wassermann report some experiments on the -swelling of calcium alginate fibres in salt solutions. ey noted that water-swollen alginate fibres when aced in various alkali-salt solutions first contract d then increase in length. The authors suggest at the contraction results from destruction of lcium ion cross-links between alginate chains as e calcium is replaced by alkali ions. They propose so that plastic flow is mainly responsible for the al swelling effect.

In the course of studies carried out some time ago, e found that water-swollen cellulosic fibres when aced in aqueous salt solutions also contract rapidly first and then re-swell. The same phenomenon curs in sugar or glycerol solutions. Some typical servations on water-swollen hydroxyethyl cellulose onofils (0·3 mole hydroxyethyl/glucose unit) are own in the accompanying graph.

We believe that the contraction is caused by water igrating out of the filament to establish osmotic uilibrium. Eventually, as the solute diffuses into e filament, the osmotic forces are reversed and ter flows into the filament, causing an increase in length. It appears to us that the same processes are probably responsible for the shrinking – swelling phenomenon of calcium alginate fibres in salt solutions. If this is true, then considerations of cross-linking and plastic flow are unnecessary.



e-swelling in sugar and glycerol solutions

Re swelling in water after equilibrium established in sugar and glycerol solutions

e-swelling of hydroxyethyl cellulose monofil (0·3 mole hydroxyethyl/glucose unit). Gel monofil dried, then re wet in water

Flory[1], Hermans[2], and others have developed theories which consider swelling as being an osmotic phenomenon. According to these theories, which appear to be applicable in the present case, swelling is related to the entropy of chain configuration, and equilibrium is established when osmotic entropy and entropy of chain configuration are equal (neglecting heat of mixing). If osmotic entropy is changed by adding a solute to the swelling liquid, the swollen structure will shrink. If a solute diffuses into the swollen structure, osmotic entropy changes and swelling will increase. This can be demonstrated quite simply by allowing a cellulose monofil to come to equilibrium with a sugar solution and then placing it in water, as indicated in the graph. Water migrates in to establish equilibrium with sugar molecules in the swollen cellulose structure, increasing its swelling beyond the water-swollen state. As the sugar molecules diffuse out of the gel, it gradually returns to its original water-swollen dimensions.

H. G. Ingersoll
A. A. Johnson

Chemical Department, Experimental Station,
E. I. du Pont de Nemours and Co.,
Wilmington, Delaware.
April 19.

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[1] Flory and Rehner, *J. Chem. Phys.*, 11, 521 (1943); Flory, *Chem. Rev.*, 35, 51 (1944).

[2] Hermans, J. J., *Trans. Farad. Soc.*, 43, 91, pt. 8–9 (Aug.–Sept. 1947).

The Potato Caterpillar Pest (*Agrotis* spec.) of Tristan da Cunha

The reports of the Norwegian Scientific Expedition to Tristan da Cunha (1937–38) and of the naval authorities who were stationed on the island during the Second World War have directed attention to the fact that the potato crop, on which the islanders depend so much for food, was seriously affected by the ravage of a caterpillar. Before the departure of the recent expedition sent to the islands by a group of South African fishing interests, it was impossible to find out more about this pest.

As members of this expedition, which left Cape Town on January 29 in the M.V. *Pequena*, it was one of our tasks to study the 'potato grub' problem and to try to find a method of control. We were informed by the Rev. C. P. Lawrence and islanders that the pest had only been noticed since the old custom of using kelp (consisting chiefly of *Macrocystis pyrifera*, Ag., and a small amount of *Ecklonia* sp.) as manure for the potato patches was abandoned and sheep manure used instead. If this observation be accurate, it suggests an interesting line of research, for the kelp would seem to render the soil unsuitable for the development of the caterpillar. In the one month available such a line of research could not be followed, but time did permit the testing of the effects of insecticides on the caterpillars.

We found that only one species of insect was responsible for the damage. Dr. A. J. T. Janse of the University of Pretoria, who was kind enough to examine material of the species, has come to the conclusion that the species is not like any that he knows from Europe or South Africa and, therefore, has not been able to name the species.

Badly defoliated potato plants after having been attacked by the caterpillars. (Photograph by Dr. G. J. Broekhuysen)

The damage done by the caterpillars is very serious, and although we were told that the infestation this season was less than usual, we were none the less impressed by the heavy damage caused. Many patches had been completely defoliated and caterpillars were eating the haulms of the defoliated plants (see photograph). In South Africa this species is not often found on potatoes, nor does it attack the foliage of the various plants on which it occurs; but feeds on the stem at soil-level.

On our arrival in the beginning of February, most of the caterpillars were in the last two instars; but by the time we left a month later, fairly large numbers of very young caterpillars had appeared, indicating a new generation. They chiefly attacked the plants during the night, and on dry days most of them burrowed into the soil at the foot of the plants. On damp days, however, many remained feeding. This habit is well known to the islanders, who send the children in the early morning to pick the caterpillars off the plants and crush them. The caterpillars were not confined to the potato, but were found feeding on a variety of plants, including grasses, thistles, *Rumex* spp., and most vegetables, except pumpkins, tomatoes, strawberries, onions and parsley. Apart from the low settlement plateau with its potato patches, the caterpillars were also found at Cave Point and Sandy Point, both of which are uninhabited. None was found on the high plateau (about 2,000 ft.) or higher up on the mountain.

The effects of three insecticides were tested in cage experiments and two in the field. *Lead arsenate* gave an unsatisfactory average mortality of 35·1 per cent in three sets of cage experiments and is also too dangerous for a backward community such as that on Tristan da Cunha to apply; it was not tried in the field. *Sodium silicofluoride*, given as a bait mixed with bran (1 in 12 by weight), gave an average mortality of 78·2 per cent in five sets of cage experiments and up to 71·6 per cent mortality in three sets of field-tests. In one of the field-tests the concentration of the poison was cut down by half. *Wettable D.D.T.* (50 per cent), in a spray (1 ounce per gallon), gave an average mortality of 88· per cent in four cage experiments and 99·1 per cen in three field-tests. Again in the last field-test th concentration of the solution was cut down by hal

Unfortunately, the number of field-tests is rathe limited; but they show nevertheless quite distinctl that the pest can be controlled by the use of eithe D.D.T. spray or sodium silicofluoride – bran bait, o by using them alternately. It will also be advisabl to control the pest on the surrounding vegetatio perhaps by the introduction of some insectivorou bird. The local thrush (*Nesocichla eremita eremita* Gould.), or 'starchy' as the islanders call it, wa found to be very fond of the caterpillars. Unfortun ately, the large number of rats have nearly exterm inated this bird on Tristan. If the rat menace coul be checked the thrushes might increase, and in an event their numbers could be augmented from th flocks on the neighbouring islands of Nightingale an Inaccessible.

A full account of the experiments conducted wi be submitted for publication to the *Journal of th Entomological Society of Southern Africa.*

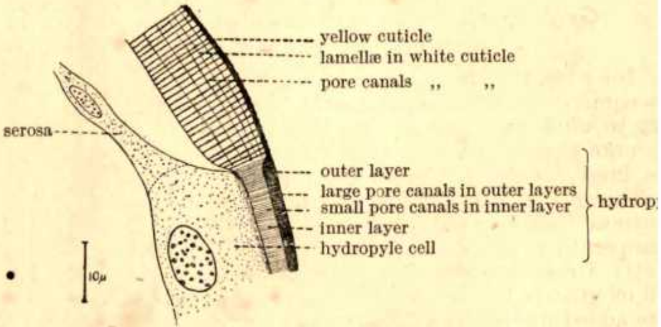
G. J. BROEKHUYSEN
W. MACNAE

Department of Zoology,
University of Cape Town.

Pore Canals in the Egg Membranes of *Locustana pardalina* Walk.

IT has been shown by Slifer[1] that in the egg *Melanoplus differentialis* water is taken up through small, circular, specialized area (the hydropyle) in tl yellow cuticle. This structure, consisting of tw layers, is situated at the posterior tip of the eg and is a secretory product of a group of enlarge serosal cells (hydropyle cells). According to h description, these two layers are continuous with tl so-called yellow and white cuticles which cover tl remainder of the egg. The outer layer of the hydr pyle is several times thicker than the correspondi layer of the unspecialized yellow cuticle and is al distinctly striated. These striations (pore canals) ru at right angles to the surface. Slifer also describ the inner layer of the hydropyle as being continuo with the white cuticle and of the same structure.

In the egg of the South African brown locu (*Locustana pardalina*) the structure of the out layers of the hydropyle corresponds in every deta to that of *Melanoplus*. The substance of the inn layer, however, appears to be more homogeneo than the white cuticle of the unspecialized part



Semi-diagrammatic representation of the posterior tip of the egg of *L. pardalina* showing a small portion of the hydropyle region and adjacent unspecialized yellow and white cuticles the egg and contains a series of very small pore canals which penetrate this layer at right angles, linking up with the larger pore canals in the outer layer. These small canals are very difficult to demonstrate, but they show up distinctly in paraffin sections slightly verstained in hæmatoxylin. This suggests that they contain cytoplasmic filaments originating in the underlying hydropyle cells. The white cuticle of the remainder of the egg is distinctly laminated, and like the inner layer of the hydropyle it also contains pore anals but of a much larger size.

A detailed account of these and other features of he egg of *Locustana* will appear elsewhere.

J. J. MATTHÉE

Department of Zoology,
Cambridge.
April 9.

Slifer, E. H., *Quart. J. Mic. Sci.*, 8, 437 (1938).

Control of Intestinal Microflora

IN view of recent work which has directed attention o the importance of the intestinal microflora in nutrition, examinations of the fæces were made on a number of children receiving treatment with treptomycin.

Films showed a fair proportion of Gram-negative bacilli; but in most cases none could be grown. In other cases, streptomycin-resistant strains of *A. ærogenes* were found on culture. In no case could any *B. coli* or Gram-negative bacillus other than *A. ærogenes* be grown.

A strain of smooth *B. coli* was made streptomycin-resistant, and after attempts at inoculation by mouth had failed, rectal inoculation was successful. This has now been carried out on two cases, and in each case the organism appeared in the stools in less than 48 hours; in one case it persisted until treatment was uspended (11 days), and in the other case it is still present at the time of writing (16 days). It is now only just resistant to 10–20 units of streptomycin per ml.

This technique may be useful in assessing the part played by various other species of micro-organisms in nutrition; and also possibly in epidemiological problems.

My thanks are due to Prof. W. F. Gaisford for his ready co-operation, and to my laboratory steward, Mr. H. Ward, for his untiring assistance.

H. DALTON

Royal Manchester Children's Hospital,
Pendlebury.
April 14.

Growth of *Culex molestus* under Sterile Conditions

Aedes ægyptii and *Culex pipiens* are the only two mosquitoes which have hitherto been reared from egg to adult under sterile conditions. It is interesting o note that the autogenous *Culex molestus* can also be bred without difficulty on sterile media.

The following media were found suitable for this purpose (all experiments were carried out at a temperature of 28° C.).

(1) Dried or fresh yeast (autoclaved) 1·2 gm. to 5 ml. distilled water to which 25 eggs of *C. molestus* were added under sterile conditions. On this medium he mosquitoes developed from eggs to adult in 0·5–13 days, but the adults were not viable.

(2) Water plus dried yeast plus the following vitamins: thiamin, riboflavin, pantothenic acid, niacin, pyridoxin, folic acid (each 10 γ per ml.), biotin 0·14 γ per ml. This was the optimum medium, and the development from egg to adult lasted 7·5 days. The mosquitoes were viable. Obviously 1·2 gm. of the best samples of yeast available did not contain sufficient of the above factors to produce viable adults.

(3) Liver extract plus dried yeast (autoclaved) (Trager's medium for *A. ægyptii*). Development from egg to adult lasted 14 days and the adults were viable. Water extract of the same yeast and liver extract allowed development from egg to adult in 20 days; but the adults which emerged were not viable.

(4) Water, glucose (0·1 per cent), a mixture of salts (0·2 per cent), casein hydrolysate (2 per cent) and the above-mentioned vitamin B complex (but with only 7·5 γ biotin per ml.) plus ascorbic acid 150 γ per ml. Although development on this medium was relatively slow (eggs to viable adults in 25 days), it proved to be the most suitable for studying the nutritional requirements of all stages of *Culex molestus*. Thus in the absence of pantothenic acid, all other factors being present, there was no development beyond the first instar; in the absence of thiamin, riboflavin or pyridoxin, the larvæ die in the second instar; in the absence of folic acid the larvæ reach the fourth instar but never pupate. In the absence of niacin the whole developmental cycle lasts 42 days and the adults are viable. In the absence of biotin the cycle lasts 36 days, but the adults are not viable. Ascorbic acid is not essential for complete development of viable mosquitoes, but in its absence the cycle is prolonged to 29 days.

It is interesting to note that the viable females raised on sterile media were autogenous and laid eggs in the absence of any kind of nutrition. Full details will be published elsewhere.

I have to thank Prof. S. Adler for his advice and interest in this work.

E. P. LICHTENSTEIN

Department of Parasitology,
Hebrew University,
Jerusalem.
April 1.

Mosquitoes and Malaria

WITH reference to the recent article on the Ronald Ross Jubilee[1], it may be of interest to note that, in a paper read at a meeting of the Royal Scottish Geographical Society in April 1892, Dr. H. Martyn Clark, of Amritsar, remarked "that, as some insects carry the pollen of one plant to the flower of another, so mosquitos [*sic*] transplant the malarial germ to a suitable *nidus* by directly inoculating their victims with it"[2]. He further stated that "it will probably some day be ascertained that the mosquito fulfils a part in their [that is, the germs of malaria] transmission". As Ross met Manson in 1894, and Manson brought forward the mosquito theory in that year, Clark's adumbration seems to be worthy of recall.

J. H. KENNETH

The Scottish Geographical Magazine,
Synod Hall, Castle Terrace,
Edinburgh 1.

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[1] *Nature*, 162, 50 (1948).

[2] Clark, H. M., "Remarks on Malaria and Acclimatisation", *Scot. Geog. Mag.*, 9, 294 (1893).

CHEMISTRY RESEARCH BOARD

A REPORT of the Chemistry Research Board which prefaces the report of the Director of the Chemical Research Laboratory for the year 1946 covers the nine-year period January 1, 1938, to December 31, 1946*, and thus presents a summary of the more important developments since the publication of the second report of the Board, which covered the three years ending December 31, 1937. A fuller account is promised in a further report which is still in preparation.

Both the Board's report and that of the Director devote considerable space to discussion of the post-war plans for the work of the Laboratory. The Chemistry Research Board proposed that the work of the Laboratory should be concentrated on a few well-selected topics in the fields of coal tar, corrosion of metals, inorganic chemistry, high polymers and plastics, organic intermediates and microbiology. For the present, owing to limitations of space, it is proposed that microbiological studies should be concentrated on corrosion problems, and the Board recommends that throughout its work the Laboratory should pay special attention to the development of new techniques. To implement this programme, expenditure at the rate of £70,000 per annum will be required as well as non-recurrent expenditure on equipment estimated at £20,000; these proposals have been approved by the Committee of the Privy Council for Scientific and Industrial Research.

The Director of the Laboratory in his report details the objectives of the work of the five main research sections in which the scientific staff of twenty-five scientific officers, thirty-three experimental officers and assistants, and twenty-five laboratory assistants has been organised to implement these proposals. There are also two non-sectional groups for exploratory and special work under the Director and Assistant Director, respectively. The present objectives comprise the investigation of corrosion in immersed and atmospheric conditions with the view of the prevention of rusting, tarnishing and corrosion of ferrous and non-ferrous metals in industrial use; the investigation of the microbiological corrosion of metals, particularly in soil, by the influence of bacteria which reduce sulphates, and the investigation of *ad hoc* corrosion problems of industrial importance. In the inorganic field they include the investigation of semi-rare metals, especially their isolation from wastes and low-grade sources, the study and development of physical methods of analysis, and development of micro-analytical methods and other new techniques; in that of high polymers and plastics, the determination of the relations between structure and properties and the preparation of improved plastic materials such as glues and ion-exchange resins; and in the coal tar field, the isolation and identification of tar constituents using the newest methods of separation and analysis, determination of the physical and physico-chemical constants of tar constituents and derived or related substances, and the development of new uses for tar products and their derivatives. The programme also includes the study of high-pressure operations and the production of useful chemicals by such means, and the preparation of compounds capable of polymerization or co-polymerization, particularly those containin silicon.

The Board's report, as well as that of the Directo refers to some of the directions in which progress ha been made on these main items during 1946, and th latter report describes the new work done by th non-sectional groups in collaboration with th Agricultural Research Council on the formulation c salves or smears for control of ticks and in devisin a new micro method for the rapid determination o D.D.T. Satisfactory results have also been obtaine by this section in work on blow-fly control. In th Engineering Services, the Corrosion Section has redesigned the coupling used for the slow rotation o specimens so as to ensure positive and concentri alignment of the spindles to the shafts, and a sectione view of the arrangement is included in the repor Investigations of the corrosion-rate of mild steel i salt solution using the high-speed rotor suggest tha the nature of the surface finish may appreciabl influence corrosion-rates and the reproducibility o results.

The Corrosion of Metals Section has continued t develop both the high-speed and the low-speed roto techniques for immersed conditions, and with th former technique has investigated the influence o surface preparation on the reproducibility of corrosion-rate and the influence of movement on th corrosion-rate of mild steel in fresh water. Using th new endless belt and beaker type of apparatus fo accelerated atmospheric corrosion tests recently note (*Nature*, 162, 90; 1948) the corrosion of steel in sal water atmospheres and the effect of impact damag on the corrosion of painted steel have been examined In collaboration with the Light Division of th National Physical Laboratory, a light-reflexion mete utilizing the integrating sphere principle, has bee constructed, and in collaboration with the Britis Iron and Steel Research Association the corrosio behaviour of a comprehensive series of low allo steels is being investigated, using the oxyge absorption apparatus and the low-speed roto apparatus. An extensive search is being made fc organic corrosion inhibitors more efficient tha sodium benzoate. Other work has been concerne with wrapping materials and with vapour-phas inhibitors, as well as with the influence variou methods of surface treatment have on the corrosio resistance of mild steel and on the protection afforde by applied coatings.

In the Inorganic Section an attempt is being mad to correlate the rare metal content of flue dust an coal ash with that of the fuel from which the dust o ash originated; and methods of extraction o germanium and gallium from flue dust are bein studied. The physical chemistry group has give attention to detection and possible estimation c some minor metals by fluorescent technique; and i work on foams for fire fighting, carried out for th Ministry of Home Security, a portable foam mete has been designed which has been very useful i large-scale experiments with petrol fires.

The High Polymers and Plastics Section's comprehensive study of the mechanical properties c reinforced plastics, commenced, jointly with th Engineering Division of the National Physical Laboratory, during the War, has led to a clearer understanding of the relationships existing between th mechanical properties of laminated plastics and th properties of their components. In connexion wit the study of weathering properties, a more convenien pparatus is being constructed for the accurate etermination of the sorption isotherms of phenol-ormaldehyde resins, and the study of the relation etween structure and dielectric properties of high olymers is being resumed. A critical review has een made of the literature dealing with the ion-xchange properties of high polymers, and exploratory ork commenced on the 'Wofatits'. In the field of dhesives, work has been carried out to improve the tting of resins from monohydric phenols and also f rescorcinol-formaldehyde resins. A cold-setting sorcinol-formaldehyde glue S.R.38, developed in 944–45, has shown excellent strength and durability. study has also been made of glues for light alloys.

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* Department of Scientific and Industrial Research. Report of the Chemistry Research Board for the Period 1938–1946, with Report of the Director of the Chemical Research Laboratory for the Year 1946. Pp. iv + 68. (London: H.M. Stationery Office, 1948.) 1*s*. 3*d*. net.

The Coal Tar Section has completed and brought to operation an all-metal semi-scale fractionating lumn and has used the column in the preparation f a tar-oil fraction containing the two methyl-aphthalenes. A high-vacuum pumping system has een set up to manipulate highly purified and ygroscopic materials. A new expression has been educed for the relationship between differential anges of composition with boiling-point and applied the quantitative calculations of the changes in mposition with temperature of the azeotrope rmed between ethyl acetate and ethyl alcohol. esults obtained in the separation of 2 : 6-butidine, picoline and γ-picoline by azeotropic distillation ith acetic acid are recapitulated in the report, and method worked out for the separation of crude ylole fractions has been applied to the examination a number of crudes of different origin. Some work as been done on the fractionation of lutidine bases, d a method of estimating acenaphthylene in enaphthene based on ultra-violet absorption spec-ography has been applied to the determination of e acenaphthylene content of the crude material rmed in the dehydrogenation of acenaphthene.

In the Organic Intermediates Section, preliminary ork on organic compounds from boron was not romising; the chief attention was therefore given the organic compounds from silicon, including the rect synthesis of methylchlorosilanes and their paration by fractional distillation and alcoholysis, d the preparation of organo-silica resins and astomers. Results obtained in the hydrogenation metallic salts of fatty acids indicate that lead salts ay prove superior to those of copper.

The report of the Chemistry Research Board itself fers to many of these investigations, which are scribed in somewhat greater detail in the Director's port. The former report also mentions the estab-hment, on the Board's recommendation, of a joint nel on acetylene chemistry, with the Director of e Laboratory as chairman, between the Department Scientific and Industrial Research and the Ministry Supply, to consider the present position of the search on and development and production of etylene in the United Kingdom and its utilization an intermediate product in chemical industry. he Board has also recommended the resumption of ork on the 'Oxo' reaction between olefins, carbon onoxide and hydrogen to yield aldehydes. Reference the work of the Laboratory during the war years very brief; but among its contributions to the war fort thus singled out for mention is the rotor test r assessing the relative value of a variety of pro-ctive coatings, the evaluation of anti-freeze aterials and the discovery of the inhibitive pro-rties of sodium benzoate, both as an addition to ueous solutions and when incorporated in wrapping materials. A long series of experiments in the Laboratory showed that suitable carbon blacks could be prepared from indigenous material, particularly coal tar products, and a highly successful foam for fighting petrol fires was also developed from indigenous sources. Much attention was given to the development of a food yeast from *Torula utilis* as an insurance against possible shortage of protein food, and on the basis of this war-time research and development, the Colonial Office has now erected a full-scale plant in Jamaica. The shortage of derris led the Laboratory to collaborate with the Agricultural Research Council in the development of products for the control of animal parasites, and a satisfactory D.D.T. emulsion was finally formulated for the control of blow-fly on sheep.

Lists of papers published from the Laboratory during 1946 and of British patents and patent applications granted or filed during the year are appended to the report.

A summary account of current work at the Laboratory was published in *Nature* of July 17, p. 90.

PRODUCTION OF INDOLE BY *ESCHERICHIA COLI*

By Dr. EDWIN A. DAWES

Department of Biochemistry, University of Leeds

THE mechanism of the production of indole by *Escherichia coli* has attracted the attention of many workers since Hopkins and Cole[1] first demonstrated that the precursor of indole is tryptophan. The problem is an intriguing one among the bacterial degradation of amino-acids, inasmuch as fission of a carbon–carbon bond occurs at a position in the molecule remote from the amino- and carboxyl-groups, instead of the more usual carbon–nitrogen split. It became even more intriguing when an exhaustive survey of theoretically possible intermediates in the reaction failed to give rise to indole in the presence of the organism.

In 1922, Frieber[2] described a series of growth experiments in which tryptophan in the growth medium was replaced by various indole derivatives, and he found that no indole was produced from 3-indolecarboxylic acid, 2 : 3-indoledicarboxylic acid, skatole, 3-indolealdehyde, 3-indoleacetic acid, β-3-indolepyruvic acid and β-3-indole-ethylamine. In spite of the failure of 3-indoleacetic acid to give rise to indole he postulated that the reaction occurred in two stages, namely: (1) formation of 3-indoleacetic acid; and (2) the breakdown of this compound to indole; only the former occurring in the presence of fermentable carbohydrate.

Harden[3], in 1930, gave the reaction as follows: Tryptophan → β-3-indolepropionic acid → 3-indoleacetic acid → indole.

Extensive work on this subject appeared in 1935 by Woods[4] who, using the washed viable cell suspension technique, demonstrated that five atoms of oxygen are required for the complete oxidation of one molecule of tryptophan, and that *D*-tryptophan is not metabolized; and he presented strong presumptive evidence for the anaerobic production of β-3-indolepropionic acid (cf. Hopkins and Cole[5]). He also investigated the action of cell suspensions of *Esch. coli* on various possible intermediates[6], and he was forced to reject Harden's hypothesis[3] and also that of Raistrick[7] based on analogy with histidine metabolism. Compounds tried included those used by Frieber[2] and also β-3-indoleacrylic acid, all of which gave no indole production. β-3-Indolepyruvic acid, but only in the presence of ammonia, gave 10 per cent production of indole, presumably due to tryptophan being first formed.

Again in 1935, Happold and Hoyle[8], simultaneously and independently, using non-viable cell suspensions, obtained similar results to Woods with the possible intermediates, and they gave the name 'tryptophanase' to the enzyme complex which is responsible for the reaction. They went on to show that in the presence of fermentable carbohydrate the failure to produce indole is presumably due to the non-production of the tryptophanase system[9]. This observation was afterwards verified by Evans, Handley and Happold[10], in reply to criticism by Fildes[11], and they later showed that complete inhibition of indole production only occurs in the presence of phenylalanine and tyrosine[12].

Meanwhile, Baker and Happold[13] had been concerned with the determination of essential structural conditions necessary for the reaction to occur. By systematically modifying the tryptophan molecule, it was shown that an intact side-chain is necessary for indole production, and (later) that the =NH group of the indole nucleus must be unsubstituted[14]. On the basis of this work, a tentative mechanism for the reaction was suggested involving reductive fission of an intact alanine side-chain.

However, in 1942, Krebs, Hafez and Eggleston[15] suggested that β-*o*-aminophenylacetaldehyde is the effective indole-producing intermediate. They assumed that oxidation of the tryptophan molecule yields β-*o*-aminophenylethanol, which then condenses spontaneously to form indole. This was not substantiated, and the Leeds workers[14] showed that with β-*o*-aminophenylethanol the best results represented only 22 per cent conversion to indole in 18 hours, whereas with tryptophan the yield was 90 per cent in less than 2 hours; furthermore, dimedon completely inhibited the former reaction but was without effect on the tryptophan–indole reaction.

The next hypothesis concerning the mechanism of the reaction was put forward by Tatum and Bonner[16] in 1944. From a study of the way in which a mutant strain of the mould *Neurospora crassa* synthesizes tryptophan from indole and serine, they postulated that the breakdown of tryptophan to indole by *Esch. coli* is a reversal of this reaction, that is, hydrolytic fission to yield indole and serine. In support of this, experiments were quoted in which inhibition of indole production is produced by the addition of serine to tryptophan in the presence of sterile washed suspensions of the organism, the effect being specific and a function of the concentration; the biosynthesis of tryptophan from indole and serine was also claimed. The biosynthesis of tryptophan by *Esch. coli* was not verified by Fildes[17] or the present author.

Since all the 3-indolyl derivatives tried failed to give rise to indole, the hypotheses of Baker and Happold[13] and Tatum and Bonner[16] involving fission of the intact side-chain, as alanine and serine respectively, were eminently attractive. Dawes, Dawson and Happold[18] conducted an analytical investigation of the reaction employing paper chromatography, and making use of Dawson's[19] observations of the effect of 'Mepacrine' on the tryptophanase activity of *Esch. coli*. Dawson showed that under the influence of 'Mepacrine' there is no oxygen uptake by washed cells over an initial 6 minutes while indole is produced in reduced amount The possibility of oxidation of any intermediate i these circumstances is much reduced, and under suc conditions alanine was detected whereas serine wa never found, thus strengthening Baker and Happold' hypothesis. Attempts to produce alanine by chemica reductive fission of tryptophan using Raney nicke catalyst failed, although indole was produced. Thi may not be due to true reductive fission but rathe the catalytic effect of a heavy metal on tryptopha as in Herzfeld's[20] experiments, and more recently i the work of Kuiken, Lyman and Hale[21].

The inhibitory action of serine on indole formatio was shown to depend on the degree of saturation o tryptophanase with tryptophan, and to be not simpl a function of concentration; while the possibility o a phosphoclastic fission occurring to yield indole an serinephosphoric acid was examined by pape chromatography and rejected.

Dawes, Dawson and Happold[22] obtained th enzyme in the cell-free state and investigated th action of various recognized inhibitors[23,24] on it. I this way evidence was obtained for the presence o carbonyl and iron-containing components, whil spectrophotometric analysis furnished evidence of nicotinamide system; iron was detected by spectrochemical analysis. The enzyme could be resolved b dialysis, and riboflavin was shown to be present i both apoenzyme and dialysate by microbiologica assay. Reactivation of the apoenzyme was achieve with pyridoxal phosphate, riboflavin and diphosphopyridine nucleotide. Crude enzyme extracts performed the reaction with consumption of five atom of oxygen, but the partially purified enzyme produce indole anaerobically as recorded by Wood *et al.*[25] Such samples required only pyridoxal phosphate a coenzyme, and hence riboflavin and diphospho pyridine nucleotide appear to be concerned in th further oxidation of the pyruvic acid first formed purification removes the enzyme(s) concerned in this

However, that alanine is not the normal inte mediate in indole production was shown by Wood Gunsalus and Umbreit[25], who partially purified th enzyme by ammonium sulphate fractionation an found that it was then resolved and could be re activated by pyridoxal phosphate. This enzym would not deaminate alanine or serine, while sti producing indole from tryptophan, and hence neith could be intermediates in the reaction; the produc of the reaction are one mole each of indole, pyruvi acid and ammonia, and no oxygen is taken up in th process.

It seems a pity that Wood *et al.* call the enzym which effects the fission 'tryptophanase', when th term was originally used to connote the complex pe forming the complete oxidation. An iron-containin system appears to function in the overall oxidatio reaction, and it is significant that verdoperoxida and cytochrome *c* both stimulate indole productio

The Michaelis constant of tryptophanase is give as $2\cdot5 \times 10^{-5}$ by Wood *et al.*, but they state that t half maximum reaction-rate is obtained with 35 μg tryptophan per ml. and this gives a K_M value 1·7 × 10^{-4} and is more in accord with the autho figure of $4\cdot1 \times 10^{-4}$.

The fact that indole is formed anaerobically rais interesting speculation on the claims of Hopkins an Cole and Woods that β-3-indolepropionic acid produced in anaerobic culture; strain differences ma well account for this. However, the search for inte ediates in the reaction has now been cleared up by Vood *et al.*, although α-aminoacrylic acid may be he primary fission product (this would decompose pontaneously to pyruvic acid and ammonia in queous medium), and the reaction is a balanced one om the oxido-reduction point of view. The detection f alanine in the presence of 'Mepacrine' may be due a diversion of the normal reaction path, such as ydrogenation of α-aminoacrylic acid, or to reaminaon of the pyruvic acid product.

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EXCITATION PROCESSES IN MOLECULAR NITROGEN

By R. W. NICHOLLS

Imperial College of Science and Technology, London

N controlled electron experiments it has been usually assumed[1] that in the emission of the triplet nds of molecular nitrogen, transitions to the upper vels of the band systems concerned come about rectly as a result of collisions of the first kind beeen molecules in the ground-state $X^1\Sigma_g^+$ and fast ctrons. A further assumption made is that the ergy values of the upper states of the bands ncerned are the voltages at which they respectively pear when excited by an electron beam of conlled energy. These assumptions lead to the placing the triplet-levels approximately 2 volts higher an the normally accepted values based on reliable ectroscopic evidence[2]. In particular, the $A^3\Sigma_u^+$-el would be placed about 2 volts above the value gested by the analysis of the Vegard – Kaplan nds $A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$.

The results of these experiments[1], which are reasonly consistent, are summarized in the table on p. 232. It would seem, therefore, that the assumptions mentioned are in error. This view is further strengthened by the following facts.

(1) Only singlet systems are obtained in absorption experiments in nitrogen, namely, the Lyman – Birge – Hopfield and Birge – Hopfield bands. The triplet bands do not appear in absorption, and consequently as electron and photon collisions with molecules generally result in the same excitation, it would be expected that electron collisions with ground-state molecules would excite the singlet- rather than the triplet-levels.

(2) The multiplicity change (singlet-triplet) involved in direct excitation of the triplet-levels from the singlet ground-state makes such a transition forbidden, and therefore a relatively rare event, both in the case of electron collisions and of photon collisions.

It is the purpose of this note to suggest a more probable excitation process which accounts for the observed experimental results without incurring an artificial raising of the triplet-levels, and which violates neither the selection rules nor the Franck – Condon principle.

It is suggested that primary excitation by collisions between ground-state molecules and electrons results in the population of the singlet-levels: $a^1\Pi$ and b. b^3 is a group of eight levels between 12·5 and 14 volts (the upper states of the Birge – Hopfield and Gaydon bands), which for the purposes of this discussion may be considered together. By analogy with the atomic case[4], we expect the excitation probability function of a level for non-intercombination (singlet-singlet) transitions to rise from zero at the energy of the level in question to a broad maximum somewhat above it. A singlet-level will therefore be most populated when the exciting electrons have the energy corresponding to this maximum. Population of the triplet-levels can then come about by intercombination collisions of the second kind between slow electrons and the molecules in the excited singlet-states. For such second-kind collisions to be effective, two considerations have to be taken into account: (1) The balance between the life-time of a molecule in an excited state and the collision frequency of slow electrons. This is governed by excitation conditions and depends greatly on pressure. (2) The balance between the transition probability and the probability that, on collisions between an excited molecule and a slow electron, intercombination transitions of the second kind will occur. This is governed by molecular constants only.

An analysis which has been made of the excitation kinetics of this mechanism shows it to be more likely than the one previously assumed. Details of this analysis will be published shortly.

This mechanism was suggested primarily by a comparison of the energies of the singlet-levels with the electron energies at which the triplet bands appeared (see table). The appearance potential of the first positive bands, *after correction by extrapolation to the* (0,0) *band*, is approximately 9·5 volts, which is about the value for the maximum excitation probability of the $a^1\Pi$-level. The appearance potential of the second positive bands is approximately 13 volts, which again is very near the maximum probability of excitation of the b-levels. The fact that the first positive appears at approximately 9·5 volts on the excitation of the $a^1\Pi$-level, and that it is not fully developed until the second positive bands appear at approximately 13 volts, reaching a maximum with

	Energy-levels			Band systems	Appearance potentials (volts)	Remarks
	Singlets	Energy (volts)	Triplets			
N_2	$X^1\Sigma_g^+$ (ground-state)	0		$A^3\Sigma_u^+ \to X^1\Sigma_g^+$ Vegard – Kaplan		Forbidden transition
		6·2	$A^3\Sigma_u^+$			
		7·3	$B^3\Pi_g$	$B^3\Pi_g \to A^3\Sigma_u^+$ First positive	9·3 (S), 9·4 (V), 9·5 (D)	Fully developed on excitation of second positive, maximum intensity at ~ 15 volts
	$a^1\Pi_g$	8·5				
		11	$C^3\Pi_u$	$C^3\Pi_u \to B^3\Pi_g$ Second positive	12 (D), 13 (S), 13·16 (T, W), 13·4 (V)	Maximum intensity at ~15 volts
		12·8	$D^3\Sigma_u^+$	$D^3\Sigma_u^+ \to B^3\Pi_g$ Fourth positive	15 (D)	Maximum intensity at ~20 volts
	b (8 levels)	$\left\{\begin{matrix}12{\cdot}5\\14\end{matrix}\right.$				
N_2^+	Doublets			$B'^2\Sigma_u^+ \to X'^2\Sigma_g^+$ First negative	18 (D), 19 (S)	Maximum intensity at ~ 80 volts
	$X'^2\Sigma_g^+$	15·6				
	$B'^2\Sigma_u^+$	18·7				

(S), Sponer; (D), Duncan; (T, W), Thompson and Williams; (V), Vegard.

them, strongly suggests that the primary population of the B^3 -vibrational-levels, below the $a^1\Pi$-level, is due to collisions of the second kind between slow electrons and molecules in the $a^1\Pi$-state, while the secondary population of the $B^3\Pi$-levels, especially those which lie above the $a^1\Pi$-level, results from the emission of the second positive bands $C^3\Pi \to B^3\Pi$. A further factor contributing to the population of the $B^3\Pi$-levels, when b is excited, would be collisions of the second kind between slow electrons and molecules in the b-state. The fourth positive system $D^3\Sigma \to B^3\Pi$ appears at 15 volts when certain of the b-levels which lie above the $D^3\Sigma$-level become populated, and reaches a maximum intensity at approximately 20 volts. Owing to the metastability of the $A^3\Sigma$-level, numerous collisions of the second kind with slow electrons will be probable. A radiationless $A^3\Sigma \to X^1\Sigma$ transition will therefore be more likely than the emission of the Vegard – Kaplan bands in most usual forms of discharge in nitrogen. The first negative system $B'^2\Sigma \to X'^2\Sigma$ of N_2^+ will be excited directly by first-kind collision between ground-state $X^1\Sigma$ N_2 molecules and fast electrons.

The mechanism thus adequately accounts for the observed excitation potentials in terms of known levels of nitrogen. Further facts in its favour are:

(1) It is in accordance with the Franck – Condon principle in initial excitation.

(2) There is no change in multiplicity in the initial excitation.

(3) The recently proposed g symmetry of the $a^1\Pi$-level[5] renders that level metastable, thus raising the excitation life-time and making collisions of the second kind even more probable. Although the metastability tends to make the initial excitation less probable, the fact that the singlet bands appear in absorption shows that it can, and does, occur with a greater probability than the singlet-triplet excitation. The long path-length required for this absorption to occur provides experimental evidence for the met stability, as was pointed out by Herzberg[5].

The above ideas are a result of work attempting correlate spectroscopic and electrical observations a glow discharge in nitrogen. Should the suggeste mechanism prove to be correct, it may have a important bearing on auroral excitation, since man current theories of the aurora include direct single triplet excitation of neutral nitrogen, N_2, by electron

I should like to express my grateful thanks Dr. R. W. B. Pearse for valuable discussions on th subject.

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INTERNATIONAL GEOLOGICAL CONGRESS

PREPARATIONS are now well advanced for t Eighteenth Session of the International Geologic Congress. So far about 1,500 geologists, representi some sixty countries, have registered as membe The programme of long excursions associated wi the Congress begins on August 7.

The Session will be formally inaugurated at meeting of the General Assembly in the Royal Albe Hall on August 25, when Mr. Herbert Morrison w welcome the delegates and members on behalf of t British Government, and Sir John Anderson, honora president of the General Organising Committee, w speak on behalf of that Committee. Prof. H. J Read, president of the Geological Society of Londo is president-designate of the Session.

During the following days there will be an extensive eries of sectional meetings, at which about two undred and fifty papers, of which only a few can e mentioned in this notice, and covering a very ide range of topics, are due to be presented.

In the Section on Problems of Geochemistry, uestions connected with the development and igration of magmas and the genesis of ore deposits, he geochemical history of single elements, and the rigin of serpentines will be discussed by distinguished ontributors, including Dr. N. L. Bowen of Washingon, Prof. H. von Eckermann of Stockholm, Prof. P. iggli of Zurich and Prof. W. Wahl of Helsingfors. n another petrological section, devoted to "Metaomatic Processes in Metamorphism", the 'magmasts' and the 'transformists' will present contrasting iews on the respective importance of magmatic and ydrothermal penetration and of solid diffusion in the rocess of granitization and of metamorphism in eneral. The contributors include Prof. P. Eskola of inland, Prof. N. H. Magnusson of Stockholm, Prof. . Wegmann of Neuchatel, Prof. H. G. Backlund of ppsala, and Prof. Ian Campbell of California.

Stratigraphical and palæontological problems will e discussed by several sections. The Section on hythm in Sedimentation will include papers by rof. R. C. Moore, Dr. H. R. Wanless, and other merican authors on cyclic sedimentation in the alæozoic Rocks of the United States, and by Prof. . F. Troedsson of Stockholm and other authors on hythm in the Mesozoic and Tertiary sediments of urope. Prof. A. Renier of Brussels, Dr. S. J. Dijkstra f Heerlen, Prof. Y. C. Sun of Peiping, Dr. J. J. orsky of Leningrad, and Dr. F. K. G. Mullereid of exico City are among contributors who will deal ith general and regional problems of facies corelation in the Section on Faunal and Floral Facies nd Zonal Correlation. The correlation of continental ertebrate-bearing rocks will be discussed in a eparate section, and the overseas contributors nclude Dr. C. Teixeira of Lisbon, Mlle. M. Richard f Algiers, Dr. R. A. Stirton of California and Prof. rik Stensiö of Stockholm. This Section will also old a joint meeting with the Section on the Pliocene–leistocene Boundary. The latter will attempt to each an agreed definition of the lower limit of the leistocene System by synthesis of the views of ecialist contributors, including Dr. L. S. B. Leakey f Kenya, Dr. A. Halicka of Warsaw, Dr. D. N. adia of India, Prof. van der Vlerk of Leyden, Prof. . Migliorini of Florence and Prof. C. Arambourg of aris. Another section will discuss the relation etween earth movements and organic evolution, nd includes papers by Drs. K. Zapletal and L. V. ěpek of Czechoslovakia, Academician V. A. Obruchev f Moscow, and Dr. A. Chavan of Nanterre.

An interesting field of inquiry is covered by the ection on the Geology of Sea and Ocean Floors. In is a number of American geologists will describe cent work on submarine geology of the Northern arshalls, including recent borings on Bikini Atoll; nd Prof. C. Francis-Bœuf of Paris will speak of the se of the 'Bathyscaphe-Piccard-Cosyns' in subarine studies. Other contributors are Prof. R. M. ield of Princeton, Prof. P. H. Kuenen of Groningen, nd Dr. J. S. Lee of Nanking.

Three sections are specifically devoted to applied eology. A symposium on the geology, paragenesis nd reserves of the ores of lead and zinc has been repared under the editorship of Dr. K. C. Dunham nd will be discussed by a special section. Its assessment of world reserves suggests that little more than about nineteen years production of lead ores and twenty-four years production of zinc ores can be foreseen. The Section on the Geological Results of Applied Geophysics will deal with recent magnetic, electrical, gravitational and seismic work on diverse problems in many countries. The Section on the Geology of Petroleum will include a wide range of papers on general and regional subjects, among which recent work in the oilfields of the Middle East is prominent.

There is also a section in which a great variety of miscellaneous papers will be presented. Among these, tectonic studies predominate, and the authors include Prof. A. Noe-Nygaard of Copenhagen, Prof. O. Holtedahl of Oslo, Prof. A. Demay of Paris, and Dr. A. Heim of Zurich.

The Association des Services Géologiques Africains will hold a series of open meetings at which a synthesis of research on African geology during the last decade will be attempted, and problems of correlation within the African continent will be discussed. The International Palæontological Union will also hold open meetings, including one specially devoted to the stratigraphical use of Foraminifera and another to the nomenclature of fossils. A series of special meetings on the mineralogy and geology of clays has been organised in conjunction with the Clay Minerals Group of the Mineralogical Society.

Three major items in the technical programme are special addresses on the structural history of Britain, by Sir Edward Bailey and Prof. O. T. Jones, who will respectively deal with Scotland and with England and Wales; and a colour film and lecture on the new Mexican volcano Paricutin, presented by Dr. F. H. Pough of the American Museum of Natural History.

During the period of the Session receptions will be given by H.M. Government, by the Geological Society of London, the University of London and a number of other authorities and institutions.

A series of ninety-six day and half-day excursions demonstrating the geology of south-eastern England will take place during the period August 20–September 4. After the closing meeting of the General Assembly on September 1, there will also be another series of seventeen long excursions covering practically the whole of Great Britain and Eastern Ireland.

CONDENSATION OF INTERSTELLAR MATERIAL INTO STARS

F. HOYLE has suggested (*Mon. Not. Roy. Astro. Soc.*, **107**, 4; 1948) a criterion for determining the degree of condensation of interstellar material into stars. Observational data for disk-shaped nebulæ, such as *M* 31 and *M* 33, suggest that only a small fraction of the total mass is in the form of stars, whereas Oort has found that the elliptical nebula NGC 3115 must be almost entirely composed of stars. The paper is devoted to a consideration of the factors that determine the fraction by mass of a nebula that is condensed into stars, and a new method for attacking this problem is developed which suggests that condensing stars with masses exceeding 0·2 that of the sun must become rotationally unstable before reaching the main sequence stage, and such stars must evolve by ejecting material until their masses are reduced below the critical value. Present available information suggests that the ejected material is thrown off to infinity, and hence stars forming in the main body of nebulæ such as *M* 31 or *M* 33 have masses less than 0·2 that of the sun at the time of condensation to the main series state; but the masses can afterwards increase by accretion of interstellar matter. The application of the criterion shows that we should expect both the nuclei of disk-shaped nebulæ and the elliptical nebulæ to be almost entirely condensed, but the main body of a disk-shaped nebula such as *M* 31 would be largely uncondensed. The highly condensed state of the nuclei of disk-shaped nebulæ and elliptical nebulæ receives an important application in determining the ages of the extragalactic nebulæ, and Hoyle shows that these are of the order 5×10^9 years.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Plant Pathologist (Scientific Officer Grade), and a Field Officer (Experimental Officer Grade), in connexion with potato storage investigations at the University of Nottingham, Sutton Bonington—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (August 14).

Charles Brotherton Scholarship and United Kingdom Gas Corporation Scholarships in the Department of Coal Gas and Fuel Industries with Metallurgy—The Registrar, The University, Leeds 2 (August 14).

Technical Assistant (Grade B) in the Botany Department, chiefly for mycological work—The Secretary and Registrar, University College of North Wales, Bangor (August 14).

Assistant Lecturer (Grade III) in Geology—The Secretary, The University, Edmund Street, Birmingham 3 (August 14).

Research Fellow to lead a research group engaged on work connected with the chemical constitution of coal, and two Research Workers—The Secretary, The University, Birmingham 3 (August 15).

Lecturers in (*a*) Physics, with subsidiary Mathematics, (*b*) Electrical and Mechanical Engineering, in the Ministry of Supply School of Electronics, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (August 16).

Lecturer in Civil Engineering—The Registrar, The University, Leeds 2 (August 16).

Lecturer in the Department of Geology with special qualifications in Mineralogy and Petrology—The Registrar, The University, Manchester 13 (August 20).

Principal Scientific Officer to lead a team engaged in experimental and design work, involving problems of pilot plant for chemical engineering, heat transfer and development of special instrumentation and remote control methods, and Senior Scientific Officers for experimental and design work, involving similar problems, in the Engineering Division of the Atomic Energy Research Establishment, Harwell, Berks, under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W., quoting No. 2205 (August 26).

Lecturer (Grade IIc or IIb) in the Department of Chemical Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (August 30).

Lecturer in Psychology in the University of Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W. 1 (August 31).

Demonstrators in Biology and Chemistry—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (August 31).

Physicist to the Department of Radiotherapy—The Superintendent, Guy's Hospital, London, S.E.1 (August 31).

Senior Organic Chemist in the Biochemistry Section for work on the organic constituents of fruit-bearing plants—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 31).

Lecturer in Mathematics—The Registrar, University College, Southampton (September 4).

Lecturer or Assistant Lecturer in Mathematics, with special qualifications in Applied Mathematics—The Registrar, University College of Wales, Aberystwyth (September 4).

Tutorial Studentships in Electrical Engineering, and Organic Chemistry in the Department of Physiology—The Registrar, King's College, Strand, London, W.C.2 (September 13).

Director of Museums—The Town Clerk, City Chambers, Glasgow, W.2 (September 15).

Professor of Civil Engineering in Natal University College—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 15).

Mullard Readership in Electronics at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 15).

Lecturer in Graphics and Machine Drawing, a Lecturer in Entomology, a Senior Lecturer in Organic Chemistry, and a Senior Lecturer in Inorganic Chemistry—The Registrar, Rhodes University College, Grahamstown, South Africa (September 15).

Senior Lecturer in the Department of Botany—The Registrar, The University, Manchester 13 (September 17).

Readership in Mathematics at Birkbeck College—The Academi Registrar, University of London, Senate House, London, W.C.1 (September 22).

Readership in Civil Engineering at King's College, Strand—Th Academic Registrar, University of London, Senate House, Londo W.C.1 (October 1).

Economic Botanist in the Department of Agriculture, Britis Guiana, to take charge of the Central Rice Station—The Director o Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Technician in Chemistry Department—The College of th Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

Ecologist in the Tsetse Control Department, Government o Uganda—The Director of Recruitment, Colonial Service, 15 Victori Street, London, S.W.1.

Controller of Agriculture in Cyrenaica—The War Office C.4(E), Room 447, Metropole Buildings, Northumberland Avenue London, W.C.2.

Entomologists for advisory and research work on crop pests and special research on the sisal weevil, on the staff of the Government o Tanganyika—The Director of Recruitment, Colonial Service, 1 Victoria Street, London, S.W.1.

Lighting Engineers, Heating and Ventilation Engineers, an Technical Research Officers, in the Factory Standards and Desig Branch of the Australian Department of Labour and National Servic —Mr. T. C. Graham, Australia House, Strand, London, W.C.2.

Game Ranger in Tanganyika, and a Game Warden in the Gol Coast—The Director of Recruitment, Colonial Service, 15 Victori Street, London, S.W.1.

Head of the College—The Clerk, National College of Rubbe Technology, Northern Polytechnic, Holloway Road, London, N.7.

Chief Computor in the Survey Department, Nigeria—Th Director of Recruitment, Colonial Service, Colonial Office, Sanctuar Buildings, Great Smith Street, London, S.W.1.

Lecturer in Mathematics in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2

Senior Laboratory Steward (chemistry and biology)—Th Bursar, Merchant Taylors' School, Sandy Lodge, Northwood, Middx

Research Assistants (2, men or women) in the Department o Chemistry for work in physical-organic chemistry—The Professor Chemistry, Royal Holloway College, Englefield Green, Surrey.

Lecturer or an Assistant Lecturer in Geology—The Registrar The University, Nottingham.

Assistant Manager of the acid and ammonia works at Phoeni Wharf, East Greenwich—The Secretary, South Metropolitan Gas Co. 709 Old Kent Road, London, S.E.5, endorsed 'Assistant Manager—Chemical Works'.

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SCIENCE AND ITS SOCIAL RELATIONS

THE resolutions adopted by the Committee on Science and its Social Relations of the International Council of Scientific Unions at its meeting in Paris during June 15–16, and which have been forwarded to the scientific press and to scientific institutions, reflect faithfully the trend of thought among a considerable body of scientific men throughout the world. The recent review of the work of the Rockefeller Foundation in 1947 by its president, Dr. Raymond B. Fosdick, gives witness to similar views. At this meeting, Dr. C. H. Desch was the only British representative, Prof. F. J. M. Stratton, who was chairman during 1937–48, having retired on appointment as deputy scientific adviser to the War Office. The resolutions were the outcome of extensive discussions on the method of working to be adopted by the Committee and on its future programme of work, and in this connexion the first resolution affirms the opinion of the Committee that the most urgent problems of the social relations of science are to-day, first, the dangers threatening science from the fact that research in large measure has become dependent on military sources and on industry for its financing, and secondly, the way in which the results of science are actually introduced into society.

Both these problems were emphasized by the Committee in the circular letter issued in October 1947, and the first is the subject of keen debate in the United States at the present time. While the extension of Government research is regarded with a measure of distrust, a couple of recent articles indicate like concern at the growing practice of using university laboratories for the conduct of research sponsored by industry, and urge that the support which industry gives to university research should not be tied to the financing of particular projects, beyond designating a broad general field of research. Mr. S. Tout condemns outright the arrangements announced in the *New York Times* last January between seven industrial firms and the University of Chicago in regard to atomic research as not in the public interest. He urges that universities and like institutions should discontinue research for private enterprise and limit themselves to research for the public benefit.

The position in this matter varies from one country to another, and there does not appear to be any reason for believing that in Great Britain there is at present any serious danger that the direction of academic research is being deflected by industrial endowment. Endowments, such as the research fellowships established by Imperial Chemical Industries, Ltd., or Turner and Newall, Ltd., are entirely free from such restrictions other than that the research is to be conducted in some specific branch of science. Any malaise in Britain is rather related to the dangers arising from the subvention of research from military sources to which the Committee on Science and its Social Relations directs attention in its third resolution. The Committee believes that the increasing influence of the military on scientific research will lead sooner or later through its secrecy restrictions to the abrogation of the traditional freedom of expression and of publication, and will result in directed research not planned primarily for the benefit of science and mankind but rather for its destruction.

While it is possible that the fears entertained on this point are exaggerated, it seems just as certain that the Atomic Energy Commission must concern itself with the social implications of atomic power; for it is on that matter that liberty and equalitarian democracy become incompatible. Dr. M. H. Stone, of the University of Chicago, pointed out last year in *Science* (**105**, 507; 1947) that the Commission would have to concern itself with many questions which fall within the domain of the social sciences, and that it is important that similar attention should be given to the social effects of many other innovations flowing from our laboratories. Dr. Fosdick, in the Rockefeller Foundation report referred to above, clearly had the same point in mind when, in discussing the unity of science, he referred to the way in which the activities of the Institute for the Unity of Science in New York, towards which the Foundation made a grant in 1947, included research which cuts across the traditional demarcation lines of specialized disciplines and departments, the utilization of new knowledge in logic, the study of meaning and how it is communicated, and research on the philosophical, psychological and sociological backgrounds of science.

More important, however, in this connexion is the stress which Dr. Fosdick lays elsewhere in his report on the dependence of the health of the intellectual life of the world upon the free and unhampered exchange of ideas and personnel between universities and research institutions in all countries. Achievement is usually the result of the sustained thinking of many minds driving toward a common goal in many countries. The creative spirit of man, Dr. Fosdick once more reminds us, cannot be localized or nationalized. Ideas are starved when they are fenced in behind frontiers, and barricaded research in the long run leads to intellectual stagnation.

This is why Dr. Fosdick considers that the heavy concentration in the United States of research in atomic physics is unfortunate. However necessary for the time being from the security point of view, from the point of view of the growth of knowledge the arrangement is unhealthy. All knowledge is so interlocked that we cannot control research on the destructive aspects of atomic energy without at the same time interfering with world-wide research on its beneficent possibilities. Those American men of science who suggested the postponement indefinitely of the industrial development of atomic power not only recognized the impracticability of separating the development of nuclear power for industry from the growth of atomic-bomb power, but also that in the harnessing of forces which might bring incalculable benefit to mankind, knowledge could be retarded through lack of the cross-fertilization brought about by the exchange of knowledge.

Dr. Fosdick observes further in this connexion that in the history of modern science no single country by itself has ever had the intellectual resources or the imagination to bring to full fruition all the pote tialities of a new idea, and he comments on t unfortunate growing isolation of the scientific work and scholars of Eastern Europe. The high level creative research of the distinguished mathematicia of the Soviet Union, her imaginative work in bi medicine cannot be maintained if the Soviet Gove ment prevents direct and intimate relations wi workers in these same fields in other parts of t world. Isolationism is a blight which saps t vitality of everything it seeks to preserve.

Set in this context, the statement issued in Gre Britain in July by the Atomic Scientists' Associati seems lamentably weak and compares poorly wi the report "Policy at the Crossroads" in which t U.S. State Department has recently summarized t efforts of the United States and other Governme during the last two years to secure the adoption of effective system for the control of atomic energ Undoubtedly it is clearer than it was in 1946 that t sources of disagreement between the major Pow are so deep that the institution and working of control scheme are much more difficult than at fi supposed, and that there is little chance of agreeme at the moment on the lines of the Lilienthal propos or on any more limited scheme. The United Stat Government is naturally enough unwilling to aband its lead in atomic weapons without a comple system of inspection and control which would ensu that no other country was building up such arn ments to use against America. On the other har the Soviet Union believes that in any control authori acceptable to the United States, the countries voti with the U.S.S.R. would be in a minority and th the development of atomic energy in the U.S.S. would pass under foreign direction. The attitude Soviet Russia may also be determined by the vi that any complete scheme of inspection would gi the outside world information of strategic va about the location of their industry.

While, therefore, a substantial change in int national relations is necessary before any such pla can be revived with any hope of success, the Coun of the Atomic Scientists' Association quite righ records its continuing belief that some form international control is the most desirable ultima solution of the problem of atomic weapons. T Council believes that the solution can now be soug only through the constant promotion of all measu designed to make war less likely, and to reach settlement between East and West. In its anxie to avoid taking sides, however, the Council of t Association has become vague. The commenda attempt to avoid political bias is carried too far wh it avoids passing judgment on the facts. It is scarc an act of partisanship to point out that the man science in the modern totalitarian State is essentia a servant of the State, and that it is treason, as inde the law promulgated last year in the U.S.S. illustrates, for him to divulge any knowledge wh ever, save as the State allows. The Association d less than justice to the respect of British and Americ scientific workers for the full tradition of scient freedom, or to their freely expressed impatience very restriction imposed on them in the name of ecurity. No instinctive inhibitions will hamper British or American scientific workers in the exchange f scientific information; but it is at least arguable hat collaboration as suggested by the Atomic cientists' Association is more likely to promote, for he present, a one-way traffic to the disadvantage of he Western democracies. That is undoubtedly the eal reason why the American–Soviet Science Society as had to cease its efforts to promote the interchange f scientific ideas between American and Soviet ientific workers. If an improvement in political lations is a first condition of cultural intercourse, e Atomic Scientists' Association may well have jected a shade too cursorily the proposal for a oratorium in the development of atomic energy, or at a control scheme should be established of ose nations which were willing to submit to the sential inspection and other measures.

No one would pretend that such a partial control heme would eliminate the need for secrecy, though might limit the area, and it could not well intensify e suspicion which already exists between East nd West. What it could do is demonstrate the acticability of inter-nation control over an area in hich political conditions and relations gave the ntrol a chance to operate, and in this way it might ermit international control in the full sense to be hieved at an earlier date once the political situation the world as a whole had become favourable. The ommittee on Science and its Social Relations does ot touch on this specific problem; but in more eneral terms points out that the actual problems volved in all social relations of science are problems ncerning men's attitude to scientific knowledge and its application, in particular, to the power given by ience.

For this reason the Committee proposes to address self to a number of scientists, sociologists, persons rominent in educational work, and others to ascer-ain their opinions on the measure in which the ethods of international scientific work contribute the creation of an international spirit and to the aintenance of peace and on the ways in which ientific organisations and scientific men could tensify their activities for the maintenance of peace. his inquiry should be terminated before the end of eptember 1948, and the results will be presented to e secretariats of the United Nations Organisation d of its Educational, Scientific and Cultural rganisation as well as to the International Scientific nions. It appears from the memorandum that the ommittee contemplates investigations into these roblems with the help of psychology, the social iences, economics and juridical science as well as of e medical, agricultural and engineering sciences. particular, the Committee urges the United Nations ducational, Scientific and Cultural Organisation to omote the formation of international organisations presenting the medical and the engineering sciences. is true that the composition of the Committee on ience and its Social Relations gives it little authority speak for the engineering and medical sciences: en for the physical sciences its basis may well be regarded as altogether too narrow to be representative. If that limitation is kept in mind, the proceedings at its meeting last June demonstrate that the Committee should nevertheless prove of real value in indicating gaps in the field which need attention, and in stimulating thought about general and particular problems.

In both respects it can be claimed that the present memorandum merits careful consideration by the world of science, and as Dr. Lampitt recently remarked in Edinburgh, at the annual meeting of the Society of Chemical Industry, too little is known, in Great Britain even, of the work of the international unions. Besides its observations on the danger to science inherent in subvention from military science, the Committee elaborated the principles of a Charter for Scientists which deserve full discussion, and in particular from the point of view of their practicability in industrial as well as in Government employment. It also focuses attention on two other principal aspects of the social relations of science: the changes introduced in human societies through technological developments of science; and the antagonisms between biological order and social order.

In regard to the first of these, the Committee suggests for investigation as soon as possible, in addition to subjects already proposed by the secretariats of the Natural Sciences Section of the United Nations Educational, Scientific and Cultural Organisation, the effect on society of such developments as vitamins, new races of wheat and other food grains, artificial insemination, television, products derived from nylon, antibiotics, sulphonamides, etc., and the medical applications of artificial radioactive elements. As a first step, it is proposed to create two subcommittees to consider the formation of study groups to investigate the various items, and another subcommittee will be formed to organise meetings of specialists where the points of view of the biologist, the sociologist and the psychologist can be brought to bear on the explanation of antagonisms between human biology and society.

The Committee on Science and its Social Relations may thus be making a much more vital contribution to the development of international understanding than the Atomic Scientists Association or like bodies are able to do at the present time. It is, of course, important that there should be no duplication of effort, and that the limitations of what is practicable at the present time should be kept in mind. Fortunately, the memorandum from the Committee on Science and its Social Relations indicates that the Committee is anxious to work harmoniously with the International Council of Scientific Unions and the United Nations Educational, Scientific and Cultural Organisation, and that it only proposes independent action where gaps are clearly seen to exist, and then by agreement as to the means to be used. There can, therefore, only be welcome for this further declaration as to the dependence of scientific advance on full freedom of communication and discussion, and for the proposals to foster fresh opportunities for contact between creative minds at those borderlands of the sciences which have in the past proved so often their fertilizing and stimulating power in intellectual effort.

LAWS AND CONSTITUTIONS

The Federalist, or the New Constitution

By Alexander Hamilton, James Madison and John Jay. Pp. lxxi + 484. (Oxford: Basil Blackwell, 1948.) 9*s.* 6*d.* net.

A Fragment on Government and An Introduction to the Principles of Morals and Legislation

By Jeremy Bentham. Pp. lxvii + 435. (Oxford: Basil Blackwell, 1948.) 9*s.* 6*d.* net.

IN an interesting comment on "The Federalist", immediately after the publication in 1788 of the last of the essays of which it is composed, Washington wrote to Hamilton: "When the transient circumstances and fugitive performances which attended this crisis shall have disappeared, that work will merit the notice of posterity, because in it are candidly discussed the principles of freedom and the topics of government, which will always be interesting to mankind, so long as they shall be connected in civil society". With the rapid increase of American power in the past half-century, and the significant emphasis placed upon the 'American way of life' in current political agitations, it is important that some effort should be made to understand the influences that have shaped the growth of the great Republic, and "The Federalist" must always stand as a revealing commentary on the struggles of its early days. Here it is presented in the simple but attractive format of Blackwell's "Political Texts" series, with a valuable introduction by Max Beloff.

The work is essentially a practical contribution to the controversies that raged about the constitution of the new United States during 1787–88; but at the same time, as Washington's comment suggests, it is concerned with some of the fundamental problems of politics. While seeking to justify the constitution, it also provided, by inference, a cautious analysis of society and of society's instrument, the State. But the analysis of society is based upon a belief in natural rights that was characteristic of the age and that had already found expression in the challenging words of the Declaration of Independence. Government and law, it was held, had the limited task of preserving natural rights, and especially the rights of property: "As long as the reason of man continues fallible . . . different opinions will be formed. . . . The diversity in the faculties of men, from which the rights of property originate, is not less an insuperable obstacle to an uniformity of interests. The protection of those faculties is the first object of government. From the protection of different and unequal faculties of acquiring property, the possession of different degrees and kinds of property immediately results; and from the influence of these on the sentiments and views of the respective proprietors, ensues a division of the society into different interests and parties. . . . A landed interest, a manufacturing interest, a mercantile interest, a moneyed interest . . . grow up of necessity in civilized nations. . . . The regulation of these various and interfering interests forms the principal task of modern legislation."

It would be unwise to read into this more than it was meant to convey; but here, as elsewhere in "The Federalist", are to be found the origins of the differences over the interpretation of 'democracy' that to-day divide east and west. Many of the ideas of the work look back to Locke a century earlier; but the framers of the American constitution were able to go far beyond Locke in basing their new system on a fundamental, written constitution. To this fact is to be attributed much of the static quality and legalistic character of the constitutional development of th United States, modified though this has been, from Jefferson to Roosevelt, by new glosses. In short "The Federalist" is a valuable contribution to th study of contemporary history. The philosopher may condemn its limitations; but it has been described as "the finest study in the economic interpretation of politics which exists in any language", and, as Mr Beloff rightly points out, "a text which can still be argued about, is a text worth reading". It has moreover, acquired a new significance through the present discussions on "Western Union".

The American Declaration of Independence was issued in 1776, a year which proved to be somethin of an *annus mirabilis*, for it saw also the appearanc of two other works of lasting influence, namely, Adam Smith's "Wealth of Nations" and Bentham's "Fragment on Government", which was itself a commentary on yet another book of importance in the politica evolution of Britain and America, Blackstone' "Commentaries on the Laws of England" (1765). In the same year, too, Bentham was working on a introduction to a new penal code, which finall appeared in 1789 as "An Introduction to the Principles of Morals and Legislation". The "Fragment and "Principles", Bentham's earliest works, now appear together in a convenient volume, introduce in a clear and balanced survey by Mr. Wilfrid Harrison. The two works, Mr. Harrison claims, "occupy special place in political theory. They are the first major works in which a clear statement is given of the nature of government as an instrument the value o which is to be judged by its effects, and in which at th same time far-reaching claims are made in regard t the potential effectiveness of government." Earli philosophers who had written of the State as a huma rather than a divine institution had concerned themselves far more with the contractual obligation underlying it than with its actual working. Bentham like the authors of "The Federalist", turned to practical issues, and sought by a critical examination o the conduct of man in society to suggest the lines o improvement. His own copy of the "Fragment", a Mr. Harrison reminds us, was inscribed by him "This was the very first publication by which men a large were invited to break loose from the tramme of authority and ancestor-worship on the field o law"; while the very opening of the work link investigation ("discovery") with "reformation".

Bentham was thus typical of the best that his ag could produce, though his influence was not widel felt until the great period of reform that opened in th eighteen-twenties, towards the end of his long lif Whether, but for the French Revolution and th horror of change that it excited, he could hav achieved more at an earlier period cannot now b decided; but the influence of this typically eighteenth century thinker of the pre-industrial era is writ larg upon the history of Britain and British ideas in th nineteenth century. That influence flowed large from Bentham, the philosophical radical of the lat period. The interest of these earlier works lies part in the optimistic view of human nature which led hi later to declare of the period in which they we written that he "never suspected that the people i power were against reform; [he] supposed they onl wanted to know what was good in order to embrac it". Utilitarianism is now a largely discredited cree but its place in nineteenth century developmen nnot be ignored. Bentham's work, vast in quantity, s fragmentary and limited in scope; but his method critical thinking, as set out, for example, in the osing words of the "Fragment", was sound, and ith "The Federalist" in mind one may read with terest its application in the "Principles" to the eas of the Declaration of Independence. "With en, who are unanimous and hearty about *measures*", entham wrote, "nothing is so weak but may pass in e character of a *reason*." The remark, and the ethod, have lost none of their validity during the riod of nearly two centuries since these words were t down.

MAURICE BRUCE

BERKELEY: FATHER OF PLANT PATHOLOGY

ytopathological Classics, No. 8

bservations, Botanical and Physiological, on the otato Murrain. By M. J. Berkeley; together with lections from Berkeley's "Vegetable Pathology" ade by the Plant Pathology Committee of the ritish Mycological Society. Pp. 108. (East Lan- ng, Mich.: American Phytopathological Society, 48.) 1.50 dollars.

MODERN farmers and gardeners are now well acquainted with the possibilities of control of lant disease. Should a new trouble be found, it is sually only a matter of time before a palliative or medy is discovered. It is, therefore, somewhat ifficult for us to realize the state of passive acceptance crop 'blights' which prevailed a century ago. We n, however, give a far greater measure of apprecia- on than could be accorded by his contemporaries to e Rev. Miles Joseph Berkeley. He, more than any ther, established on a sure foundation the concep- on of plant disease caused by parasitic fungi.

It is true that fungi had been found growing on lants to their detriment before Berkeley's classic aper on the 'potato murrain' appeared. There was, owever, no clear indication whether they were the rimary cause, or a secondary effect, of the diseased ondition. Berkeley's full powers were called forth y his celebrated literary controversy with Dr. John indley, who stated the purely physiological view at the 'murrain' was due to disturbed water lations resulting from unusual climatic conditions.

is impossible not to feel reverence for the scholar- ip and erudition of Berkeley's paper. Now that it reprinted in this classic form, it can provide back- round for teacher and student, and still give spiration to the more specialized mycologist.

The selections from "Vegetable Pathology" made y the Plant Pathology Committee of the British ycological Society provoke rather a different note humility. The completeness of Berkeley's concep- on of disease as abnormal functioning of plants ads, as yet, no corresponding completeness in odern studies. We are, alas, only too well acquainted ith 'Congelatio, freezing' and 'Sphrigosis, rankness', ut know all too little about them. Should anyone k us the cause of 'Exostosis, hard excrescences nsisting of sound tissue', we can only say we know ey occur, and shake our heads about the cause. is not that we have been idle, for studies on virus, n mineral deficiencies and on some non-parasitic aladies have explained many of Berkeley's classified iseases. The science of genetics has elucidated still ore. The real shortcoming is that whereas Berkeley directed the attention of mankind to damage caused by parasitic fungi, and showed that it was amenable to control—he it was who suggested the use of sulphur and lime to Mr. Tucker—the science of plant pathology languished until twenty years ago. It then began to gather momentum, is now beginning to command the respect of practical growers, and should look forward to a brighter future.

JOHN GRAINGER

FROM RADIUM TO THE ATOMIC BOMB

Atomic Energy

By Dr. R. R. Nimmo. (Frontiers of Science Series.) Pp. 201. (London: Pilot Press, Ltd., 1947.) 9*s*. 6*d*.

THE 'Frontiers of Science' series, of which this is the first number, is stated to be "intended for the growing non-specialist public which wants to keep abreast of recent scientific developments and so keep pace with a changing world". Atomic energy is undoubtedly one such important scientific development, and the general editor of the series, Dr. A. C. B. Lovell, has chosen well in asking Dr. Nimmo to write an account of the progress made in nuclear physics from the discovery of radioactivity in 1896 to the release of the first atomic bomb in 1945. Dr. Nimmo was, during the Second World War, a member of the British team engaged on the atomic bomb project in the United States, and has since been working at the University of Birmingham on the construction of particle accelerators, so that he writes on his subject with considerable authority and knowledge. It is true that Dr. Nimmo divulges no secrets, nor gives any information that is not contained in the official Smyth Report; but he does not hesitate to read between the lines and to set down in detail all reasonable deductions that an expert in this field can make from the official information.

To those with a moderate knowledge of chemistry and physics the first half of the book can be recommended as an excellent introduction to modern atomic structure and as an account of modern experimental techniques. The second half of the book deals with nuclear fission, chain reactions, uranium piles, plutonium, the atomic bomb and atomic energy plants, and will be read with interest by all who have not access to, nor the time nor ability to wade through, the mass of uncorrelated information which has been published during the last few years.

The last chapter of the book, on atomic energy and the future, is naturally speculative, but the problems to be faced and overcome are clearly stated, and the difficulties in the way of rapid development of nuclear physics, such as considerations of military security and the delay in the declassification of fundamental data, are specifically mentioned. The author's attitude is well summed-up in the concluding sentence of the book, "The future is full of hope and promise, but only if we see to it that never again are these new powers used for killing and destruction".

The reviewer has two faults to find with this otherwise excellent book. One is that, though reference is made to the health hazards in atomic energy work, little or no reference is made to the great benefits of the use of radioactive tracers in medicine, agriculture and industry. The other is the unusual arrangement of type and size of page, which, with its long close lines, is very fatiguing to the reader.

S. WEINTROUB

UNIVERSITY EDUCATION IN NOTTINGHAM

By Prof. H. T. H. PIAGGIO

ON July 9, 1948, the King in Council conferred full university status upon University College, Nottingham, so that the efforts of more than seventy years were crowned with success. In 1875 Mr. Richard Enfield asked the Nottingham Corporation to erect buildings to accommodate the Cambridge University extension lectures then being delivered in the city, and to add a library and a chemical laboratory. An anonymous donor offered £10,000 for this purpose. The Corporation adopted the scheme in an improved form, to include also a natural history museum and provision for the teaching of several branches of science, which up to then had been carried on by the Mechanics' Institute. The foundation stone was laid in 1877, and the College opened in 1881. At first there were only four professors, the Rev. J. F. Blake (natural sciences), Dr. F. Clowes (chemistry and metallurgy), Dr. J. A. Fleming (physics, mathematics and mechanics), and the Rev. J. E. Symes (English), with four lecturers, two demonstrators, and fifteen part-time teachers of science. Dr. Fleming (later Sir Ambrose Fleming, the inventor of the thermionic valve) left after one year, and was succeeded by Mr. William Garnett. At first there was no principal; but Dr. Clowes acted in this capacity from 1887 until 1890, and Mr. Symes from 1890 until 1911, both in addition to their professorial duties. A professor of engineering was appointed in 1884. In the following year the College started to train teachers. In 1893 a new wing was opened for the engineering and technical students, designed by the versatile Dr. Frank Granger, who later became professor of classics and philosophy. In 1898, Mr. Ernest Weekley, afterwards well known for his books on philology, became professor of French, and Dr. F. S. Kipping, from whose researches on the organic compounds of silicon the new silicone plastic industry has developed, became professor of chemistry. The culmination of this period of development was the Charter of Incorporation (as a University College) conferred by the Privy Council in 1903.

After this, for some reason, there was a check to the development. Perhaps the splendid initiative of the Nottingham Corporation in founding the College led the citizens to think that there was no need for them to take an active interest. Certainly the neighbouring counties considered it purely a Nottingham affair, which was no responsibility of theirs. In 1911 it became evident to Mr. W. H. Heaton, who after many years as professor of physics and mathematics had been appointed principal, that if a great effort was not made, the College was likely to decline. He established professorships of mining, economics and commerce, geology and geography, and history, and in 1913 there were hopes of a full charter. But in 1914 came war, and for four years the College was nearly empty. In 1919 the ex-Service men returned in embarrassing numbers, and the buildings were greatly overcrowded. The site in Shakespeare Street had very little room for expansion. There was difficulty in obtaining staff, and the financial position gave cause for anxiety. At a time when the difficulties seemed almost insuperable, Alderman E. Huntsman directed the attention of Sir Jesse Boot (afterwards Lord Trent) to the good work done by the College; thus, for example, an evening student Mr. E. H. Barton, was able to become a professor o physics, a fellow of the Royal Society, and a recognized authority on acoustics. Sir Jesse's interes was aroused, and he allocated to the College a larg site with a setting of exceptional beauty above th lake in University Park. Since then the Colleg Council has acquired a good deal of adjacent land and is now in the happy position of having room fo as many lecture rooms, laboratories, and halls o residence as are likely to be required for very man years to come. The new buildings were opened b King George V in 1928; but for some years longe the Faculty of Applied Science remained in Shakespeare Street, Nottingham, which also remained th headquarters of the vigorous Adult Educatio Department set up in 1920 under Mr. (later Prof Robert Peers. This Department is one of the larges of its kind in Great Britain.

In 1930 Mr. Hugh Stewart became principal, an threw himself with great energy into preparing fo full university status. In particular he emphasize the importance of research. He pointed out th necessity of transforming the governing body to tak account of the fact that the College now served th whole of the East Midlands. Unfortunately, hi incessant labours caused his untimely death in 1934 After a year with Dr. Granger as acting-principal Mr. H. A. S. Wortley was appointed principal. H had gained an extensive knowledge of the needs o the area in his former capacity as professor o education, and his wide popularity enabled him t carry through changes which, though necessary, wer sometimes a break with local traditions. In 1938 h obtained the supplementary charter, which reconstituted the governing body on the lines suggeste by Principal Stewart. From 1939 until 1945 progres was again stopped by war. In 1945 the Universit College handed over the Shakespeare Street building and the responsibility for evening classes, and technical education to a new authority, the Nottinghan and District Technical College. In 1947 the Midlan Agricultural College became part of the Universit College. In the same year was set up an Institute c Education, which will co-ordinate education activities, including research, over a wide area.

It was anticipated that Principal Wortley's nex achievement would be the attainment of a fu charter; but worn out with the double burden the war years, during which he also acted as deput regional commissioner, his health collapsed, and h died suddenly in 1947. The arduous task of gatherin up, at short notice, the many tangled threads half-completed schemes was taken up by Prof. Peer who, as acting-principal, had the satisfaction reaching the goal towards which so many had strive for so long. He has also greatly strengthened th staff, made fuller provision for research, and draw up the degree regulations for the new universit Mr. B. L. Hallward, for many years fellow of Pete house, Cambridge, and at present headmaster Clifton College, will become the first vice-chancello The chancellor is Lord Trent, previously preside and chairman of the College Council. He is the so of the College's great benefactor.

The University will start with five faculties, art (including law, theology, music, economics and soci administration), education, pure science (includin pharmacy), applied science (mechanical, electric and civil engineering, mining and fuels) and agr culture (including horticulture). New professorship re being established, and new buildings erected. he number of students is now about three times hat in 1938–39, and applicants have to be refused or lack of room. Negotiations to consider how the University and the technical colleges of the area can o-operate are in progress.

In addition to all the usual academic subjects except medicine), the University will deal with ertain special branches in which it feels particularly trong. It will continue the biochemical studies of he late Prof. J. M. Gulland, but with a shift of mphasis from nucleic acids to heterocyclic organic ompounds of importance in chemotherapy. Pharmacy will continue to receive much attention, and will develop on the research side. Among other strong points are magnetism, mycology (with a raduate diploma), ecology and parasitology of reshwater fishes, soil mechanics, statistical methods, own planning, and Biblical and related studies. The East Midlands is an important mining area, and the University is dealing with the related geological problems, and with mine ventilation. Experiments n new methods of mine illumination are expected to ontribute to the health and amenities of the workers t the coal face.

A Board of Local Studies has been set up. Con-ributions have already been made to Roman-British rchæology, the history of the Civil War (which started in Nottingham) and of other national events with a local setting, also of economic conditions in he eighteenth and nineteenth century, particularly of the lace and hosiery trade. A valuable source of information about medieval social and economic conditions is now available in the University library, in which Lord Middleton and Mrs. Percy Clifton, representing two families which go back for many centuries, have deposited their family records. Economic conditions of our own time will be studied by the rapidly increasing Department of Economics and Social Study, which is now to be subdivided. We look forward with confidence to the contribution he University will make to the East Midlands, to he nation, and to the international fraternity of learning.

ENZYMATIC CONTROL OF CELL DIVISION IN MICRO-ORGANISMS*

By Dr. WALTER J. NICKERSON
(John Simon Guggenheim Memorial Fellow)
Laboratorium voor Microbiologie, Delft

FROM lines of evidence converging from apparently widely separated fields it now appears possible to assemble evidence indicating that cell division in micro-organisms, and probably also in other organ-sms, is under the control of a unit enzymatic mechanism. The lines of investigation, developed quite independently, forming the foundations for this thesis are: (1) physico-chemical studies by Hinshelwood and co-workers[1] on the kinetics of bacterial growth and the state of balance between division and elongation; (2) the studies of Witkin[2] (genetic), Eisenstark and Clark[3] (electron microscope), and others[20,21,22] on irradiated bacteria; (3) cytochemical investigations of Pratt and Dufrenoy[4] on the mode of action of penicillin; (4) metabolic studies on dimorphic pathogenic fungi by Nickerson and Edwards[5]; and (5) examination of the chemical control of morphogenesis in yeasts by Jillson and Nickerson[6], the common denominator in all of these lines of investigation being a close examination of the effects of inimical or critical conditions on the morphogenesis of dividing cells. The examinations have revealed a common fundamental attribute of cell division of micro-organisms.

This fundamental attribute may be expressed by the use of a simple notation. Bacteria (B) may be induced to elongate into filaments (F) by various treatments which inhibit cell division but which do not simultaneously inhibit growth. The process itself may be denoted as a $B \rightarrow F$ conversion. Likewise with yeasts (Y), it is possible both to induce elongation into mycelia (M) structures through inhibition of cell division, and to inhibit the process in yeasts that normally show $Y \rightarrow M$ conversions as a characteristic feature. There are, furthermore, fungi which can be interconverted from a mycelial to a yeast form by changes in temperature alone, and for these it seems permissible to write $Y \rightleftharpoons M$ as an expression of the phenomenon. In the three cases the normal division mechanism by which micro-organisms maintain a single-cell condition may be inhibited without the simultaneous inhibition of other metabolic processes, thus permitting the organism to grow, unchecked, as a filament. Other common properties of the $B \rightarrow F$ and $Y \rightarrow M$ processes, as will be shown, permit the assumption that a comparable mechanism is being affected in the three cases.

Hinshelwood has developed a very convenient concept with respect to the change $B \rightarrow F$ from his studies on the action of proflavine, *m*-cresol, and of the effect of the nitrogen source on bacterial growth. Normal growth is viewed as the result of a balance between a division (D) factor and an elongation (L) factor; the latter factor has been shown to be diffusible. This diffusibility of the elongation factor L was recorded from the property of culture filtrates from *Bact. lactis aerogenes* of hastening the onset of growth, through a shortening of the lag period, when added to culture media; in some instances division did not keep pace, and the process $B \rightarrow F$ resulted. Other methods for disturbing the balance between the division and elongation factors included the incorporation into a nutrient medium of traces of *m*-cresol or proflavine; these agents selectively inhibited division without exerting marked suppressive action on other cell functions, with the result that cultures of *Bact. lactis aerogenes* so treated consisted of tangled masses of long thread-like elements.

While the appearance of the $B \rightarrow F$ phenomena is not markedly apparent with most bacteria in ordinary culture media, the production of the $Y \rightarrow M$ process and the occurrence of $Y \rightleftharpoons M$ among several of the pathogenic fungi are essential characteristics of their identification. It will be well to present at once the reasons for believing that the growth of yeasts by budding and of bacteria by fission may be accomplished in a comparable fashion despite apparent morphological differences between the two modes of growth. At least three rather convincing reasons may be advanced for this view. (1) Budding of yeasts has been shown[37] to exhibit the same mechanical principle (Principle of Least Action) characterizing the growth of other cells with determinate axes (*inter alia*, rod-shaped bacteria), for a yeast bud arises so that its long axis is a tangent to the mother cell at the point of contact. (2) There are genera of yeasts, for example, *Saccaromycodes*, which reproduce by fission, as do bacteria, but which are ostensibly related to other yeasts. (3) As will be shown, certain substances in trace concentrations promote the process $B \rightarrow F$ (and, furthermore, the promotion of $B \rightarrow F$ in Gram-positive bacteria is accompanied by a loss of Gram-positivity); these same substances, in trace concentrations, promote the process $Y \rightarrow M$ and loss of Gram-positivity in yeasts. Having set forth seemingly valid reasons for believing that the division of yeasts and of bacteria result from the action of closely comparable mechanisms, we may proceed with further comparisons.

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* Based on a lecture given at the London School of Hygiene and Tropical Medicine on March 22, 1948.

Among the yeasts, the order Mycotoruloideæ is characterized by the formation of mycelial structures; three genera, *Candida*, *Trichosporon* and *Brettanomyces*, are included in the group. Experimental work pertinent to the discussion has been carried out mainly with species of *Candida*. In this genus there is one species, *C. albicans*, undoubtedly pathogenic for man and experimental animals, together with species of probable pathogenicity, and others that are non-pathogenic. All species exhibit the process $Y \rightarrow M$ under appropriate conditions. *C. albicans* may cause infections of various tissues, including chronic infections of the skin and nails. These latter regions may also be infected by other pathogenic fungi, the dermatophytes; now it is a clinical fact that mixed fungus infections of the skin or nails are rarely encountered. With isolates of *C. albicans* and the dermatophyte, *Trichophyton rubrum*, obtained from nail infections, Jillson and Nickerson[6] attempted to learn if the growth of one fungus could inhibit the growth of the other in culture and thus contribute an explanation for the known clinical situation. Such was, indeed, found to be probable. But the inhibitory effect exerted on *C. albicans* by *T. rubrum* was of a differential type; only the development of mycelial structure, *M*, was inhibited, whereas growth in the yeast phase, *Y*, was not appreciably affected. This *T. rubrum* effect was obtained first in two-membered pure cultures, and later shown to result from the production of two diffusible metabolic products, which have been partially characterized. Recently it has been found that activity in one of the fractions is probably the result of its —SH group content.

Early in the study of the effects of penicillin action on micro-organisms, it was found by Gardner[7] that sub-bacteriostatic concentrations of penicillin induced $B \rightarrow F$ conversions in Gram-negative as well as in Gram-positive bacteria. More recently, the cytochemical investigations of Pratt and Dufrenoy[4] have amply confirmed this point and demonstrated that Gram-positive bacteria become Gram-negative in the process. The latter authors have also made it clear that the probable mode of action of penicillin against Gram-negative organisms is the same as against Gram-positive organisms, in spite of the higher concentrations needed to achieve effects against the Gram-negative group. A very significant point emerging from these researches[4] is the implication of —SH group oxidation with the mode of action of penicillin. In plate inhibition-zone studies with *Staphylococcus aureus*, positive tests for —SH groups were always obtained with cells in the uninhibited regions, but were never obtained in the inhibited zone. The fact that loss of stainability of the Gram-positive complex accompanied the $B \rightarrow F$ process, resultin from penicillin action, also implicates —SH grou oxidation, since Henry and Stacey's[8] investigation on the chemical nature of the Gram-positive comple have shown it to be magnesium ribonucleate wit associated —SH groups; oxidation to S—S abolishe the stainability of the complex. Pratt and Dufreno have expressed the view[4] that penicillin exerts i bacteriostatic effect by promoting the oxidation —SH to S—S, and Cavallito[9] has shown that cystei can suppress the action of penicillin, presumably b acting as an —SH donor.

The probability that —SH groups represent th active component of one of the *T. rubrum* filtra factors effecting a suppression of the $Y \rightarrow M$ proces may be taken as further evidence of the similarity cell division processes in bacteria and in yeast Similarity in the action of cobalt on penicilli inhibition and on the $Y \rightarrow M$ process further link —SH groups in the two processes. Pratt an Dufrenoy[4] have noted that trace amounts of th cobalt ion Co^{++} increase the sensitivity of micr organisms to penicillin inhibition. It seems possib that the effect of cobalt lies in its ability to for complexes with cysteine, as shown by the work Michaelis[10]. In studies on the toxicity of cobalt t yeasts[11], a very sharp break appeared in the curve c growth *v.* concentration of cobalt ion in the region c $M/10,000$ Co^{++}. Employing radioactive Co^{56+58}, was found[11] that most of the activity accumulated i growing yeast cells in one distinct fraction. Th activity was retained in the cells during prolonge washing and during ether-acetone extraction, bu was removed by cold 10 per cent trichloracetic aci extraction. The Co^{56+58} was precipitable from thi extract on standing, after neutralization, as a ligh brownish flocculant. Work on the type of bindin for the cobalt in this fraction is in progress. Th addition of Co^{++} to media, in amounts insufficient t inhibit growth, favours the development of $Y \rightarrow$ process in yeasts ordinarily existing only in a *Y* for on agar media. *Hansenula anomala* has been pa ticularly examined in this connexion[12,13]. It develop much elongated cells, which tend to remain attache to give an appearance suggesting 'trees', on a mal agar medium with added cobalt ions. Cystei antagonizes the cobalt ion effect.

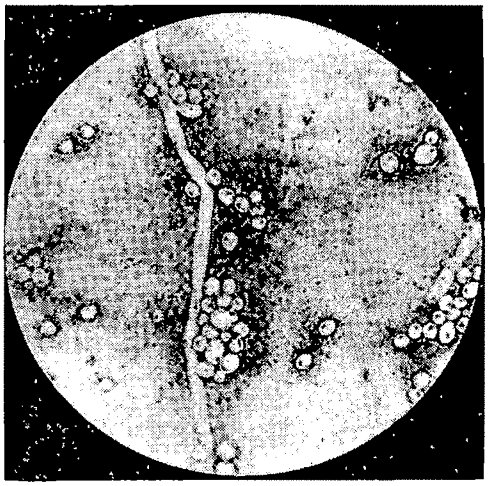

Fig. 1. *Candida albicans* from untreated slide culture on potato agar showing normal production of *Y*- and *M*-forms. Stained with 1 per cent aqueous toluidine blue; distinct nucleus in each *Y*-cell; three nuclei may be discerned along the length of the *M* filament. × 750

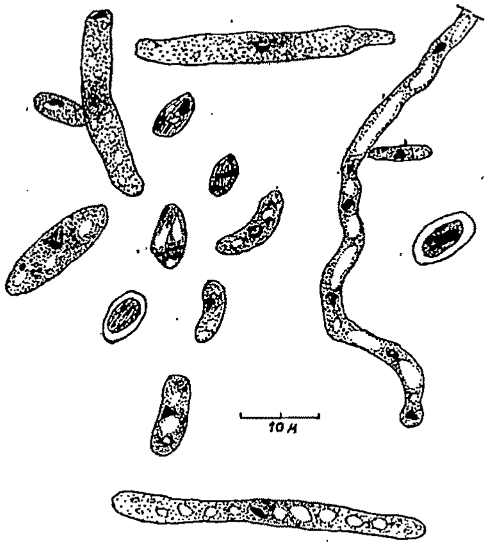

Fig. 2. *Trichosporon capitatum* from potato agar slide culture with penicillin (10 O.U./ml.). Toluidine blue staining. Production of two types of *Y*-cells (arthrospores and blastospores) is characteristic of this yeast. Nuclei were spaced at more or less regular intervals for more than 100 μ along the partially drawn *M*-filament

The implication of the —SH group of cysteine in he division processes of bacteria and of yeasts recalls he earlier work of Voegtlin and Chalkley[14] on *mœba proteus*, of Hammett[15] on *Paramecium*, and f Brachet[16] on the embryonic development of mphibia. In all this work, a relationship between —SH groups and cell division was strongly indicated. Vith *Amœba* it appeared[14] that glutathione enhanced he rate of nuclear growth (while cupric ions impeded t), thus speeding cell division, since division occurred egularly at an almost constant nuclear volume. In he experiments of Chalkley and Daniel[17] on *Amœba*, t was found that on the failure of fission processes experimentally induced) to result in cell division, here remained no 'residual tendency' towards ivision; the cell was left with two nuclei. Division f one of these was necessary before cell division ould again occur. In a general way, this relationhip holds with yeasts for $Y \rightarrow M$ processes. Excemely long filaments may be observed with only ne or a few nuclei scattered along the length of the *I* growth. With *Candida albicans*, which produces lusters of blastospores (uninucleate *Y* cells) at loci paced along an *M* axis (see Fig. 1), we may have an xample wherein division of an *M*-nucleus results, ot in division of the already formed filament, but intensive localized budding of yeast cells. In other nstances (Fig. 2) *M*-elements may be seen with umerous nuclei scattered along the filament. In he $Y \rightarrow M$ process it appears that the normal close ssociation between nuclear and cell division is isrupted so that growth occurs without cell ivision, while nuclear division may or may not ccur.

In the experiments of Hinshelwood on bacteria and f Nickerson *et al.* on yeasts, a very large proportion of the cells exposed to the various division-inhibiting substances were found to have entered an elongated state. Normally, with *C. albicans*, one may observe mycelia production around the entire border of a colony. The very high proportion of cells exhibiting an inhibited division, but uninhibited growth (defined as an irreversible increase in volume, following Went and Thimann[18]), seems to preclude the operation of mutational or survival-selection mechanisms as the basis for the observed phenomena. This is strengthened by the reversible nature of the processes, since filament or mycelial stages may readily give rise to bacterial or yeast forms of growth following the removal of the active chemical agents and transfer to suitable growth media. It seems permissible to regard the inhibition of division as the inhibition of an enzymatic mechanism, which may resume functioning when the inhibiting agents are removed. The effectiveness of proflavine, *m*-cresol, cysteine, and cobalt in trace concentrations against the division mechanism of growing cells favours an enzyme-inhibition concept. The specificity of these substances for the division mechanism of growing cells favours a unit enzyme-inhibition concept.

The argument in favour of a unit enzymatic division mechanism in cells of micro-organisms based on the specific response of cells to trace concentrations of proflavine, *m*-cresol, cobalt, and cysteine may be even more forcefully presented in the case of penicillin. Penicillin, as Dubos[19] has emphasized, does not act as a generalized, non-specific protoplasmic poison; its effectiveness in high dilution favours the concept of attack on specific loci of the cell. Much evidence now points to the action of sodium-penicillin G as operating through a shift toward the right in the —SH $\rightleftharpoons$ S—S functions of the cells; as has been noted, cysteine (—SH) suppresses the action of penicillin. The action of penicillin *in sub-bacteriostatic concentrations* in promoting the process $B \rightarrow F$ is one of the first detectable effects of penicillin. This specificity at extreme dilution is significant. The parallel (see Table) between the general phenomena of the processes of filament formation in bacteria, mycelium formation in yeasts, and penicillin action indicates a common specific functional unit as the sensitive locus in the cell.

Such a unitary enzyme concept is supported by genetic studies on irradiated bacteria (Witkin[2], Lea[20]), and by electron microscope studies of irradiated bacteria (Eisenstark and Clark[3]). Following ionizing radiation of bacterial cultures, Kempster[21] early observed that cells might fail to divide but retained the power of growth since elongated filaments were produced. Haberman and Ellsworth[22] have produced elongated cocci by such procedures, and Witkin[2] obtained greatly elongated cells of *Esch. coli*. The elongations following radiation have generally been observed to be irreversible.

Witkin, employing X-radiation, has obtained permanent $B \rightarrow F$ conversions; her analysis of the dosage-response data indicates a 'one hit–one gene' inactivation. Examination of filaments of *Esch. coli* (X-ray induced) in the electron microscope by

Agents uncoupling cell-division from cell-growth

Compound	$B \rightarrow F$	$Y \rightarrow M$	Gram positivity	Ribonuclease action
Proflavine	promoted[1]	promoted[13]	abolished[13,31]	inhibited[30]
Cobalt	promoted[4,11]	promoted[12]	abolished[12]	
Cysteine	prevented[4,11]	prevented[12]	preserved[12]	
Penicillin	promoted[4,7]	promoted[12]	abolished[4]	inhibited[33]

Eisenstark and Clark revealed 'breaks' spaced periodically along the length of a filament; they put forward the hypothesis that an "enzyme responsible for pinching off the cell wall in normal bacterial fission has been destroyed by rays while other enzyme systems continue to function".

With the group of pathogenic fungi exhibiting the process $M \rightleftharpoons Y$, depending on the temperature of incubation, it has recently been shown by Levine and Ordal[23] and by Nickerson and Edwards[5] that the interconversion of form is solely a function of temperature. The $M \rightleftharpoons Y$ transformations in *Blastomyces dermatitidis* and *B. brasiliensis* are obtainable without difficulty on a simple nutrient medium (consisting of ammonium-nitrogen, inorganic salts and glucose) just as they are obtained on complex media. No growth-factor requirements have been observed for either species of *Blastomyces*, nor have special atmospheric requirements been found to be necessary for the process $M \rightleftharpoons Y$. Since no chemical agent need be added to the cultures to promote the morphogenetic transformations, it seems that effects of temperature on the metabolism of these organisms may be examined more closely for possible clues to its action in the regulation of morphogenesis.

Oxygen consumption seemed particularly important in this regard; respiratory measurements were made on washed, vigorous mycelia over a range of temperature in an ultra-micro respirometer. With intervals of 3–5° over a range from 3–45°, it appeared that plots of rate *v.* temperature in degrees lent themselves to a separation of two ranges, 3–20° and 20–40°. However, plots of rate *v.* the reciprocal of absolute temperature gave curves which were slightly concave downwards; no 'breaks' or 'critical points' were noticeable. These data fit well with the recent mathematical formalization for temperature increments in biological processes elaborated by Morales[24] on the basis of the Johnson–Eyring formulation[25] of absolute reaction-rates. In this interpretation, two rate-limiting processes control the observed reaction-rates; at lower temperatures (3–20°) the splitting of substrate-enzyme complexes is rate-limiting, while in the higher range (20–40°) reversible enzymic denaturation becomes rate-limiting. Such a formulation does not imply 'breaks' in the plots of rate *v.* the reciprocal of absolute temperature. Rather, it leads to curves that are smoothly concave downwards.

No clues of the physiological mechanism underlying the *thermal dimorphism* of *Blastomyces* were obtained from these experiments on the effect of small temperature changes on oxygen consumption. When similar measurements were made on mycelial preparations exposed to large changes in temperature (15° or more) there appeared what is commonly termed 'overshoot', or exaggerated response, phenomena. (It should be pointed out that the process $M \rightarrow Y$ is obtained with these organisms following the transfer of a mycelial culture from room temperature to the 37° C. incubator—a jump of more than 15° C.) Following an abrupt increase from 5 to 20°, the rate of oxygen consumption was briefly higher than expected for the 20°-level, following which it rapidly recovered to the normal rate for the indicated temperature. (The brief higher level is not an artefact of technique.) An increase from 20° to 40° resulted in a tremendously increased rate of oxygen consumption that slowly levelled off to the rate anticipated for 40° C. If we view the rate of oxygen consumption as normally being determined in the range 5–20° by a constant k_1, which is a measure of the rate of enzyme substrate splitting and, in th range 20–40°, as the result of two simultaneous rate limiting phenomena k_1 and k_2 (the constant for reversible enzyme denaturation), we may write th following expression:

$$5^\circ \xrightarrow{k_1} 20^\circ \underset{k_2}{\overset{k_1}{\rightleftharpoons}} 40^\circ$$

where the arrow to the right indicates increasin velocity of reaction and that to the left (←, denotin reversibility) indicates a decreasing effect on velocity Since at any given temperature in the range 20–40 the rate of oxygen consumption is constant for man hours, we may conclude that k_1 and k_2 have achieve a steady state. The large, abrupt increases in temperature upset this steady state to produce a situatio which may be expressed by:

$$\underset{\underset{k_2}{\overset{k_1}{\rightleftharpoons}}}{20^\circ} \xrightarrow[\text{change of} > 15^\circ]{\text{abrupt}} \left[\xrightarrow[k_1]{40^\circ} \right] \xrightarrow{\text{time}} \underset{\underset{k_2}{\overset{k_1}{\rightleftharpoons}}}{40^\circ} \ \text{(gradual restoration)}$$

The temporary apparent suppression of the rate-limiting factor k_2 is deduced from the overshoot i oxygen consumption. That this 'apparent suppression' probably results from measurable difference i the speeds with which the two rate-limiting processe return to equilibria is seen from the difference i times required for the reappearance of a steady stat at 20° and at 40° after large jumps to these temperatures.

In view of the fact that the other aspects of th metabolism of *Blastomyces* investigated thus far other than oxygen consumption, are comparable fo the yeast and the mycelial forms, we are inclined t attach importance to the results for respiration, i the sense that they may indicate the physiologica basis for the observed thermal dimorphism. We ma conceive that the cell division enzyme complex (D lies at the end of a chain of consecutive reaction which produce its substrate (s); it is further conceivable that (D) must compete for (s) with anothe enzyme complex (X) which is concerned with cel elongation.

$$s \begin{array}{l} \overset{D}{\nearrow} \ \text{division} \\ \underset{X}{\searrow} \ \text{elongation} \end{array}$$

Let (s) be produced by reactions for which the rate limiting processes are only of the enzyme-substrat splitting category, and assume that (X) has a highe affinity for (s) than has (D). Under such conditions elongation will result and division will be suppressed If, for the reaction $s \xrightarrow{X}$ elongation, the rate limiting factor is the reversible denaturation of (X) it may be possible for the reaction $s \xrightarrow{D}$ division t predominate at higher temperatures. In view of th lag in 'adjustment' of the process in respiration whic probably is rate-limiting by reason of its reversibl denaturation, we might say that a parallel phenomenon, operating in a growth mechanism of th type conjectured, would result in a supply of (s saturating (X), thus permitting an initiation of th (D) reaction.

The actual nature of D, X and s (and definitive evidence for their existence) must be left for future nvestigations. In view of Hinshelwood's implication of the importance of the source of nitrogen for the $S \rightarrow F$ process in *Bact. lactis aerogenes*, and earlier work of Langeron and Guerra[26] along similar lines for the $Y \rightarrow M$ process in *C. albicans*, we may see ndications of the nature of (s). Viewing elongation as 'straight growth' and division as 'curved growth', t may reasonably be imagined that 'rigid' or 'flexible' molecules resulted respectively from the action of X or D. In this connexion the recent investigations of Jeener[27] and Lyons[34] on the fibrinogen-fibrin proteins are suggestive; the critical importance of —SH ⇌ —S—S— in this process makes it even more suggestive, since —SH maintenance inhibited ibrin formation, and —SH donors maintain spherical growth of yeast cells. The analogy between maintenance of cell division and the prevention of disulphide-link formation in a fibrous protein may actually be far more than a superficial one. As Astbury[35] has so fascinatingly written, ". . . the molecular plan of the keratin–myosin–fibrinogen group is one of the great primal ideas in vital architecture. . . . It represents a fundamental power of he cell of synthesizing elastic fibrous protein of a standard molecular form, yet whose details can be adapted to a variety of ends as the processes of differentiation demand." The ability of a cell to grow may then reside in its ability to form elastic fibrous protein, and its ability to divide may reside in its potential to prevent the formation of intermolecular disulphide links and resultant loss of molecular elasticity. Such a concept of cell division is, in fact, reminiscent of that elaborated by Rapkine[36] everal years ago, who held that cell division is accompanied by configurational rearrangements of cell protein resulting in an increase in the appearance of protein —SH groups.

In view of recent work[28] on the mechanism of action of acridines (proflavine, trypaflavine), we may consider some relationships of nucleic acid metabolism in $Y \rightarrow M$ phenomena. Acridines are believed o exert their growth- (and respiration-) inhibition effects by union with nucleoproteins of the cell[28]; this inhibition may be overcome by addition of nucleic acid[29,30]; nucleic acid-proflavine complexes have been prepared[30]. It is clear that the ribose nucleic acid content of cells that have undergone the $Y \rightarrow M$ process is greatly lowered; they are Gram-negative, and are stained scarcely at all by pyronin from the Pappenheim–Unna mixture. Yet these cells have grown and undoubtedly synthesized protein. Populations of elongated cells may be grown (excluding the possibility of 'redistribution' from the Y form) which are pyronin 'negative'[13]. Spiegelman and Kamen[31] have recently queried the correlation between nucleic acid metabolism and protein synhesis. Results from the study of the $Y \rightarrow M$ and $S \rightarrow F$ processes *appear* to augment their query. But f particular types of protein synthesis (and mainenance of elasticity) are involved in division processes, it may be that it is with these that nucleic acid metabolism is associated[16] during normal growth and cell division.

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PHYSICAL PROPERTIES OF SUBSTANCES OF HIGH PERMITTIVITY

ON June 12, the Electronics Group of the Institute of Physics held a symposium on substances of high permittivity, the so-called ferro-electrics. Three papers were followed by a discussion. Original results were reported by speakers both in the last two papers and in the discussion—a sign of the considerable interest shown.

A survey of the electrical and crystallographic background of ferro-electricity was given by Dr. Vera Daniel (British Electrical Research Association). She pointed out that the essential feature of ferro-electric materials is that they consist of domains with a spontaneous electric polarization. With no external field and in equilibrium, the moments of these domains cancel each other. The effect of a field on a specimen of such a material is two-fold. It influences the polarization of each domain and it may also reverse the polarization of domains. The spontaneous polarization of an individual domain is an equilibrium property, and at any given temperature the differential of this polarization, with regard to field strength, defines an 'equilibrium' permittivity. The permittivity of a real specimen is made up of this equilibrium permittivity plus a contribution due to the reversal of domains. The latter contribution is necessarily very sensitive to structure and implies the existence of saturation effects; for if already all domains are aligned in the direction of the field, no further domains can be reversed. The reversal of domains also leads to hysteresis.

All ferro-electric materials are crystalline, and from the point of view of the crystallographer their properties imply unusual conditions. It is not rare for crystalline substances to have a spontaneous polarization; but in the majority of cases this does not depend appreciably on electric field strength, and domains cannot be reversed by a field. It is quite exceptional that the forces controlling the polarity are as weak as to be comparable with the energy of an applied field, which is the case for ferro-electrics. All known cases of ferro-electricity are connected with the change of a structure with spontaneous polarization into one without such polarization. These changes occur gradually over a temperature interval, the spontaneous polarization decreasing more and more rapidly on approaching a critical temperature, called the Curie point in analogy with ferro-magnetism. Thermodynamically, the change of structure may be a first- or second-order transition. The Curie point is associated with a sharp peak of the permittivity.

Dr. Daniel concluded by discussing experimental and theoretical work done on Rochelle salt, potassium dihydrogen phosphate and ferro-electrics of similar structures. Ferro-electric properties depend on very delicately balanced energy conditions, and their understanding presupposes a very thorough knowledge of the bonding of the crystal structure. It seems remarkable how much progress has been achieved in spite of the difficulties of the subject, even with regard to so complicated a substance as Rochelle salt[1].

Dr. D. F. Rushman (formerly of Philips Electrical, Ltd.) discussed the high permittivity titanates, such as barium titanate and its solid solutions with the titanates of other metals of the second group of the periodic system of elements.

These ceramic materials, the unusual electrical properties of which were discovered during the War, have considerable practical interest. In practice, barium titanate is prepared from barium carbonate and titanium dioxide at temperatures higher than 1,000° C. To form a dielectric it is crushed, sieved, and sintered at about 1,300° C., clay or other binder being added in small quantities, to reduce the porosity. The preparation is not simple, and care is required to produce a material of uniform quality. Dr. Rushman showed the effect of wrong firing conditions on the dielectric properties.

Dr. Rushman discussed in detail the experimental evidence which establishes the ferro-electric character of barium titanate and some of its solid solutions with other titanates. The permittivity-temperature curve shows a characteristic peak at the Curie point[2]. Saturation effects are shown very strikingly by the fall of the permittivity when the specimen is in a strong D.C. field, and the materials give characteristic hysteresis loops. It is possible to produce electrets, that is, specimens can be polarized and the polarization 'frozen in', producing a specimen analogous to a permanent magnet. The crystal structure[3] is tetragonal, with spontaneous polarization[4], in the ferro-electric temperature region and cubic, without spontaneous polarization, above the Curie point. The structural transition at the Curie point is curious in that the cubic and tetragonal phase co-exist over a temperature range of a few degrees. The specific heat has a λ point at the Curie temperature, a characteristic feature of ferro-electric and ferro-magnetic materials[5].

Dr. A. S. Devonshire (University of Bristol) dealt with the theory of dielectrics and ferro-electricity. He gave an account of original theoretical work on some features of ferro-electricity, and in particular on the spontaneous polarization in barium titanate.

The permanent polarization in titanates can be explained, Dr. Devonshire said, by the forces between electric dipoles. If a substance containing dipole breaks up into long narrow domains polarized along their length and the net polarization is zero, th mutual potential energy of the dipoles is $-\frac{2}{3}\pi P^2$ pe unit volume, where P is the polarization per uni volume. When an ionic crystal is polarized, it contain a set of pseudo-dipoles, formed by displacement of the ions. If the energy required to displace the ions is les than $\frac{2}{3}\pi P^2$, the polarized state will be the most stable one; that is, there will be a spontaneous polarization Dr. Devonshire here directed attention to a difference between ferro-magnetism and ferro-electricity. The interaction between electric dipoles is a long-rang force, that is, the force on dipoles is partly due to dipoles in distant parts of the domain. In contrast the forces which orient the magnetic dipoles in a ferro-magnet are almost entirely forces between nearest neighbours; the long-range forces are relatively very small.

The ferro-electric properties of barium titanate are due to the structure having a spontaneous polarization at temperatures below the Curie point. Dr. Devonshire classified the effect of temperature on the spontaneous polarization under three headings (1) Thermal expansion decreases the number o dipoles per unit volume. This means a decrease o polarization with temperature. (2) Thermal expansion decreases the restoring force on a displaced ion This means an increase of polarization with temperature. (3) Thermal oscillations tend to decrease th polarization with increasing temperature. The first of these effects is relatively small. The second two effects have opposite sign, but the same order of magnitude, and it is not possible to predict on theoretical grounds which predominates. Experimen shows that the polarization disappears at high temperatures. Hence the third effect must be large than the second.

The potential energy of the system is furthe decreased if the crystal expands along the direction of polarization so that it becomes more polarizable in that direction. This interaction between structure and polarization has the effect of increasing the change of polarization with temperature and accounts for the transition at the Curie point being of the firs and not of the second kind.

In the discussion, Dr. Rushman directed attention to some properties reducing the practical usefulness of titanates. One of these is their relatively low breakdown strength. Owing to the minimum thickness required for mechanical reasons, this is no serious disadvantage unless voltages above 500 V are used. Another disadvantage is the fact that the titanates, being ceramics, cannot be used in such thin layers as dielectrics like paper. The marked dependence upon temperature of the permittivity is also a drawback for general use. Dr. Rushman observed that in general a ferro-electric material can never be a really stable dielectric because its ferro-electric properties are due to a certain instability of its structure. Nevertheless, the high permittivity of the titanates makes them useful dielectric materials for special purposes.

Dr. H. F. Kay (University of Bristol) contributed data indicating the way in which domains in barium titanate single crystals are arranged. Domain boundaries follow 101 or 011 planes, and the domains are often laminar. Dr. Devonshire pointed out that this need not contradict his postulate that for the most favourable conditions of potential energy domains should be elongated. The large domains found optically may be subdivided into smaller domains of equal c direction but different direction of polarization. Dr. Kay then showed that the structural changes in barium titanate and solid solutions of barium and strontium titanate can be explained with surprising accuracy if one assumes the barium and oxygen ions to be rigid spheres with the conventionally accepted ionic radii. This assumption even gives the right value for the spontaneous polarization. However, as Dr. Kay pointed out, the physical meaning of the changes could scarcely be so simple.

Mr. M. G. Harwood (Philips Electrical, Ltd.) reported experimental results regarding the lattice parameters of the tetragonal, ferro-electric form of barium titanate over a wide range of temperature, directing particular attention to changes which occur at points below room temperature, where other workers had previously found anomalies in the dielectric properties. The axial ratio c/a, although on the whole increasing steadily with decreasing temperature, shows discontinuities at approximately +5° and −70° C., a sudden drop in the ratio being recorded at each of these temperatures. This was analysed in terms of anomalous changes of the lengths of the tetrad and diad axes, which at all other temperatures vary in a continuous and regular manner. X-ray and optical examination shows that at these two particular temperatures, where two structures co-exist over about 10° C., the domains change their direction of polarization in the absence of an applied electric field. The reason for this still awaits an explanation; but it may account for the peaks in permittivity at these points.

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GEORGE STEPHENSON, 1781-1848

ON August 12, 1848, a century ago, George Stephenson died at his home, Tapton House, Chesterfield, at the age of sixty-seven, and was buried in Trinity Church in that town. For some years he had been more concerned with his properties than with railways, taking special delight in horticulture and his Derbyshire collieries. His father had been a fireman at a Northumberland coal mine, and Stephenson himself had passed his boyhood amidst coal pits, pumping and winding engines. He had become an assistant fireman when fifteen, was the mechanical engineer at Killingworth Colliery at thirty-one, built his first colliery locomotive at thirty-three; his first railway was that laid down at Hetton mines a little later, and the famous Stockton and Darlington Railway, of which he was the engineer, was designed primarily for mineral traffic. His interest in collieries was therefore life-long.

The story of Stephenson's rise from obscurity to fame is a familiar one in industrial history. Born in the lowliest circumstances, he enjoyed none of the early advantages of Watt or Smeaton or Rennie, and it was only when eighteen, through his own perseverance and industry, he learnt to use a pen and entered the magical world of books. His mechanical ingenuity, however, was evident from the first; and it was only a year after he constructed his first locomotive, *Blucher*, that he devised the 'Geordie' miners' safety lamp, for which he was given £1,000 by his fellows. The reputation thus gained was increased by his success at Hetton, and at a time when the mechanical world was divided over the respective merits of horses, stationary engines and 'travelling engines' for industrial railways he was able to prevail upon the Darlington manufacturer, Edward Pease (1767–1858), to use locomotives, except for steep inclines, on the Stockton and Darlington line.

Moreover, through the confidence Stephenson inspired, he was enabled to secure the co-operation of Pease and others in founding the first locomotive-building works in the world. Set up at Newcastle in 1823, under the title R. Stephenson and Co., the firm supplied many of the most famous of all early locomotives. George Stephenson was then in his 'forties, his son Robert in his 'twenties, and it is impossible to dissociate the work of one from the other. Generally it may be stated that the period 1820–25 saw the construction and opening of the Stockton and Darlington Railway and the period 1825–30 the construction and opening of the much more important Liverpool and Manchester Railway, on which in 1829 took place the epoch-making Rainhill locomotive trials, which decisively placed the steam locomotive in the position of supremacy.

Needless to say, the steam railway would have come if George Stephenson had never lived; but it was his good fortune to be in the current of affairs at a critical time, and to be endowed with both the mental and physical characteristics necessary for the task which lay ahead. The locomotives of Trevithick, Hedley and Blenkinsop had preceded Stephenson's, while railroads or tramways had been in use a very long time. Then, too, many men, without any claims as inventors or engineers, saw what was possible, and their views were shared by men of high commercial standing. Before the Stockton and Darlington Railway was started and before Stephenson's factory at Newcastle was opened, in 1820 Thomas Gray, who died in poverty two months after Stephenson passed away, published his little book entitled "Observations on a General Iron Railway", which ran through five editions in five years, and contained plans for trunk lines from London to Falmouth, Dover, Edinburgh, Holyhead, etc. Still other promoters were William James, Nicolas Wood, the mining engineer, and Charles Maclaren, the editor of *The Scotsman*.

By this time the advancement of civil engineering and mechanical engineering in the eighteenth century had given Britain great constructional works and engine shops, the supply of iron for rails, boilers and engines was ample and many men were ready to follow in the footsteps of Stephenson. His lines and his shops, too, provided the training grounds for the future railway engineers, and so it was that with the completion of the Liverpool and Manchester Railway the great era of railway construction began. In Great Britain alone, by 1840 there were more than 800 miles of lines open, by 1860 more than 10,000 and by 1880 some 18,000 miles. Not a single engineer of those days would have denied that the world was entitled to regard George Stephenson as 'the father of railways'.

NEWS and VIEWS

Sir Francis Darwin (1848–1925)

THE third son of Charles Darwin gave early evidence of a scientific bent. Born at Down a century ago, on August 16, 1848, he took his degree at Cambridge in 1870 with a first class in the Natural Sciences Tripos. After studying medicine at St. George's Hospital, London, and obtaining the Cambridge M.B. in 1875, he acted as his father's secretary for eight years. In 1884 he was appointed lecturer, and four years later reader, in botany at Cambridge. At that time plant physiology was beginning to supersede the study of systematic botanical description. Francis Darwin's class-book "The Practical Physiology of Plants" (1894) went into several editions, for it was the first book of its kind in Britain. His researches on growth curvatures in plants and on the control of water-loss by plants attracted considerable attention. He was a popular lecturer, being engagingly simple and direct. Though possessed of strong prejudices and inclined to be intolerant, his was a lovable personality, charming, kindly and humorous. He was an accomplished musician and devoted to dogs, which, unlike human beings, never bored him. Many honours came his way. Elected a fellow of the Royal Society in 1882, he was foreign secretary during 1903–9 and vice-president in 1907. In the following year he became president of the British Association, and he was knighted in 1913. He died at Cambridge on September 19, 1925. It is appropriate that his best and best-known book should be the "Life and Letters of Charles Darwin" (1887).

Statistics of the Ministry of Labour and National Service

THE standing Interdepartmental Committee on Social and Economic Research was appointed in January 1947 to survey and advise upon research work in Government departments and in particular to bring to the notice of departments the potential value for research purposes of the material which they collect, and to suggest new methods and areas of collection. It has also to advise on how there could be made available to research workers information gathered for their own purposes by the departments which has potential value as material for research. The Committee has selected as the first major department for survey (London: H.M. Stationery Office. 9*d*. net) the Ministry of Labour and National Service, which has a tradition of co-operation with research workers. The first results of this survey have been published as a booklet which describes the development of the Ministry of Labour's Statistical Service and the information at present collected by the Ministry on employment and unemployment, wages, earnings, hours and industrial relations, retail prices and family budgets, the changes which have occurred in the form of collection and the effect upon the comparability of successive statistics. In addition to a list of published sources of information, there is included a subject index to published sources of Ministry of Labour statistics. The booklet is experimental in form; but it is hoped that it will prove of value to teachers and students in the universities as well as to other research workers, and criticism and suggestions for improvement will be welcomed by the Committee.

Marconi Transmitters for East Africa

A NEW system of short-wave radio communication is planned in East Africa, where a total of forty-eight Marconi short-wave transmitters are to be installed to provide a comprehensive communications network for ground-to-air and point-to-point communications for the rapidly expanding civil aviation services—both local and trunk routes—and for administrative, public and meteorological traffic. The new services, which will operate throughout the three territories of Kenya, Uganda and Tanganyika, are required to meet the needs of post-war expansion and re-organisation of the East Africa Posts and Telegraphs Department's Services. Two of the latest types of Marconi transmitters have been chosen for this new service. They are Type *TGS*. 541—a 200-watt transmitter with a frequency range of 1·5–23 Mc./s., and Type *TGS*. 501—a 100-watt set covering a frequency range of 1·5–13 Mc./s. Both types of transmitter are compact, easily operated equipments designed for operation on radiotelephony or telegraphy. Special features include crystal-control with provision for the rapid selection of any one of six working frequencies—a particularly useful asset where a large volume of traffic is handled. Frequency tolerances are well within the very fine limits laid down by international regulations. Work has already begun at the Marconi Company's Chelmsford Works on the construction of the first of these transmitters which are to be installed at Mbeya Airfield, Tanganyika.

Quarterly Journal of Mechanics and Applied Mathematics

THIS new journal is intended to provide a medium for the publication of papers on classical mechanics and mathematical techniques. The first number dated March 1948, which has recently been issued contains papers by D. C. Pack, R. Hill, D. R. Hartree and S. Johnston, W. G. Bickley, S. Goldstein, A. D. Young, M. J. Lighthill, and Sir Geoffrey Taylor. Rather more than half of these papers deal with hydrodynamics and its applications to aerodynamics or internal ballistics; the others deal with elasticity or methods and results useful in computation. The editors are Prof. G. C. McVittie and Prof. V. C. A. Ferraro, assisted by an editorial board which includes most of the leading British applied mathematicians. The publishers are the Oxford University Press, and the subscription is £2 a year for the four numbers.

Earthquakes during June

DURING June there occurred at least nine world-shaking earthquakes and a great number of smaller ones. The greatest two of the month were that on June 28, which caused heavy casualties and severe property damage in and around Fukui, West Honshu, Japan (*Nature*, July 10, p. 57) and which gave ground amplitudes at Durham of 115μ, and that on June 30 which caused casualties and property damage on the island of Levkas and the nearby mainland of Greece and gave ground amplitudes of 220μ at Kew. The other great shocks were on June 15 near the southern coast of Honshu, Japan; on June 18 in the Solomon Islands region; on June 21 in the Celebes Sea; on June 27 (2) off the northern coast of Honduras and south of the Alaska Peninsula; and on June 29 (2) in the Samoan Islands region and in Transcaucasia. An earthquake only slightly less intense occurred on June 13 from a focus the epicentre of which was near lat. 43° 31′ N., long. 12° 8′ E. This caused some property damage and at least one death at Sa epolcro in the Italian Province of Arezzo. Also uring the month there was a swarm of earthquakes ı the Karlsruhe, Rasstat, Lauterbourg area. The warm began on June 1 and lasted practically the hole month, the greatest shock of the series being lt on June 7 with scale VI to VII (some chimneys own) at Karlsruhe. The epicentre of this shock was ear lat. 49° 04′ N., long. 8° 19′ E. some 9 km. orth-west of Karlsruhe, and the depth of focus has een estimated at 20–30 km. The energy of the ocks of this swarm did not travel far, but was ecorded by the seismographs at Strasbourg, Stuttgart nd the Swiss observatories. Apart from the observa- ories mentioned above, reports for the month have lso been received from the U.S. Coast and Geodetic urvey, Aberdeen, Beograd, Cleveland (Ohio), De ilt, Toledo and Uccle.

ialactic Noise

R. v. d. R. Woolley has discussed in a recent aper (*Mon. Not. Roy. Astro. Soc.*, 107, 3; 1948) the ieory of the origin of the galactic radiation. Since udio workers consider it short-wave radiation and ectroscopists regard it as very long-wave radiation, is undesirable to refer to it by a name embodying ny idea of wave-length, and the appropriate term noise' has been adopted since it can be heard on the rphones. Eddington discussed the temperature of nterstellar space in "The Internal Constitution of ie Stars", and estimated it at about 10,000°; but ter he suggested that the absorption in space of ltra-violet quanta would reduce the temperature. 3y temperature he meant the parameter appearing ı the Maxwellian velocity distribution of the free ectrons.) Woolley investigates the problems of mperature and the degree of ionization in inter- ellar space, and concludes that if the noise is due free-free transitions, it must certainly come from ot regions in interstellar space and almost certainly om regions where the density is above the average. ı these circumstances, if 'cold' regions, that is, gions of low hydrogen ionization, do not contribute ppreciably to the noise, then an observed amount galactic noise from a particular part of the sky nplies a minimum bright hydrogen emission from ıat part. If observation fails to reveal this bright ydrogen emission, the only conclusion is that alactic noise is not due to free-free transitions. If ie noise is due to free-free transitions, it is shown ıat the minimum number of Hα quanta received er sq. cm. per second per unit solid angle of the sky within reach of observation with modern equipment.

inematograph Films of Living Cells

C. C. Speidel (*Amer. Scientist*, 36, 237; 1948) escribes with some very fine illustrations the results e has obtained by fast cinematography of cells inside ie living animal. He used regenerating tail tissue f the tadpole for his observations, and shows that ellular organisation may be studied here with results hich tissue cultures cannot provide. Regeneration f nerve fibres, showing the manner in which their irection and anastomosing take place, mitosis in a erve cell and the relative movements of the two aughter nuclei, the movement of lymphocytes and iapedesis of leucocytes are among the many beautiful esults of this method of observation. The salvaging extravasated blood cell by cell by the sprouting a lymph vessel is startling, while the movement of uscle fibres in contraction and relaxation may be followed step by step. It would seem that this method of analysis would be of great value in further studies of development, especially in the little-known differentiation of plant tissues.

Tests of Mosquito Repellents

When Australian forces began campaigning during the Second World War in the highly malarious islands of the south-west Pacific area, a very urgent need was an effective mosquito repellent. Bulletin No. 213 (1947) of the Commonwealth of Australia Council for Scientific and Industrial Research describes laboratory and field tests conducted by Major R. N. McCullough and Capt. D. F. Waterhouse with this object in view. More than 125 substances were tested for use as repellents against both anopheline and culicine mosquitoes. The chief species used in these experiments were *Anopheles punctulatus farauti*, the yellow-fever mosquito *Aedes ægypti*, and the common pest mosquito *Aedes vigilax*. The work involved was a co-operative investigation between the Council for Scientific and Industrial Research and the Army. Taking all factors into account, dimethyl phthalate was by far the most satisfactory repellent tested. Also, it is almost completely odourless and has very little or no irritant effect on the skin of the hands and face, to which it is applied. A number of other synthetic and naturally occurring substances were tested with indifferent results. Many essential oils were quite ineffective, while the two most promising were too irritant to use. Pyrethrum preparations gave consistently poor results. The treatment of clothing with dimethyl phthalate prevented mosquitoes from attacking through the material, except to a very limited degree, up to 72 hours after application. As a result of these investigations of repellents, and of those on a larger scale in the United States, the manufacture of adequate quantities of dimethyl phthalate was organised and the substance made available to the Australian fighting forces in 1943, some special forces being supplied with it as early as March 1943.

Control of Weeds

Prof. G. E. Blackman, in a short paper on "Recent Developments in the Control of Weeds" (*J. Roy. Hort. Soc.*, 73, 5; May, 1948), summarizes some useful results on the effectiveness of various selective weed-killers. Sulphuric acid gave the best control of goosegrass, *Galium aparine*; methyl-chloro-phenoxy-acetic acid gave the best kill of shepherd's needle, *Scandix pecten-veneris*, and common red poppy, *Papaver rhœas*; and dinitro-*ortho*-cresol was most toxic to scentless mayweed, *Matricaria inodora*, but also gave control equal to the acetic acid compound of *P. rhœas*. The use of sulphuric acid is still most effective, particularly against weeds of the onion crop. Spraying with this acid gives about 90 per cent of the yield obtained by hand weeding and hoeing, but at very much less expense in labour. Charlock is susceptible to control by growth-substance sprays at all stages from seedling to flowering, though poppies are susceptible only as seedlings.

Tomato Spotted Wilt Virus

The disease of tomatoes caused by spotted wilt virus often shows considerable variation in severity. D. O. Norris has now shown (Bull. 202, Coun. Sci. and Ind. Res., Australia; Melbourne, 1946) that this is due to varying combinations of at least five strains of the virus. The paper describes and figures the symptoms of these strains on sixteen host species, and indicates suitable tests for the presence of strains in a particular disease. The thermal death-point of spotted wilt complexes is considered to be about 10° C. higher than the usual value of 42° C. This is a rather unwelcome discovery from the point of view of possible control. On the other hand, the finding of a high degree of resistance to spotted wilt by *Lycopersicum peruvianum* is likely to be of considerable importance in breeding.

Clutch and Brood-size in the Robin

The inquiry into clutch and brood-size in the robin (*Erithacus rubecula*), which was first reported by David Lack in 1946, has now been closed. Later observations show that the breeding season in Holland is later than in Britain but is earlier in North France, Germany and Switzerland than inland in Europe at a similar latitude (*British Birds*, 41, No. 4; April, 1948). The tendency for the average clutch-size of the robin in England and Wales to be highest in May, lower in April, and lower still in March, June and July has been confirmed It has also been shown that the average clutch-size is different in different years and there may be a correlation between fine weather and higher clutch-size. The average clutch-size in Ireland is approximately the same as in England and Wales, but in Scotland the average clutch-size is higher than in England and Wales. Nesting is more successful in May than in April, possibly because in April the ground vegetation is not so well grown as in May, leaving the nests less exposed to predators.

International Committee for Bird Preservation

The report of the British Section of the International Committee for Bird Preservation (The Secretary, c/o British Museum (Natural History), Cromwell Road, London, S.W.7) is a record of much good work. For some years past naturalists and others have been perturbed by the decline in the wildfowl population of the world, and, among other things, the report contains an account of the Committee's work in investigating the situation as it affects the wildfowl of Europe. Among the activities are the ringing of duck to trace their migration routes. A duck decoy at Orielton is being used for this purpose, and ringing on a lesser scale is being carried out at other decoys in Great Britain. In 1947, the headquarters of the Committee, previously in Brussels, were transferred to London, and the British Museum (Natural History) is now the centre of the organisation, which has thirty-four national sections from all five continents.

The Film in Scientific Research

The Sciences Committee of the Scientific Film Association is arranging a one-day conference on "The Film in Scientific Research", to be held on October 12 at the Royal Institution, London. The chair will be taken by Mr. J. E. Cummins, chief scientific liaison officer in London of the Australian Government, and the Conference will be opened by Sir Robert Watson-Watt. The Conference will include discussions by British and foreign men of science on the value of scientific films as a research tool in various branches of science; the function of the research film in giving up-to-date information in a particular field; scientific films as an aid to the training of scientific workers; scientific films as a medium for explaining to the general public important results of scientific research; and techn aspects of the use of films in scientific research. Conference will conclude with a two-hour showin British and foreign research films. Material sugge for discussion and information as to the existenc availability of research films suitable for showin the Conference should be sent to the Hono Secretary, Sciences Committee, Scientific Film A ciation, 34 Soho Square, London, W.1, as soo possible.

Announcements

We regret to announce the following deaths:

Mr. S. G. Brown, F.R.S., known for his work on gyroscopic compass and numerous other mechan instruments, on August 7, aged seventy-five.

Mr. Harry E. Burton, principal astronomer and h of the Equatorial Division of the U.S. Naval Obse tory from 1929 until June 30, 1948, on July aged seventy.

Mr. J. R. Cowie, chairman of Council of the Bri Electrical and Allied Industries Research Associat on August 5.

Dr. Henry Guppy, C.B.E., librarian of the J Rylands Library, Manchester, on August 4, a eighty-six.

The chairman of the Royal Society's Lib Committee, Prof. E. N. da C. Andrade, has accep an invitation by the Council to become hono librarian to the Society during his tenure of chair ship of the Library Committee.

Sir Lewis Fermor, director of the Geolog Survey of India during 1932–35, has been ele *Correspondant Etranger* of the Société Géologiqu France.

Sir Frank Stockdale, chairman of the Colo Development Corporation, has been appointed c man of the governing body of the Imperial Colleg Tropical Agriculture, in succession to Sir Macfadyen, who has been associated with the Col since 1928.

Mr. Seton Lloyd, technical adviser to the Di torate of Antiquities in the Government of Iraq, been appointed director of the British Institut Archæology at Ankara in succession to Prof. Garstang, as from March 1, 1949.

Mr. R. McChlery, former Rhodes scholar since 1926, a member of the Agricultural Departm Salisbury, has been seconded to the Central Afr Council to take up the new appointment of Cen African Scientific Liaison Officer in the Un Kingdom, and to establish a Central African Scien Liaison Office in the British Commonwealth of Nat Scientific Offices, London.

Dr. A. E. A. Werner has recently joined the of the National Gallery, Trafalgar Square, as rese chemist. He was previously reader in chemistr Trinity College, Dublin.

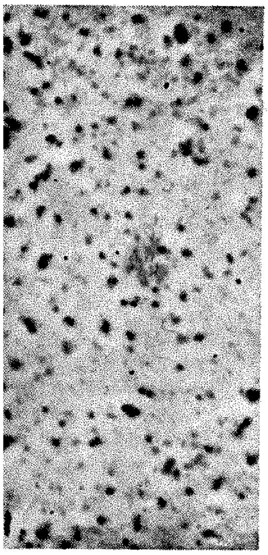
A Conference of German Hygienists and Mi biologists is being held at Stuttgart during August 27. Among the topics to be discussed are: tu culosis in animals and its chemotherapy; immun tion against virus diseases; milk hygiene in Germa human helminthiasis and its chemotherapy; hu and animal trichinosis; rickettsia toxins; phology and ecology of bacteria; bacteriology enteritis; serum reactions, etc. Particulars ca obtained from Prof. G. Lutz, Heusteigstr. Stuttgart-S.

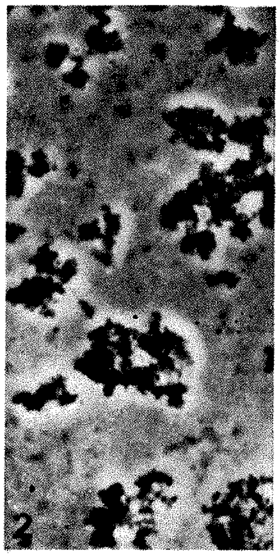
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Phase-Contrast Microscopy of Viruses

Those who have used phase-contrast microscopy ll have been impressed by the apparent high solving power of the method. It is frequently ssible to observe very fine fibrils and particles with clarity hitherto only obtained by dark-ground umination. Thus, I have observed living *Leptospira*, id to be only 0·15 μ in width, as well as very small anules inside bacteria.





It was to be expected, therefore, that at least the rger viruses would be visible by phase-contrast umination, and this has now been verified. Fig. 1 ows a smear of psittacosis virus (× 1600), and g. 2 one of vaccinia (× 1600). The preparations ere unstained and mounted in water. It is important distinguish between ***visibility*** and ***resolution*** of the rticles. The photographs were taken with commercial (Cooke, Troughton and Simms) equipment, ing an oil immersion lens, rated N.A. 1·3 with ase-ring diameter approximately two thirds of the erture. The expected resolution under these contions, using green light, would be of the order 0·3 μ. One would thus scarcely expect to obtain true resolution of virus particles; but that does not eclude the possibility of detecting their presence. ius, the vaccinia particles seemed spherical, not rrel-shaped, as in the electron microscope. The tter appearance may, of course, be due to a drying tefact.

As a rough approximation, it would be expected at particles below the limit of resolution would pear to remain about the same order of size, but ould have less contrast, appearing in shades of ey instead of black. The visibility of small particles the phase-contrast microscope depends on conast, which is in turn governed by the refractive dex of the particles and by the characteristics of e apparatus. Leaving aside the possibility of improving contrast by variation of the refractive index of the mounting medium, perhaps the most hopeful method of increasing the visibility is by alteration of the phase, and particularly the amplitude, characteristics of the phase plate. Given favourable material, there is probably no reason why much smaller viruses should not be seen, using a strongly absorbing phase plate with an intense light source.

It remains to be seen how useful the method will prove in virus research. It is valuable in that it allows fresh unstained material to be used; but it is, of course, non-specific and there is no simple means of distinguishing viruses from other small particles. An obvious application is to the study of the development of virus bodies in living cells.

I wish to thank Prof. S. P. Bedson for supplying the virus material.

Robert Barer

Department of Human Anatomy,
Oxford.
July 10.

Experimental Hydronephrosis Studied by the Colchicine Method

The colchicine method was first used to study compensatory hypertrophy of the kidney by A. P. Dustin and S. Zylberszac[1,2], who noticed that a few days after ligation of the ureter, colchicine induced numerous 'stathmocineses' (arrested mitoses) in the kidney (Fig. 1).

This phenomenon has been reinvestigated in the adult rat, nine hours after injection of 2·0 mgm./kgm. of colchicine, mitosis being counted in the obstructed and the opposite kidneys. The total number of divisions was counted in median sections and, in order to compare the figures more accurately, these were corrected per 100 gm. of animal weight (Fig. 2).

In the obstructed kidney, two days after ligation, numerous stathmocineses are found in the interstitial cells, convoluted tubules, loops of Henle, distal convoluted tubules and collecting tubules. None is seen in the glomeruli. The mitoses remain numerous during the five succeeding days, especially in the proximal convoluted tubules. After one week, mitoses decrease as the kidney undergoes progressive atrophy through dilatation of the pelvis. In the opposite kidney, mitoses in the tubules increase on the

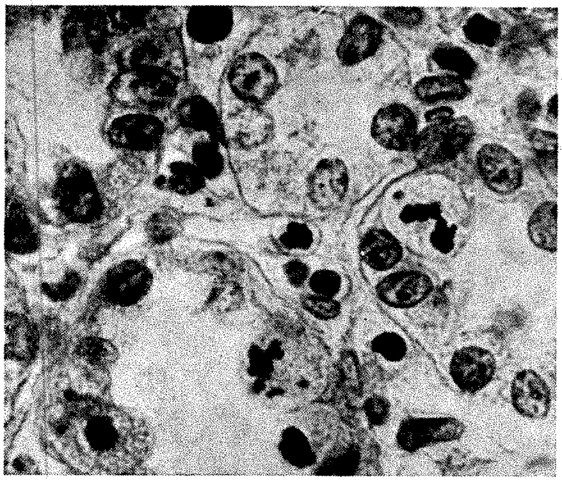


Fig. 1. Stathmocineses in convoluted tubules six days after renal obstruction

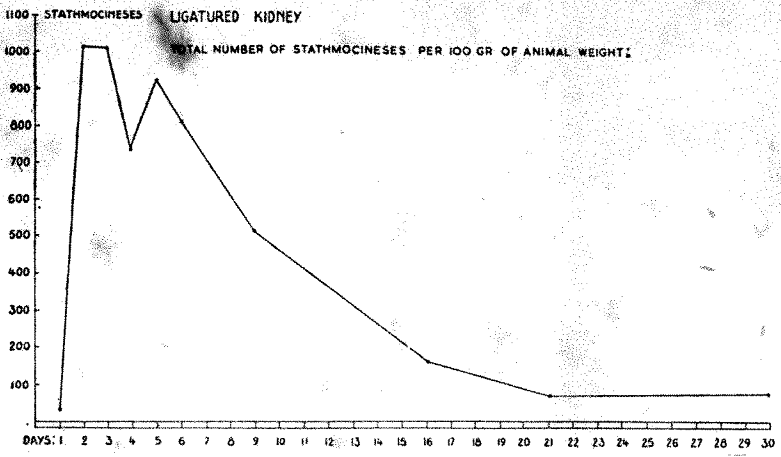


Fig. 2

second day after ligation, and reach a maximum at four days. The number of these mitoses remains at about the same level for as much as thirty days, the level being similar to that observed by the same method in compensatory hypertrophy.

These results are, in our opinion[3], comparable with those of Hartman[4], and Bollman and Mann[5]. These authors created uretero-intestinal fistulæ, leading to a slow reabsorption of urine in the intestine. They observed hypertrophy of the kidneys and also an acceleration of compensatory hypertrophy, with numerous mitoses in the tubules. Wilson[6] supposed that the hypertrophy of the kidneys may be induced by some urinary components. In hydronephrosis, their reabsorption by the kidney tubules would first promote mitoses in the ligated kidney. Soon after, these same substances, taken back by the general circulation, would stimulate cellular proliferation in the opposite kidney.

These experiments may be expected to throw more light not only on the mechanism of compensatory hypertrophy, but also on the chemical nature of the stimulus. Detailed results will be published shortly in the *Bulletin de l'Académie Royale de Médecine de Belgique.*

MARC HERLANT
Laboratory of Pathological Anatomy,
University of Brussels.
June 30.

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Induced Adenocarcinoma of the Stomach in Mice

THE great rarity of malignant tumours in the glandular stomach of all lower animals is generally admitted. The only records of spontaneous adenocarcinoma in mice seem to be three cases among 142,000 post-mortem examinations by Wells, Slye and Holmes[1], two in *Mus musculus* and one in *Peromyscus*. Strong[2] has reported adenocarcinoma in mice of his *NHO* line, derived from ancestors injected with methylcholanthrene and selected for resistance to local sarcoma-indu
tion ; but these animals are
representative of the species.

Two series of mice fed by
with cotton-seed oil previou
heated to 350° C. for four ho
have yielded tumours of t
stomach unlike any that we ha
seen in other mice of similar a
in a variety of experiments dur
the past twenty years.

In the first series, forty-eig
mice of mixed stock bred in t
laboratory were fed on rat-cak
and drank daily a solution
heated cotton-seed oil (40 m
plus croton oil (4 ml.) dissolved
ether soap solution (356 ml.
diluted with ten volumes of wat
During the first year of expe
ment the ether was evaporate
but afterwards this was not done, as it was thoug
that the ether might improve the miscibility of t
oil with the gastric contents. This solution contain
1·0 per cent of heated cotton-seed oil and 0·1 p
cent croton oil, later reduced to 0·05 per cent becau
some animals died with hæmorrhages from the *pa*
glandularis of the stomach. The average daily co
sumption per mouse was 5 ml.

Of nine mice that survived for eighteen mont
two developed papillomas of the fore-stomach a
one died with a massive malignant tumour involvi
both parts of the stomach. This tumour show
evidence of multiple points of origin and includ
squamous papilloma and carcinoma in the fo
stomach and adenoacanthoma in the glandul
stomach. There was a secondary deposit of t
latter type of tumour in a mesenteric lymph no
The last survivor of this group died after twent
nine months of experiment, with four papillomas
the fore-stomach but no lesion of the glandul
stomach.

In repetitions of this experiment, only tumours
the fore-stomach have so far occurred.

These experiments are summarized in the acco
panying table.

In the second series of experiments, mice of simil
origin were fed on powdered rat-cake containi
0·5 per cent by weight of black pepper. The drinki
water contained 1·0 per cent heated cotton-seed
in soap solution as previously described. Of fi

Diet	Initial No. of mice	Stomach tumour incidence in survivors after first tumour	Duration of expt. at time of first tumour (days)	Diagnosis
Heated cotton-seed oil plus croton oil	48	3/9	540	Single squamou papilloma; 1 mixe squamous papill oma, squamous car cinoma and adeno acanthoma; 4 squa mous papillomas
	12	1/3	387	1 big papilloma
	12	1/9	406	1 small papilloma
	12	1/5	452	1 medium papillom
Croton oil only	12	1/6	487	1 small papilloma
Unheated cotton-seed oil only	12	1/11	310	Polyposis of pylori canal
Cotton-seed oil plus croton oil	12	1/2	501	Polyp in duodenum close to pylorus

rvivors for sixteen months, one died at that time ith a large ulcerated tumour involving the pylorus ıd proximal part of the duodenum. This proved be an adenocarcinoma, which had invaded the ncreas and a lymph node by direct extension. The her four survivors are still living after twenty-four onths of experiment.

In another experiment, twelve mice on similar et yielded no tumours in two that survived for ore than fifteen months. In 309 mice of similar igin in other experiments not involving known rcinogens, no gastric tumours were found.

We have not been able to identify any known rcinogen in any of the heated fats or lipids, examed by methods that will detect one part in ten illion of 3 : 4-benzpyrene. Moreover, even the esence of traces of known carcinogens would not count for the induction of adenocarcinoma of the omach, since very large numbers of mice have been inted with potent carcinogens in many laboratories ıd must have licked off and swallowed considerable nounts without a single case of gastric adenorcinoma being recorded. In this laboratory, mice d with known carcinogens have frequently deloped papilloma and carcinoma of the fore-stomach, ıt no tumours of the glandular stomach have curred.

Evidence that heated fats and lipids contain tential carcinogens was recently reviewed by one us[5]; but the induction of stomach tumours in mice feeding experiments with such substances are few d not generally accepted. Waterman[6] claimed one se of adenocarcinoma of the stomach in a mouse d with heated cholesterol oleate; but this has not en confirmed. Roffo[7] made numerous claims to ve induced adenocarcinoma of the stomachs of rats d on a variety of heated fats; but his copious ustrations do not support this diagnosis, and the ork has not been confirmed. The two cases reported re cannot be statistically assessed; but it seems ore probable that they were the result of the periment than of chance.

P. R. Peacock
S. Beck

Research Department,
lasgow Royal Cancer Hospital,
132 Hill Street, Glasgow, C.3.
June 21.

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Physical Nature of Mouse Brain

Most histologists refer to the possible existence of ground substance in the brain. Neurofibrils or glial res of the cortex impregnated in a successful silver eparation by no means completely fill the space ailable. Presumably in life these nerve terminals d glial fibres are even further separated from one other, since the processes of fixation, dehydration, c., produce considerable shrinkage.

The physical properties of mouse brain as a whole, of a piece of excised cortex, suggest that this is a bstance with a continuous structure resembling that of a firm paste. It is opaque, soft, sticky, almost plastic, with a marked avidity for water.

Using either direct or dark-ground illumination, a film of fresh brain tissue appears granular, the separate granules adhering to one another and giving the whole field a hazy appearance. This granularity is evident at a magnification of × 80 and is best studied by means of dark-ground illumination at × 1,000[1]. Even at this magnification separate granules are not distinct. Some show Brownian movement; but the majority adhere to one another, forming a more or less continuous film. Pressure on the coverslip causes sluggish streaming movements; but on releasing the pressure the displaced parts recoil and the original appearance is restored. A piece of fresh cortex was placed in 1 per cent aqueous methylene blue for one minute, crushed between two slides and examined by direct illumination. Movement between the two slides or light pressure caused streaming displacements of the blue cortical cells in an unstained granular matrix. On cessation of movement or release of pressure the original grouping of cells was restored. The cells themselves showed marked elasticity and could not be ruptured. They were intact, suggesting that the granularity was not due to cell debris. Heavier pressure merely thinned the film by causing a gliding movement of brain substance towards the edge of the preparation with extrusion beneath the borders of the covering slide.

It has been pointed out that the cells and fibrils impregnated with silver do not occupy all the available space in a histological preparation. It seems improbable that the granularity described merely represents the fresh state of those structures which become impregnated with silver in fixed tissue. A strong impression is received that this granular substance is the ground substance of the brain, being present in considerable quantity in the mouse cortex.

M. C. H. Dodgson

Department of Pathology,
St. Thomas's Hospital Medical School,
London, S.E.1.

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Some Unusual Findings on the Carcinogenic Action of Urethane in Mice

The induction of pulmonary tumours in mice following ethyl carbamate (urethane) treatment was originally described by Nettleship, Henshaw and Meyer[1] and has been confirmed by numerous workers. Similar effects of urethane in the rat have been noted by Jaffe[2]. The lung tumours described have been adenomata, usually multiple, appearing by three months after oral or injected, single or multiple doses of urethane (solutions of 5 or 10 per cent). In histological appearance the tumours are the same as spontaneous lung tumours arising in strain *A* mice and are of relatively low-grade malignancy. Successful transplantation has not been reported. The findings reported below were obtained on Rockland 'Swiss' albino mice in experiments investigating the carcinogenic action of urethane. The preliminary results obtained are so unusual that they are presented in a very incomplete form, so that the effects may be looked for by other investigators and the apparent action considered by those using urethane for clinical therapy. More detailed results will be presented shortly from a repetition of these and other experiments now in progress.

(1) Seven young female mice, 20 gm., received a single subcutaneous injection of 25 per cent urethane in a 5 per cent solution of zinc acetate, 0·1 c.c. per 10 gm. body weight, with the view of slow absorption. Such an injection caused a local tissue necrosis which healed in two to three weeks. After three months and four months respectively, in two mice a rapid general enlargement of lymph glands was noted. Both animals, at autopsy three weeks later, showed extensive lymphosarcoma, all glands being involved and markedly enlarged. Histologically the tumours were highly malignant, and extensive spread to gut, liver and kidneys was noted. The usual lung adenomata were also present. A third mouse after five months developed a slower growing tumour behind the humerus (at least one inch from the injection site). At autopsy a large, spongy, blood-filled tumour was found. Histologically the sections showed a malignant hæmangio-endothelioma, and no metastases were noted. Lung adenomata were present. Spontaneous malignant tumours of these types have never been observed in more than a hundred mice of the same strain and age used for other experiments in the laboratory. Control experiments using 25 per cent urethane and 5 per cent zinc acetate alone, and other substances causing retardation of absorption[3], are not yet complete.

(2) The lungs of a mouse containing multiple large adenomata induced by previous urethane treatment (discontinued for the previous five months) were ground in saline and injected into sixteen mice. One half of the group received intrapleural, and the other half subcutaneous, injections. After six months, four of each group were killed. Two mice of the first group and all four mice of the second group showed single or multiple lung adenomata. These tumours were typical of those induced by urethane injections.

(3) The lungs of mice which had received a single subcutaneous injection of 0·1 c.c. per 10 gm. body-weight of 5 per cent urethane 3, 6, or 24 hours previously were ground up and injected into normal female mice. The equivalent of one lung was given to each animal by subcutaneous injection. Four animals of each of these three groups were killed five to six months later. Eleven of the twelve animals showed single or multiple lung adenomata similar in all respects to those caused by urethane injections. No other lesions were noted.

(4) Experiments using lung suspensions similar to those of paragraph (3), but made from animals which had received three daily injections of urethane, showed the same result, three of four mice developing lung adenomata.

(5) One control experiment was performed in which lungs from normal uninjected mice were administered in the same fashion under the same conditions. At autopsy, three mice which had received the injections did not show any lung adenomata.

It is obviously inadvisable to speculate on the significance of these preliminary experiments until more extensive ones have been completed. It appears, however, that rapidly growing, highly malignant tumours have been produced in mice following the injections of a strong urethane solution and zinc acetate. In other experiments a suspension of the lungs of mice which had received small doses of urethane, when given subcutaneously, produced adenomata of the lungs in a high percentage of animals. Although it is possible that the injected urethane might be concentrated in the lung tissu there was no experimental evidence to suggest th as the explanation of these observations.

This work has been carried out with grants in ai from the National Cancer Institute of Canada an the Ontario Cancer Research Foundation.

R. L. Noble
M. Jean Millar

Collip Medical Research Laboratory,
University of Western Ontario,
London, Ontario.
June 30.

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Reaction of Effector Cells to Chemical Transmitters

Earlier work has led us to the view that th intervention of peripheral elements has a fund mental role in the regulation of nervous activity This regulation, in fact, is not exclusively conditione by the nature of the transmitter or by its mode formation. It depends to a great extent on the mor or less specific reactions of the effector cells to th substances liberated by nerve stimulation. Thus tw transmitters, acetylcholine and adrenalin, act in different way on organs like the heart and th intestines, which present different histological stru tures. But adrenalin causes contraction of the uter of the pregnant cat and relaxation of the uter of the non-pregnant cat, that is, the action of th same transmitter is dependent on the functional co ditions of the reacting tissue. This suggests th possibility of local intervention of sex hormones i the peripheral regulation mechanisms of the uterus for it has been shown by Courrier that these hormon are capable of direct action on that organ and th the hormonal antagonism between œstrin and pro esterone, for example, is directly concerned with i effector cells.

We have therefore carried out more general exper ments on the isólated uterus of the rabbit, whic was the test-organ of Courrier, to find out to wha extent the responses of this organ to acetylcholin and adrenalin may be influenced by previous trea ment with different sex hormones.

The rabbit uterus reacts to acetylcholine as we as to adrenalin by contraction. This analogous actio is remarkable; for the effects of both are not onl inhibited by atropine, but also sensitized by eserin The actions of the two transmitters can, howeve be differentiated by yohimbine, which reduces th effect of adrenalin without modifying that of acety choline; and we observed also that relatively sma doses of adrenalin could produce contractions i uteri which showed very slight sensitivity to acety choline. It thus appears scarcely likely that adrenali produces its contracting effect by mobilizing acety choline in that organ.

This curious synergism of the two transmitters not affected by sex hormones. The untreated uteru of very young animals is absolutely insensitive to th two substances, and becomes sensitive to both afte 30–50 γ of œstrin have been administered to th animals over a period of several days. The sam modifications occur with the uteri of ovariectomize rabbits. This evolution of sensitivity: (1) does not increase with the administration of larger amounts of the hormone than the active dose; (2) is not peculiar to œstrin, but can also be obtained with testosterone (1–10 mgm.), progesterone (1–10 mgm.), desoxycorticosterone (1–10 mgm.), or with a mixture of œstrin and progesterone initiating the classical transformation of the uterus mucosa described as 'dentelle'. The reaction of the uterus to the transmitters seems, however, more marked after the administration of testosterone or œstrin than after that of desoxycorticosterone.

But this apparent uniformity of response hides very complex cell changes. When the rabbit uterus is immersed in Tyrode solution for 15–90 min. in the presence of oxygen and at a temperature of about 37°, it gives off a substance which is capable of decreasing the muscular tone of an isolated intestine preparation. This tone can be increased by the fluid obtained in the same circumstances from the uterus of an animal which has been treated with testosterone. The latter effect may also be observed, though generally to a lesser extent, with fluids obtained from rabbit uteri treated with progesterone alone or combined with œstrin. The liquid obtained after desoxycorticosterone sometimes provokes an amplification of the spontaneous intestinal movements. We conclude from these results that sex hormones are capable of creating modifications in the biochemical reactivity of the receptor cells of the uterus which may result in the secretion of substances capable of influencing in a more general way the tone of unstriated muscles, and of acting by this indirect mechanism on the humoral agents of the autonomic nervous system.

These results, however, do not explain why the same transmitter, adrenalin, causes the uterus of the rabbit to contract and the uterus of the guinea pig to relax, that is, of animals of the same species presenting analogous hormonal levels. We therefore administered a small dose of adrenalin to the isolated rabbit uterus and transferred, after contact varying from 15 to 40 min., the surrounding fluid to an isolated guinea pig uterus. This fluid produced a contraction of the guinea pig uterus which originally reacted to the administration of adrenalin with relaxation. The effect is not reciprocal in character; fluid obtained after the action of adrenalin on the guinea pig uterus still has a contracting effect on a rabbit uterus. On the other hand, when the fluid containing adrenalin after having been in contact with the rabbit uterus is transferred to the isolated intestine, it causes the usual inhibitory action of adrenalin on that organ, and a fluid containing adrenalin after having been in contact with the small intestine continues to produce contraction of the isolated rabbit uterus.

These findings suggest the presence of a special agent in the rabbit uterus conditioning the paradoxical action of adrenalin on that organ. They suggest in a more general way that the biological analysis of isotonic liquids which have been in contact during various periods and under various conditions with isolated organs may constitute a profitable method for the study of the behaviour of effector cells.

B. Minz

Laboratoire de Physiologie générale de la Sorbonne,
Paris.

April 20.

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A Nemestrinid Parasite of *Schistocerca gregaria* (Forsk.)

During dissections of an immature male specimen of the desert locust, *Schistocerca gregaria* (Forskål), a yellowish larva of Nemestrinidæ was found feeding on the testes and the surrounding adipose tissue. It was 1 cm. long. Its posterior end was surrounded by a chitinous cup leading to a slender respiratory tube *c.* 2 cm. long, which was constricted transversally along its whole length (these constrictions disappear when pressed during the preparation). The respiratory tube went longitudinally along the midgut and then was bent at right-angles towards the spiracle of the first abdominal segment. The tube was more or less uniform in width, becoming dilated at the cup surrounding the posterior spiracle of the larva. The end of the tube entered the meeting place of the tracheæ, which was considerably expanded. The chitin of this end was blackish-brown, due to pathological changes.

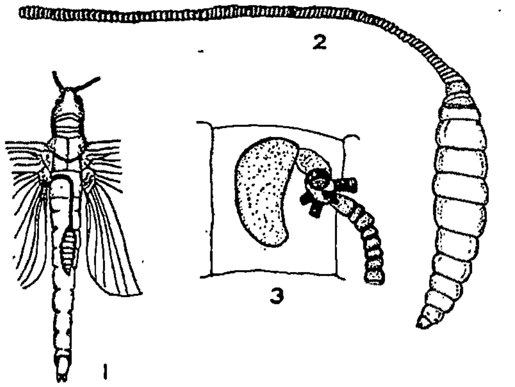

Fig. 1. *Schistocerca* dissected showing the Nemestrinid larva with the respiratory tube. ⅓ Nat. size
Fig. 2. Nemestrinid larva with the respiratory tube. × 3
Fig. 3. The spiracle, tympanal organ and the respiratory tube shown from inside

Potgieter[1] has described a Nemestrinid *Simmictus costatus* (Lw.) developing inside the body of *Locustana pardalina* (Wlk.) in South Africa. Noble[2] described larvæ, pupa and adult of *Trichopsidea œstracea* (Westw.) from *Chortoicetes terminifera* (Wlk.) in Australia. Fuller[3] has given a full description of *Trichopsidea œstracea* (Westw.) on various grasshoppers there. Crouzel and Salavin[4] described in detail two species of *Neorhynchocephalus*, *N. sulphureus* (Wied.) and *N. vitripennis* (Wied.) parasitizing the Acrididæ *Trigonophymus arrogans* Stal. and *T. elongatus* Giglio-Tos.

Unfortunately, our larva remained unidentified, as the attempt to transfer it into the body of another grasshopper failed. According to Dr. B. P. Uvarov (in correspondence), this is the first record of a Nemestrinid parasite of *Schistocerca gregaria*. I wish to express my thanks to Dr. Uvarov for his help and criticism in the preparation of this note.

A. Shulov

Hebrew University,
Jerusalem.

Feb. 3.

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[2] Noble, N. S., *Agric. Gaz., N.S.W.*, 47, 383 (1936).

[3] Fuller, M. E., *J. Coun. Sci. Indust. Res. Aust.*, 11, No. 2, 202 (1938); *Proc. Linn. Soc., N.S.W.*, 63, 95 (1938).

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Antiquity of Man in Australia

For nearly eighty years, one of the most prominent items of anatomical evidence in support of the antiquity of man in Australia has been a fragment of a supposed human molar, found by Krefft in the Wellington Caves of New South Wales.

Early doubts expressed as to the value of its evidence were based on the possibility of its adventitious presence in the caves. These doubts were afterwards dispelled by eye-witnesses, and it is now accepted that the tooth, when found, was imbedded in the characteristic cave breccia, together with remains of *Diprotodon* and *Thylacoleo*. According to the estimate of Sir Edgworth David in 1923, the association dates back to a period 7,000–12,000 years ago.

The fossil has been discussed by Krefft (1870–74), Etheridge (1890–1916), David (1923) and Anderson (1933), all of whom have accepted its human origin.

Recently, the human origin of the fragment has been questioned by Dr. T. D. Campbell, and I have considered *de novo* its possible relation to the lower mammals. To this end, the morphology of the fragment and the type and sequence of the attrition which have produced its crown pattern have been minutely compared with all indigenous Australian mammals, with all introduced and domestic mammals, and with many exotic species as well, which could possibly yield a dental fragment of the size of the fossil. Three chief results have accrued from this examination.

(1) The fossil is derived from a tooth possessing extreme functional brachydonty. At the same time, the occlusal surface exhibits large exposures of dentine in juxtaposition with broad enamel structures. While both features may be separately found in the molars of a few mammals, their concurrence in the same species is generally precluded by the structural ground-plan of the tooth. Consideration of this fundamental peculiarity of the fossil early led me to abandon the view that it was a molar tooth at all.

(2) On transferring attention to premolar teeth, close analogies in structure were soon found to exist between the fossil and the third and fourth premolars of the Macropodinæ, in an advanced stage of wear. In particular, the highly characteristic pattern of the occlusal surface of the fossil is very closely reproduced in the premolars of the black-tailed wallaby (*Macropus walabatus* L. and G.), and a study of the successive stages of attrition through which such teeth have passed correlates in the clearest way all the main structures of the fossil, with their originating centres in the unworn premolar.

(3) After direct comparison with relevant material, and with the above general conclusions as a guide, I have no doubt that Krefft's find was derived from the posterior half of the upper fourth premolar or seccator, of the right side, of *Macropus* (*Protemnodon*) *anak*, Owen, a giant Pleistocene 'wallaby', remains of which are already known from the caves, and which occur also in profusion in beds of similar and earlier age over a wide area of eastern and south-eastern Australia.

A detailed, illustrated account will follow.

H. H. Finlayson

South Australian Museum.
March 30.

Origin of the Golden Hamster *Cricetus auratus* as a Laboratory Animal

The golden (Syrian) hamster *Cricetus auratus* is now being bred in scientific institutions in Europe and America and has proved useful for various experimental investigations. Workers from different countries have written to me inquiring about the origin of the golden hamster, which is now widely distributed in many laboratories. Some of the correspondents are interested in using *Cricetus auratus* for genetics, others in the history of this hamster as a laboratory animal.

In 1930 the late Prof. Aharoni, of the Department of Zoology of the Hebrew University, Jerusalem, went on a zoological expedition to Syria (he was particularly interested in the fauna of Antioch). We were engaged on investigations for the Royal Society on Mediterranean kala azar, and the only suitable experimental animal then known was the Chinese hamster, which had to be imported from the Far East and had the additional disadvantage of not breeding in captivity. Stocks could only be replenished by importing, and lengthy experiments in the Middle East were imperilled by epidemics of *Pasteurella* to which this animal is very susceptible.

Prof. Aharoni undertook to bring specimens of *Cricetulus phœus* for our work. In addition to specimens of *Cricetulus phœus* (which were also unsatisfactory because they did not breed in captivity), Prof. Aharoni brought back a litter of eight golden hamsters collected near Aleppo which he reared and presented to the Department of Parasitology in July 1930.

Four of the animals escaped, one female was killed by a male and only three animals—one male and two females (all litter mates)—remained. From these three animals Mr. H. Ben Menahem succeeded in raising litters, and it was quickly established that this species breeds readily in captivity. It was first used for investigations on kala azar in November 1930, and was afterwards found valuable for work on tuberculosis and brucellosis. As soon as this was realized, I decided to distribute the animal as widely as possible and avoid the risk of maintaining a valuable species in one laboratory. (The animal is very susceptible to *S. typhimurium*, and wherever there is a danger of contamination with this *Salmonella*, it is advisable to vaccinate.) I brought specimens to the Collège de France (Prof. Nattan Larrier), to the Medical Research Council and to the Wellcome Bureau of Scientific Research, where Dr. E. Hindle succeeded in breeding them. Shortly before the Second World War I sent animals to India for kala azar research, and the late Prof. I. J. Kligler sent a batch to America. I also sent several batches recently to Egypt. During the War, animals infected with kala azar were sent to the United States at the request of the American Army authorities for experiments on chemotherapy; but these animals were probably not used for breeding.

To the best of my knowledge all the golden hamsters now in use as laboratory animals in Europe and America originate from the above-mentioned three litter mates—one male and two females brought to the Department of Parasitology of the Hebrew University of Jerusalem in July 1930.

It would be interesting to collect more wild specimens from the neighbourhood of Aleppo, and I hope that some worker favourably situated for this purpose will succeed in doing so.

S. ADLER

Department of Parasitology,
Hebrew University,
Jerusalem.

Determination of Plant Densities

IN surveying plant associations, it is usual to determine the valence by noting the presence or absence of each species in sample areas, and the density by counting the number of individuals of each species in the same, or other, sample areas. Two difficulties are frequently encountered in determining densities by this method, the length of time needed in the field and the intermingling of root systems of individual plants of the same species with consequent indecision as to the exact number present in the sample. The following method has the advantage of requiring one set of observations only, from which valence and density may be determined, and of avoiding counts within the sample areas.

Suppose the species has a density N/A plants per unit area and that a sampling area a is taken t times at random. Then the expected number of plants per trial will be aN/A, and the number y_0 of trials containing no individuals of the species would be expected to be given by the expression

$$y_0 = t \exp(-aN/A).$$

$$\text{Whence } \frac{N}{A} = \frac{1}{a} \cdot \log_e \cdot \frac{t}{y_0}.$$

If the number of trials is 50 and the sampling area 0·1 square metre, a graph relating density and y_0 can be drawn and shows a remarkable sensitivity for densities 33 per sq.m. to 3 per sq.m. By increasing the sampling area to 1 sq.m., the density values on the graph are reduced ten times, and we have a sensitive range from 3·3 per sq.m. to 0·3 per sq.m.

Much time has been saved in the field and results are reasonably in accord with densities found by the more laborious method.

E. J. MACHIN

Biology Department,
Cheltenham Grammar School.
June 26.

Metabolism of α : β-Dihydroxy-γ-(2-methylphenoxy)propane ('Myanesin')

IN a recent communication[1], Wyngaarden, Woods and Seevers have shown that 'Myanesin' administered intravenously to dogs appears in the urine mainly in combination with glycuronic acid, while a small amount is excreted without change. We have found that after intravenous administration to humans or rabbits, a portion is oxidized and excreted as α-hydroxy-β-(2-methylphenoxy)propionic acid. The acid may be isolated by acidifying the urine to *p*H 3, extracting with ether continuously for 24–48 hours, transferring from the ether extract into sodium bicarbonate solution and recovering from the aqueous solution by acidifying and extracting with ether. The ether-soluble product is crystallized first from carbon tetrachloride, then from water and finally from chloroform. The pure acid melts at 146–147° (corr.) (found: C, 61·2; H, 6·1; $C_{10}H_{12}O_4$ requires C, 61·2; H, 6·1 per cent). The acid is not optically active. It is identical with the acid obtained by condensing *o*-cresol with β-chlorolactic acid (found: C, 61·1; H, 6·1 per cent).

We are indebted to Dr. F. Barnett Mallinson for supplies of urine from patients who had received 'Myanesin'. Our thanks are also due to the directors of the British Drug Houses, Ltd., for permission to publish this note.

E. L. GRAVES
T. J. ELLIOTT
W. BRADLEY

Research Department,
The British Drug Houses, Ltd.,
London, N.1.
April 15.

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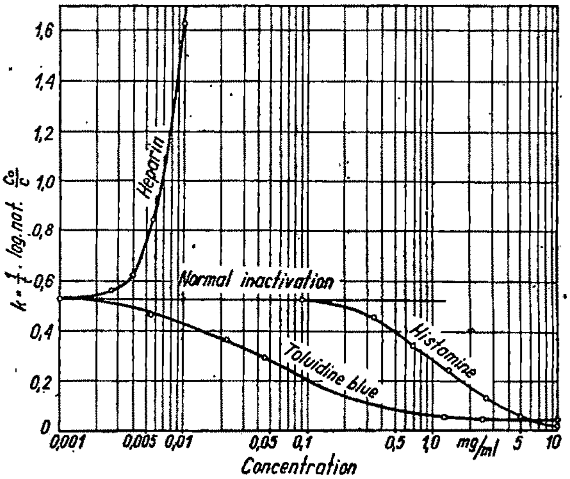
[1] *Proc. Soc. Exp. Biol. and Med.*, 66, 256 (1947).

Histamine – Heparin – Thrombin Chain Mechanism

EARLIER experiments of ours have shown that the organism regulates the coagulability of the blood by the inactivation of thrombin[1,2]. Many factors take part in the system causing the thrombin to disappear. We distinguish an adsorption effect and a fermentative inactivation process, and indicate the inactivating process by its reaction velocity factor.

We have worked out a simple and rapid process for investigating the inactivation[3]. We put thrombin of a known activity into the serum under investigation, and after an incubation period of 1, 2, 3, 5 or 10 min., we determine the time in which samples taken from the mixture make the fibrinogen coagulate. As a result of the inactivation we get increasingly longer clotting-times. From the clotting-times we determine their thrombin activity on the basis of an empirical relation, and from the data thus obtained we calculate the reaction velocity factor ($k = 1/t$ log. nat. co/c).



Change in thrombin inactivation reaction-velocity constant under the effect of heparin, toluidine blue and histamine respectively, in rabbit serum

Heparin increases the reaction velocity of the inactivation (see graph). If we bind the heparin with toluidine blue, the velocity of the inactivation diminishes decidedly[4]. We find that histamine, both *in vitro* and *in vivo*, likewise strongly decreases the inactivation, and thereby shifts the clotting capacity of the blood towards coagulation[5]. We have also shown that histamine and heparin bind one another, and have obtained a colour reaction from this[6].

As histamine and heparin are both constantly present in the blood in physiological circumstances, it must be supposed that the normal coagulability of the blood is regulated intravasally by histamine – heparin equilibrium. If this equilibrium shifts towards histamine there is a diminished inactivation and the blood coagulates better, which in certain cases can lead to intravasal fibrin precipitation. But if there is a preponderance of heparin the effect of the inactivating system increases and the blood does not clot so well. These phenomena have been thoroughly observed in pathological[7,8] and experimental[2,9,10] conditions.

Jancsó demonstrated in 1931 that a preliminary condition for the accumulation process of reticulo-endothelial systems was that the colloids to be eliminated from the blood are enclosed in a covering of fibrin, and that this colloid-fibrin complex becomes attached to the endothelium[11]. It was later also found that this occurs also as an effect of histamine[12]; but intermediate links in the chain were lacking to explain how, as an effect of histamine, the fibrin appears in the blood.

But on the basis of the foregoing, the route of the chain mechanism would appear to be briefly that histamine is produced as an effect of the foreign substances introduced into the blood. This binds the heparin and thus inhibits the inactivation of thrombin. This in turn leads to the formation of thrombin and causes intravasal fibrin precipitation. The precipitating fibrin carries off the colloids, which attach themselves to the walls of the endothelium, where their phagocytosis begins. When this phenomenon has taken place, the increasing liberation of heparin compensates for the increased clotting capacity of the blood.

On this basis, the physiological sphere of thrombin must be extended. The function of thrombin is not only to bring about extravasal clotting, but also to fulfil an at least equally important task intravasally, in starting the accumulation in the reticulo-endothelial system as one of the links in the chain of the whole process. This also throws a new light on the problem of thrombosis. Thrombosis occurs when the organism cannot, by increased liberation of heparin, restore to normal the lowered thrombin inactivation required for colloid accumulation.

M. GERENDÁS
I. CSEFKÓ
M. D. F. UDVARDY

Biochemical Laboratory,
Hungarian Biological Research Institute,
Tihany.

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[4] Gerendás, M., Udvardy, M. D. F., Pálos, A. L., and Csefkó, I., *Acta Physiol. Scand.* (in the press).

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[6] Gerendás, M., Csefkó, I., and Udvardy, M. D. F., *Acta Physiol. Scand.* (in the press).

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[8] Pálos, A. L., *Schweiz. med. Wschr.* (in the press).

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Hæmoglobin – Methæmoglobin Mixtures

WE[1] have recently had an opportunity of confirming, in a case of familial methæmoglobinæmia, the shift to the left in the oxygen dissociation curve of hæmoglobin which Darling and Roughton[2] found in hæmoglobin – methæmoglobin mixtures. They suggest that the shift in the curve may be explained by the existence of intermediate compounds, the affinity of which for oxygen is greater than that of hæmoglobin. On this assumption, the formation of methæmoglobin from hæmoglobin does not take place in a single step; but the four iron atoms of the hæmoglobin molecule may be oxidized separately and successively. If the iron in the hæmoglobin (or oxyhæmoglobin) molecule is represented as $(Fe^{++})_4$, the iron in the intermediate mixed molecules would be $(Fe^{+++})(Fe^{++})_3$, $(Fe^{+++})_2(Fe^{++})_2$, $(Fe^{+++})_3(Fe^{++})$, and that in methæmoglobin itself $(Fe^{+++})_4$. As the shift in the dissociation curve is fairly large, it is evident that quite appreciable amounts of the intermediate compounds would be present in methæmoglobin – hæmoglobin mixtures, and might afford spectroscopic evidence of their presence. Apart from its theoretical interest, the question is of some practical importance, for alterations in the absorption spectrum due to this cause would necessitate modifications in the estimation of blood methæmoglobin made by optical methods, for example, that of Evelyn and Malloy[3].

We have looked for spectroscopic evidence for the presence of the intermediate compounds by making differential measurements of the absorption at the red end of the spectrum (where methæmoglobin shows a strong absorption band), comparing optical and physical mixtures of hæmoglobin and methæmoglobin in a Spekker absorptiometer. Using two pairs of closely matched 1-cm. cells, we first filled one member of each pair with a definite volume of methæmoglobin solution containing 1 gm./100 ml. pigment. (The solution was prepared from toluene-laked, washed ox erythrocytes by the action of a small excess of sodium nitrite. It was filtered and exhaustively dialysed at 4° in a rocking dialyser and diluted with *p*H 7·4 phosphate buffer.) The other cells were filled with the same volumes of a separately dialysed, filtered and buffered solution containing 1 gm./100 ml. oxyhæmoglobin. Each oxyhæmoglobin-containing cell was then examined in conjunction with a methæmoglobin cell.

The difference in optical density between the pairs of cells (using 2 mm. Hilger red No. 1 and 2 mm. Calorex filters) was 0·002, representing the difference between the pairs of glass cells. On mixing the contents of one pair of cells, to give a 50 per cent mixture of oxyhæmoglobin and methæmoglobin, the change in absorption was not greater than 0·001, nor was any further change found in readings taken up to 18 hr. after mixing. The total absorption under the conditions used was 0·805, so that the change on mixing was less than 1 in 500 of the total absorption, that is, well within experimental error. Examination of the solutions (diluted 1 in 5) with the Hartridge reversion spectroscope also failed to show any difference between the optical and physical mixtures in the position of the methæmoglobin band in the red part of the spectrum.

If the explanation of Darling and Roughton for the shift in the dissociation curve is correct, it would appear, therefore, that the absorption spectrum of hæmoglobin derivatives is determined not by the molecule as a whole, but by the sub-molecules containing one iron atom.

Q. H. Gibson
D. C. Harrison

Department of Biochemistry,
Queen's University,
Belfast.
April 20.

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Crystal Structure of Nitronium Perchlorate

We have made an X-ray examination of the nitronium perchlorate of Goddard, Hughes and Ingold[1] and find, in agreement with Millen's observations on its Raman spectrum[1], that the crystal structure contains the ions NO_2^+ and ClO_4^-.

The crystals are monoclinic, the unit cell having dimensions $a = 9{\cdot}25$ A., $b = 6{\cdot}99$ A., $c = 7{\cdot}34$ A., with $\beta = 113{\cdot}5°$, and containing four molecules of $NClO_6$. The existence and general arrangement of the ions was discovered from two-dimensional Patterson syntheses of the intensities of X-ray reflexions in the three principal zones, and confirmed by comparison of observed and calculated structure amplitudes; the chlorate and nitronium ions are arranged alternately along twofold axes, in accordance with the space group $C\ 2/c$, the nitrogen and chlorine atoms lying on the twofold axes, with all the oxygens in general positions. By using $\{hkl\}$ structure amplitudes in sectional projections[2] we find that the NO_2^+ ion is linear with N—O $\sim 1{\cdot}1$ A., and the ClO_4^- ion approximately tetrahedral, with Cl—O $\sim 1{\cdot}5$ A. Successive Fourier refinement is now being applied to obtain more accurate values of these bond-lengths.

We are indebted to Prof. C. K. Ingold and Mr. D. R. Goddard for providing crystals specially prepared for this work.

E. G. Cox
G. A. Jeffrey
M. R. Truter

Chemistry Department,
University, Leeds.
April 23.

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Emissivity of Small Particles in Flames

It is a striking fact that solid (or massive) carbon behaves as a black body, whereas small carbon particles which are responsible for the luminosity of hydrocarbon flames have an absorption coefficient which is strongly dependent on wave-length. This difference is important in the measurement of the colour temperature of luminous flames. It has been shown theoretically by Mie[1] that the absorption coefficient is strongly dependent on wave-length when particles are smaller than a wave-length, an effect which is analogous though not identical with the dependency of scattered light on wave-length.

We have made some optical measurements on a stationary flame of aluminium flakes in air. These experiments differed from the often repeated measurements on photo-flashes since the flame had a greater depth (5–10 cm. diameter). The intensity distribution in the flame was unusual. The radiation consisted of weak AlO bands and a strong continuum which extended from the red far into the ultra-violet regions. The colour temperature was about 3,600° C. It may be shown theoretically that the enthalpy of the exhaust gases permits the temperature of the flame to reach the boiling point of aluminium oxide (Al_2O_3), which is 2,980° ± 60° C., and that nearly all the oxide is vaporized. When we threw an image of the anode of the carbon arc on to the aluminium–air flame, we observed very weak absorption in the visible and increasing absorption towards the violet region. At 3100 A. all light from the arc was absorbed. The emission coefficient, therefore, became very nearly equal to unity in the ultra-violet. By comparing the brightness of the flame at 3100 A. with the brightness of the carbon arc anode, we estimated a brightness temperature which was a little below the calculated (theoretical) temperature. Line reversal measurements (ordinarily a little high on account of the scattering effect) gave a slightly greater value than the calculated temperature.

The close agreement of these results satisfied us that the temperature of the flame was actually the boiling point of aluminium oxide. If we adopt this value, however, an explanation is needed for the high colour-temperature observed, or in other words, for the strong dependency of emissivity on wave-length. We believe that most of the aluminium oxide formed in the flame is initially in the gaseous state. The radiation may therefore originate from gaseous aluminium oxide or other gaseous products (excited thermally or by chemiluminescence), but no continuum of gaseous origin is known which extends so far. Moreover, it is perhaps significant that the conditions are very similar to those in the luminous hydrocarbon flame, where emission is undoubtedly due to small particles.

We suggest, therefore, that small droplets of aluminium oxide are the emitters in the aluminium flame, and that these particles are formed by condensation in the flame. Produced in this way, the particles are finely dispersed and very small. Their temperature is identical with the gas temperature, even if catalytic reactions occur on the surface, because the heat transfer numbers of such particles are extremely high. Some of these particles are no doubt smaller than the wave-length of light (Shechter *et al.*[2] have produced evidence of this), and the absorption and emission characteristics of such particles will behave in the same way as radiant soot. The abnormally high colour-temperature is again attributed to the optical properties of very small particles. Moreover, the colour temperature depends upon the thickness of the optical layer, because the thicker the layer the more the radiation will approach black-body conditions.

Magnesium behaved in a similar manner.

We are indebted to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

H. G. Wolfhard
W. G. Parker

Chemistry Department,
Royal Aircraft Establishment,
South Farnborough, Hants.
April 12.

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Application of Measurements of Semi-conductivity to Heterogeneous Reactions

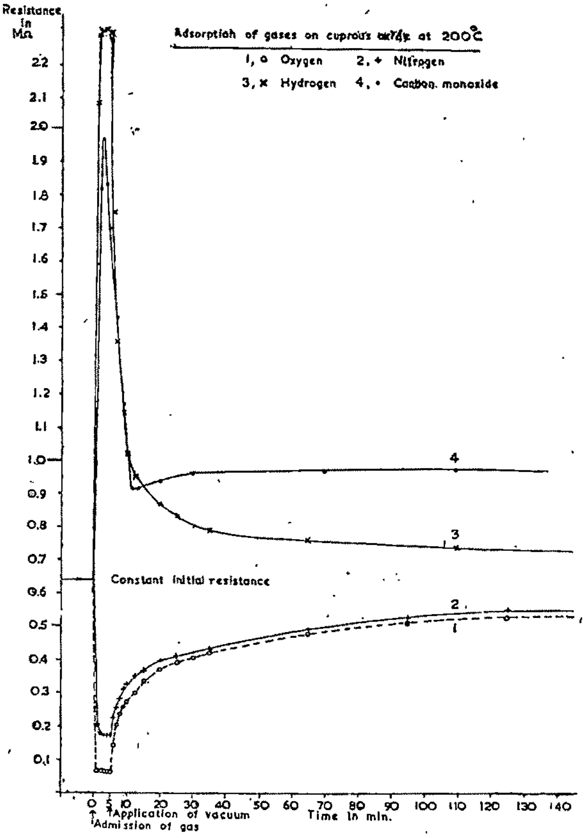
In the present investigation pure oxide films are obtained by the oxidation of evaporated metal films. Normal high-vacuum precautions are observed in the use of all-glass, greaseless systems with precise temperature control. The method of investigation which has been developed is based on the semi-conducting properties of these oxide films. Simultaneous pressure and resistivity measurements are made during the adsorption and desorption of various gases on the oxide films over a range of temperatures between 0° and 250° C. While variations in conductivity of bulk semi-conductors on exposure to air have been previously observed and reported (Anderson *et al.*), the effect has not previously been applied to the problem of catalysis. Preliminary investigations which have been carried out on copper oxide films have demonstrated the efficiency in obtaining reproducibility of the film during periodic oxidation and reduction.

On oxidation of the copper film during the initial period of oxidation the resistance measurements are effectively those of the residual copper layer, being of the order of one ohm in typical cases. This period is characterized by a parabolic uptake of oxygen. At the end of this period, which occupies several hours at 200° C., there is an extremely rapid change in resistance over a period of a few minutes before stabilizing at a high value, 350 k.ohm in a representative case. After this there is a slow exponential change in resistance to a final value corresponding to that of pure cupric oxide obtained after approximately 25,000 min. at 200° C. In this final state the film shows no increase in resistance on sustained pumping at 10^{-7} mm. mercury pressure.

On hydrogen reduction there is an induction period, after which the resistance increases to a very high maximum value, corresponding to the formation of cuprous oxide in the non-conducting state. Further reduction gives a rapid fall in resistance to a value of about 50 k.ohms in a typical case, at which point erratic readings are obtained, fluctuating between that value and a few hundred ohms. This continues for a period of about 15 min. and corresponds to the embrittlement phenomenon reported by Garner and Stone[1], probably due to the escape of water from the film. After this characteristic period the resistance falls exponentially until after about 30,000 min. the original resistance of the copper film is obtained.

For studying the effects of adsorbed gases, the films were employed in the semi-conducting region corresponding to a stoichiometric ratio lying between cuprous oxide and cupric oxide. When the film had been oxidized to the required composition it was subjected to prolonged pumping at 10^{-7} mm. mercury pressure, during which there was an increase in resistance to a constant value, 650 k.ohms in a typical case. The value of this maximum corresponds very closely to the final value of the pure cupric oxide film and did not vary significantly over a wide range of composition. This corresponds with the observations of Anderson and others on the effect of the evacuation of bulk semi-conductors.

Quantitative and qualitative information has been obtained concerning the effect of the adsorption of oxygen, nitrogen, hydrogen and carbon monoxide on the semi-conducting films in this condition. Admissions of oxygen at a series of temperatures and at pressures varying between 10^{-3} mm. and 0·3 mm. mercury pressure have shown that there is an immediate fall in resistance of great magnitude taking place within the first five seconds, followed by a slightly slower change over a few minutes (curves 1 and 2). The films are only exposed to the oxygen for a few minutes and are then subject to hard vacuum, 10^{-7} mm. pressure being attained in approximately 15 sec. During evacuation there is an increase in resistance, a very rapid second-order change at first, but becoming exponential after about 30 min. The final value obtained after about 2,500 min. is, for temperatures above 200° C., identical with the initial value; but below this temperature very protracted pumping fails to re-establish the original equilibrium condition. All curves show a very high degree of reproducibility.



The effect of nitrogen is qualitatively the same as for oxygen, while helium, which has no effect alone, modifies the effect of both adsorption and desorption by slowing down both processes to a marked degree.

On the adsorption of carbon monoxide or hydrogen the resistance increases rapidly to a very high value (curves 3 and 4). In the case of hydrogen the process is reversible, but in the case of carbon monoxide the removal of the gas, possibly as carbon dioxide, is complicated by the apparent immediate reduction and sintering of the surface, which completely alters the film characteristics. After adsorption of carbon monoxide it is possible to return the film to its standard state only by oxidizing the film completely, reducing to copper and reoxidizing. Only after this drastic processing does the film reproduce earlier results. This effect has been reported by Garner and Stone on bulk copper oxide.

The investigation is being extended to a range of temperatures enabling temperature coefficients of the various processes to be established, and to various other oxides. Precision measurements of gas adsorbed and desorbed are being introduced, and the significance of substrate is being investigated.

Although too early to embark on any rigid theoretical consideration of the significance of the results, it is clear that providing the general picture of semi-conduction as given by Mott is accepted, then these measurements must yield direct information of the nature of the catalytic processes occurring, as related to adsorbed gases on semiconducting oxide catalysts.

T. J. GRAY

Chemistry Department,
University, Bristol.
April 20.

[1] Garner, W. E., and Stone, F. S., *Nature*, 158, 915 (1946).

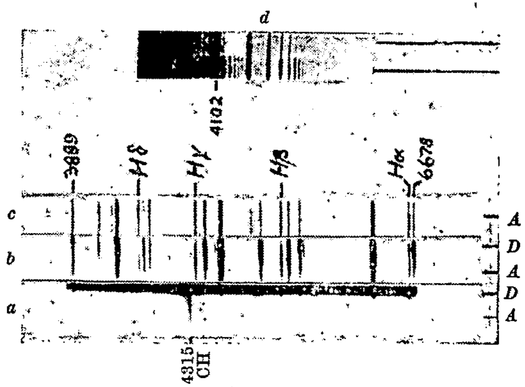
Afterglow of the Balmer Spectrum of Hydrogen

IN a paper published during the War the late Lord Rayleigh reported some new experiments about the hydrogen spectrum, indicating a duration of Balmer lines of more than 10^{-5} sec., which is roughly one thousand times greater than the values calculated from quantum mechanics and experimental results with positive rays. The method consists in producing a strong luminosity induced by a powerful condenser discharge in an electrodeless glass tube. Each discharge produces a jet of luminosity, squirting out of the electric field by thermal expansion into a side tube where the decay of the Balmer lines is observed and measured[1].

Lord Rayleigh did not attempt any explanation of this result and apparent discrepancy. Jablonski has remarked that the mean duration of lines is not always identical with the mean life in initial states of corresponding transitions. After having considered the various mechanisms which can produce atoms in the upper level, he thinks that the persistence of the luminosity results from the radiative recombination of atomic hydrogen ions[2].

Born, Fürth and Ladenburg[3] prefer to believe that Lord Rayleigh's experiments can be understood on the basis of the known relatively long life of free hydrogen atoms and their re-excitation "by radiation and, especially, by the diffusing electrons and positive ions". The rise of the relative intensity of the blue-green H_β lines (4861 A.) observed by Lord Rayleigh with decreasing luminosity is ascribed to the sensitivity of the eye, which has a maximum in the green part of the spectrum.

In view of making a choice between the two above interpretations, new experiments were performed on the hydrogen afterglow. The experimental arrangement is the same as already described[4]. It permits a careful separation of the light of the discharge from that of the afterglow one. The excitation energy used in our experiments is weak and is not sufficient to show the persistence of the luminosity in pure hydrogen. But when this element is diluted in neon or helium a strong afterglow can be observed. In the case of helium, traces of hydrogen almost always present are sufficient to give the phenomenon. Other impurities like CO and CH destroy the afterglow: the spectrum *a* shows that only the band 4315 of CH persists in this case. The impurities are eliminated either by producing a powerful discharge between two magnesium electrodes or by immersing the discharge vessel in liquid nitrogen.



D, discharge ; *A*, afterglow

Spectrum *b* shows the modification of the emission of helium containing traces of hydrogen when the discharge is cut off. The Balmer lines suffer less variations than He I lines, and the relative intensity of H I increases with time. This later variation can be seen easily by comparing the spectrum at the beginning of the afterglow with spectrum *c* emitted 10^{-3} sec. after breaking the discharge. The duration of the lines increases with the quantum number *n* and the intensity of distribution of the Balmer spectrum varies with time (compare spectra *b* and *c*).

By measuring the decay of luminosity with the time, we have evaluated the duration of the H_γ line at 10^{-4} sec. after breaking the discharge.

It is possible to show that the emission in question follows the capture of electrons by ions by studying the afterglow at the limit of the Balmer series. The discharge and the afterglow were photographed in the ultra-violet region with an Arnulf – Lyot spectrograph. The results are illustrated by the spectrum *d*. In the afterglow, the hydrogen spectrum is extended further than in the discharge; at the same time, the higher level lines of He I grow in intensity.

The above results, although they do not allow a direct comparison with Lord Rayleigh's experiments, show that hydrogen atoms can radiate the whole Balmer series in afterglow. The persistence of the lines at the limit of the series seems to be conclusively in favour of an emission by radiative recombination between ions and electrons.

RENÉE HERMAN
LOUIS HERMAN

Laboratoire des Recherches Physiques,
Faculté des Sciences,
Paris. April 14.

[1] Rayleigh, Lord, *Proc. Roy. Soc.*, A, 183, 26 (1944).
[2] Jablonski, A., *Nature*, 155, 397 (1945).
[3] Born, M., Fürth, R., and Ladenburg, R., *Nature*, 157, 159 (1946).
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Decay Scheme of ^{181}Hf

IN continuation of our previous analysis of the decay scheme of ^{181}Hf [1], we have carried the work further with higher resolving power and using a spectrometer with a thin Geiger–Müller window. We have also carried out delayed coincidence measurements to study the metastable state reported by De Benedetti and McGowan[2]. We have attempted to eliminate various possible decay schemes which have been proposed[1-3], in favour of one to be discussed here.

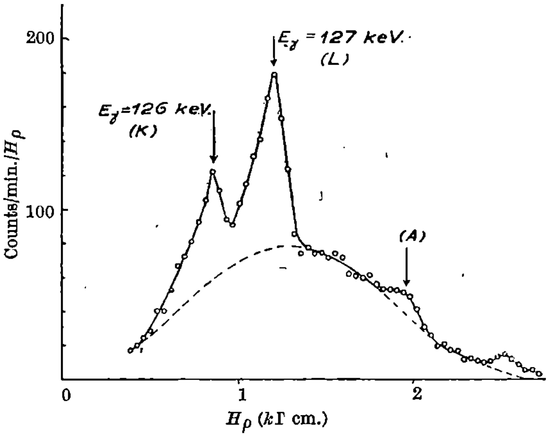

Fig. 1. The β-spectrum of ^{181}Hf (resolving power 4 per cent)

The measurements of the β-spectrum were repeated with the same spectrometer as formerly[1]. The resolving power was, however, increased to 4 per cent and the window thickness reduced to $\sim 0\cdot5$ mgm./cm.^{2}. The β-spectrum is shown in Fig. 1. It will be seen that the conversion line (A) of the 342-keV. γ-quantum which could not be discerned in the previous measurement now appears distinctly. Otherwise the two spectra are in good agreement.

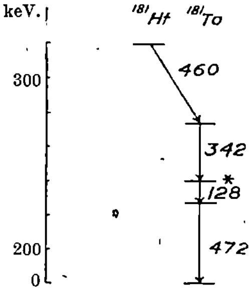

Fig. 2. Decay scheme of ^{181}Hf (all energy values given in keV.)

Delayed γγ-coincidence measurements were carried out in our standard arrangement[1], where a time-delay of $\sim$ 10 μsec. was introduced in one channel. The sample was enclosed in a lead shield 1 mm. thick. The soft radiations (the unconverted 128-keV. γ-quantum and the corresponding X-radiation) were thus practically cut off. Under these conditions, a γγ-coincidence effect amounting to $(k_{\gamma\gamma}/n_\gamma) \times 10^3 = 7 \times 10^{-3}$ was found. This effect is about half the chance coincidence effect. The experiments were repeated many times, and the chance coincidence effect was checked, after each measurement, by ^{60}Co of the same counting-rate in the tubes. These results support the decay scheme given in our previous paper[1] and reproduced here in Fig. 2. The magnitude of the coincidence-rate is in agreement with that computed (from the geometry of the arrangement, the efficiency of the γ-tubes, the half-life of the metastable state and the delay and resolving times of the amplifier).

According to the conclusions of De Benedetti and McGowan[2] the metastable state should follow directly the β-transmission. This is not in agreement with our suggestion. The reason why they have not found any effect of the γ-ray which precedes the metastable state may be due to the fact that its energy is less than the one which follows the metastable state.

J. Beneš
A. Ghosh
A. Hedgran
N. Hole

Nobel Institute for Physics,
Stockholm 50.
April 20.

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[2] De Benedetti, S., and McGowan, F. K., *Phys. Rev.*, 70, 569 (1946).

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Errors of Treatment Comparisons when Observations are Missing

In a randomized block experiment with J blocks and K treatments, for which σ^2 is the variance of the random component of the observations and for which no observations are missing, the estimated difference of the means of two treatments has variance $2\sigma^2/J$. For the case where some observations are missing, Yates[1] has shown how the missing values may be estimated, a valid analysis of variance carried out, and an unbiased estimate of the difference of means of two treatments obtained. He has given the variance of this estimate for the case of only one missing observation, and has suggested an approximation for use in other cases which may be expressed as follows.

If J_A observations are present for treatment A, and j_A of these are in blocks which contain no observation for treatment B, and if J_B observations are present for treatment B, and j_B of these are in blocks which contain no observation for treatment A, then the variance of the estimate of the difference of means of A and B is $\theta_{AB}\sigma^2$, where

$$\theta_{AB} = \frac{1}{J_A - \frac{1}{2}j_A} + \frac{1}{J_B - \frac{1}{2}j_B}; \text{ approximately.}$$

I have derived exact formulæ for θ_{AB} for all cases where not more than three observations are missing, and have compared the exact and approximate values for a wide range of values of J and K. The agreement is reasonably good when K is small but poor when K is large. The formulæ suggest that a closer approximation would be given by

$$\theta_{AB} = \frac{1}{J_A - \dfrac{1}{K-1}j_A} + \frac{1}{J_B - \dfrac{1}{K-1}j_B},$$

and this is confirmed by numerical calculation. If not more than three observations are missing and J and K are both greater than 3, the error of the approximation only exceeds 4 per cent in a very few cases. These all occur either where there are three missing observations and $J = K = 4$, or where practically all observations of one treatment or one block are missing. In most cases the error is very much smaller than this.

In practical applications an analysis of variance would first be carried out to test if there were any significant differences between treatments. If so, any pair could be tested and would be judged to differ significantly if the difference of their means exceeded $t\sqrt{\theta}\,s$, where s^2 was the error mean square with n degrees of freedom, and t was the appropriate percentage point of the t-distribution with n degrees of freedom.

J. TAYLOR

East Malling Research Station,
Nr. Maidstone,
Kent.
April 19.

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[1] Yates, F., *Emp. J. Exp. Agric.*, 1, 129 (1933).

Development of Spark Discharges

IN a recent communication[1] concerning the mechanism of growth of the leader strokes preceding spark discharges, Allibone has stated that the leader stroke develops behind a voluminous corona discharge and that the concentrated bright streamer, which is readily photographed, is in the nature of a 'core' to this corona. The same view has been expressed by ourselves on various occasions and in earlier reports[2], and not only have we succeeded in demonstrating beyond doubt the existence of this diffuse corona discharge forming the head of the leader stroke, but we have also been making extensive investigations of its characteristics during the past eighteen months.

From consideration of the rotating camera records[3], which show the existence of diffuse corona discharges in association with the brighter filamentary streamers, it became clear to us some time ago that the photographic methods of observing the development of leader strokes have certain limitations and require to be supplemented by other techniques[4]. Allibone has referred to experiments made with Lichtenberg figures, but in such measurements, where stationary recording systems are used, it is difficult to determine the sequence of the processes observed, particularly because of the diffuse nature of the discharge. Similar difficulties occur in the interpretation of rotating camera photographs, where a distinction between spatial and temporal displacements is confused when the photographed object is diffuse.

Because of the various limitations of the photographic measurements, we decided to study the growth of leader strokes by arranging for the light emission from the discharge to fall on the sensitive cathode of a photomultiplier, the output from which is amplified and is reproduced on an oscillograph screen[5]. With this technique, a very high resolution in time is possible, of less than 10^{-7} sec., and the sensitivity to light is greater than that of a photographic emulsion. Further, the intensity of the light can be determined more accurately than in the photographic method, where there is a failure in the reciprocity law when light pulses of short duration are being recorded.

With this technique we have observed the corona discharge occurring in a discharge gap between a positive point and a negative plane, for impulse voltages below that required to cause breakdown. Under these conditions, for a 50-cm. gap in air at atmospheric pressure, the corona discharge produces a light pulse as shown in the oscillogram of Fig. 1. The corresponding current pulse in the gap is of the same shape. Both pulses rise to their peak amplitude in a time 5×10^{-8} sec. and decline to a small value after 4×10^{-7} sec. By the use of slits placed between the gap and the photomultiplier the light distribution with corona has been examined, and we have found that the light is emitted from a roughly hemispherical volume, with the positive point at the centre of the plane face of the hemisphere, which is parallel to the negative plane, and with the curved face directed towards the plane. The light intensity decays continuously with distance from the point.

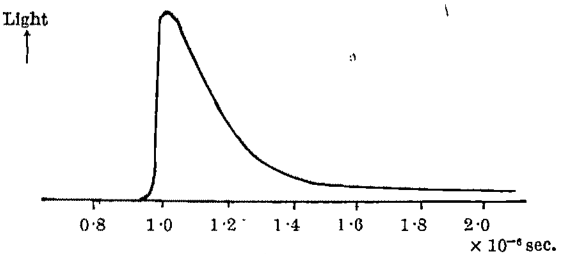

Fig. 1

When the impulse voltage applied to the gap is raised to the breakdown value, or to higher values, a leader stroke develops from the point and initiates a spark. The growth of this leader stroke has been studied by placing between the gap and the photomultiplier an opaque screen containing a slit, the position of which can be altered, so that changes of light in different parts of the gap can be recorded. As the leader stroke passes the slit it produces an increase in the light reaching the photomultiplier through the slit, and consequently a deflexion is produced on the oscillograph screen. The occurrence of the main stroke also causes a deflexion, and from measurements of the amplitude of the various deflexions and the time intervals, both the distribution of light in the leader stroke and its speed of growth can be determined. A typical oscillogram is reproduced in Fig. 2. The discharge commences as an impulse corona which is too small to appear on this oscillogram. Afterwards the light intensity passing through the slit increases gradually as shown to a peak which corresponds to the passage of the 'core' of the leader stroke across the slit. The light then decreases rapidly to a small value and increases again very suddenly when the main stroke occurs. From this evidence it is clear that the leader stroke does not consist of a point source, as this would give a sharp light pulse of duration about 10^{-7} sec., but that it is formed by a diffuse discharge which increases in intensity to a central 'core'. The distribution of the light in the leader stroke, and its size, is generally similar in appearance to the impulse corona mentioned above. Emission of light can be detected up to a distance of the order of 10 cm. ahead of the central 'core'.

Besides the measurements of the light distribution, in space and time, the speed of the leader stroke at different stages in its growth across the gap has been determined, and the current flowing in the leader stroke has been recorded oscillographically. The investigations have been made in air, at atmospheric

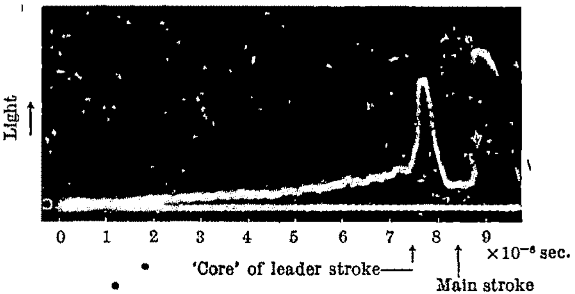

Fig. 2

and reduced pressures, and also in several other gases. A full account of these investigations will be published elsewhere.

We should like to acknowledge the financial support given to this work by the British Electrical and Allied Industries Research Association.

R. F. SAXE
J. M. MEEK

Electrical Engineering Department,
University, Liverpool.

[1] Allibone, *Nature*, 161, 970 (1948).

[2] Saxe and Meek, Brit. Elect. and Allied Ind. Res. Assoc. Report Ref. L/T.183 (1947); Report Ref. L/T.188 (1947) (completed and revised accounts are in process of issue).

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[5] Prime and Saxe, *J. Inst. Elect. Eng.* (in the press).

THE object of my recent experiments[1] was to bring out photographically what we have known for many years. With an adequate background of visual observation of spark formation, there is no difficulty in determining in general terms the sequence of occurrence of the different kinds of discharge. As the voltage applied to a point/plane gap is increased, the corona extending therefrom increases (I would not have described the volume of discharge as hemispherical in shape; Fig. 5 in ref. 2 is a very typical shape for such a discharge), and near breakdown the concentrated bright streamers or leader strokes first become obvious extending over part of the gap as described in my communication in *Nature*[1]. The technique of chopping the spark with another spark gap in parallel enables the development of the leader stroke to be followed.

Prof. Meek and Mr. Saxe's technique will be invaluable in providing quantitative data on the corona and leader stroke currents and the light emitted by these discharges; but the facts they describe are well known though not well supported by photographs. The simple Lichtenberg figure technique which I have described gives the best photographic record of the leader stroke developing out of the corona discharge; it might even be more sensitive than the photomultiplier, because Fig. 2 of ref. 2 shows unmistakable evidence of corona one metre ahead of the leader stroke, whereas the multiplier has recorded light emission only 10 cm. ahead of the central core or leader stroke.

T. E. ALLIBONE

Associated Electrical Industries, Ltd.,
Aldermaston Court,
Berkshire.

[1] *Nature*, 161, 970 (1948).

[2] *J. Inst. Elect. Eng.*, 82, 513 (1928).

Internal Pair Conversion

WHEN a γ-quantum, emitted from the nucleus of a radioactive atom, is absorbed by the same atomic system, an ordinary electron and a positron may be liberated if the energy of the γ-quantum is greater than $2mc^2$. This effect has been calculated by Jaeger and Hulme[1] on the assumption that the γ-ray is electric dipole or quadrupole radiation. I have performed the corresponding calculation for the magnetic dipole radiation and the element $Z = 84$. In calculating the coefficient, Dirac's exact wave equation of the electron is used and the process is interpreted as the transition of an ordinary electron from a negative energy to a positive energy state. The results are given in the accompanying table, where the energies are expressed in units of mc^2 and N is the number of positrons (which is, of course, equal to the number of the pairs created) per unit energy range.

Energy distribution of the electron pairs

$h\nu = 2{\cdot}62$ MeV.	$\dfrac{E_+ - 1}{h\nu - 2}$	0·159	0·383	0·612	0·840
	$N(h\nu - 2)10^4$	7·10	9·70	14·9	26·2
$h\nu = 8{\cdot}00$ MeV.	$\dfrac{E_+ - 1}{h\nu - 2}$	0·073	0·366	0·635	0·926
	$N(h\nu - 2)10^4$	31·3	48·8	77·6	58·7

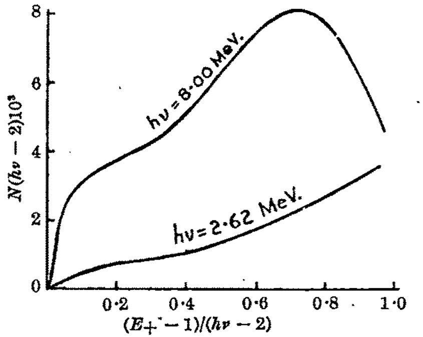


Fig. 1

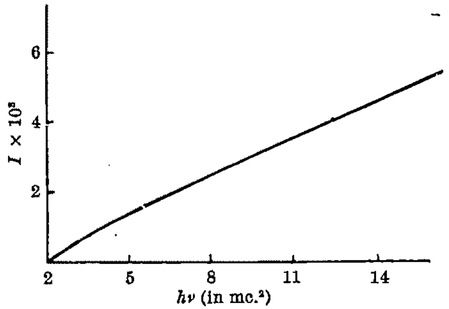


Fig. 2

In Fig. 1, $N(h\nu - 2)$ is plotted against $(E_+ - 1)/(h\nu - 2)$. The marked difference in the average energy of the electrons and positrons is due to the Coulomb forces acting on the two particles. Moreover, the curve, for $h\nu = 8{\cdot}00$ MeV., shows a maximum near the highest positron energy, as would be expected. By integrating over these curves, the coefficients of the internal pair conversion of the γ-rays are deduced. The results are:

$$I = 1{\cdot}5 \times 10^{-3} \text{ for } h\nu = 2{\cdot}62 \text{ MeV.,}$$
$$\text{and } I = 5{\cdot}6 \times 10^{-3} \text{ for } h\nu = 8{\cdot}00 \text{ MeV.}$$

If we plot I against $h\nu$ (Fig. 2), it is found that a straight line connecting these two points nearly passes through the point ($I = 0$, $h\nu = 2mc^2$).

In conclusion, I want to express my gratitude to Mrs. B. Jeffreys and Dr. N. Kemmer for their valuable discussions.

M. H. WANG

Gonville and Caius College,
Cambridge.

June 22.

[1] *Proc. Roy. Soc.*, A, 148, 708 (1935).

ISOLATION FROM ARGEMONE OIL OF DIHYDROSANGUINARINE AND SANGUINARINE: TOXICITY OF SANGUINARINE

By S. N. SARKAR
Department of Biochemistry, Oxford

ARGEMONE oil has received considerable attention during recent years on account of its alleged etiological role in epidemic dropsy[1-4]. I pointed out[5] certain anomalies of the mustard oil – argemone oil theory of epidemic dropsy and stressed the fact that a definite solution of the problem could only be arrived at by isolating the active principle from argemone oil and the suspected mustard oil, and then showing that these are chemically identical and possess similar toxic properties. Lal *et al.*[2] could not produce any satisfactory evidence on this aspect of the problem.

In a report of some preliminary work done, Sarkar and Rahman[6] stated that it was possible to precipitate the nitrogenous bases present in argemone oil as crystalline picrate, and from the crude picrate at least two fractions could be separated each of which when converted into the hydrochloride proved toxic to rats by oral administration, causing heavy mortalities. With the view of clearing up some of the important points, a detailed investigation was undertaken by me under the direction of Prof. R. A. Peters, and the relevant findings are reported here.

The main alkaloid of argemone oil has been purified by chromatographic analysis on an alumina column followed by crystallization from alcohol – benzene mixture. The purified compound (I), m.p. 190–91°, agreed in formula and properties with dihydrosanguinarine (found: C, 72·11: H, 4·54; N, 4·22; $C_{20}H_{15}O_4N$ requires C, 72·07; H, 4·51; N, 4·21 per cent). It is clear, therefore, that the formula $C_{19}H_{15}O_4N$ proposed for this compound by Mukherji, Lal and Mathur[7] is not correct. An authentic sample of dihydrosanguinarine obtained from the laboratory of the late Prof. Späth, when further purified by the present procedure, melted at 190–91°, and the mixed melting point with compound (I) did not show any depression.

Compound (I) could be readily oxidized by ferric chloride in presence of hydrochloric acid giving beautiful orange-red crystals of sanguinarine hydrochloride (II). This compound is identical with the compound obtained before in the ferric chloride test for the detection of argemone oil developed by me[8]. By the identification of the compound, the theoretical basis of the test is provided. Compound (II) was easily converted into the pseudo-cyanide, m.p. 238–39° (decomp.), and this could be reconverted into the original hydrochloride. The authentic sample of dihydrosanguinarine also behaved in the same way with ferric chloride.

Further confirmation came from the oxidation of compound (II) to oxysanguinarine, isolation of a zinc-dust distillation product, m.p. 135–135·5°, giving the fluorescence test of Graebe[9] and agreeing with the formula of α-naphthaphenanthridine, and also from the transformation of (I) into 3.4.6.7-tetramethoxy-11.12-dihydro-N-methyl-α-naphthaphenanthridine, m.p. 183–85°, and giving a mixed melting point, 182–84°, with an authentic sample, m.p. 181–83°.

Sanguinarine has been isolated from argemone oil by chromatographic analysis of the oil on a silica column, and also from the crude precipitate obtained by passing dry hydrogen chloride into an ethereal solution of the oil; the amount of sanguinarine hydrochloride obtained by the latter procedure is 0·44 mgm./c.c. of oil. In this sample of oil, dihydrosanguinarine accounted for about 87 per cent and sanguinarine for about 5 per cent of the total alkaloids present.

When sanguinarine hydrochloride was injected intraperitoneally to albino rats in a dose of 2 mgm./100 gm. body-weight, there was 100 per cent mortality. In contrast to this, dihydrosanguinarine at about two and a half times this dose, or oxysanguinarine at about four times this dose, did not kill any of the rats injected. Sanguinarine hydrochloride was also toxic when fed by mouth, and by following a suitable procedure, young albino rats (40–96 gm.) could be killed usually within a week by administering 1 mgm. of the poison daily.

In further studies of the toxic effects of sanguinarine, the eyes of two albino rats about to die from a lethal intraperitoneal dose of the hydrochloride were removed by Dr. Pirie and Dr. Jackson, and sectioned. The sections, compared with those from normal eyes, showed that there was great congestion of the capillaries of the iris, choroid and retina.

Sanguinarine hydrochloride is toxic to some enzyme systems also. It has been found, for example, that it can inhibit the oxidation of pyruvate, lactate and succinate by pigeon brain preparations. In fact, the effect on pyruvate oxidation was very marked, and with the pigeon brain homogenates used in this laboratory, about 30–35 per cent inhibition of the total oxygen uptake in presence of added pyruvate was noticed with 0·041 m*M* concentration of the poison. Addition of cocarboxylase could not prevent this inhibition.

The observed inhibition of pyruvate oxidation strongly suggests the possibility that there should be accumulation of pyruvate in the blood of persons suffering from dropsy due to argemone oil poisoning. This agrees very well with an observation of Wilson and Ghosh[10] that there was a significant rise in the bisulphite-binding capacity of the blood in epidemic dropsy cases. In a preliminary experiment carried out here, a definite rise in blood pyruvate has been noticed in rats after a heavy dose of sanguinarine hydrochloride intraperitoneally.

The inhibitory effect of sanguinarine hydrochloride on some —SH enzymes suggested the possibility that it was probably combining in some way with the essential —SH groups. This was confirmed by the observation that when B.A.L. or monothioethylene glycol was treated with an excess of sanguinarine hydrochloride at *p*H 7·4, there was a precipitate containing sulphur and the filtered solution gave negative nitroprusside test. It has not been possible as yet to purify these compounds; but analysis of a nearly pure compound with monothioethylene glycol confirms the presence of sulphur in the compound and indicates also that very probably one molecule of the base is combining with one molecule of thiol.

In vitro experiments with the pigeon brain homogenates showed that if mixed before, 50 μgm. of B.A.L. could completely protect the pyruvate oxidase system from the toxic effect of 100 μgm. of sanguinarine hydrochloride—even 20 μgm. of B.A.L. could afford about 70 per cent protection. However, B.A.L. could not reactivate the already poisoned enzyme.

These results were confirmed by *in vivo* experiments. When albino rats were injected with an excess of B.A.L. (intramuscularly) 15–20 minutes before the administration of a lethal dose of the poison (2 mgm./100 gm., intraperitoneally), there was almost complete protection and about 85 per cent of the treated rats survived.

Since B.A.L. will not reverse the *in vitro* damage to enzymes, it is unlikely to reverse any toxic effects already established by sanguinarine, but it might be useful in preventing further damage due to any unreacted poison.

The poisonous nature of sanguinarine was known before and its pharmacological effects were studied by Meyer[11].

A detailed account of the work will be published at an early date.

My grateful thanks are due to Prof. R. A. Peters for his continued interest and help and for the facilities provided. I am indebted to Dr. A. Pirie and Dr. C. R. S. Jackson for examining the eyes of some of the experimental rats, to Prof. L. Ebert for samples of dihydrosanguinarine, sanguinarine nitrate and the tetramethoxy compound, to Dr. L. A. Stocken for the sample of B.A.L. and to Prof. S. N. Bose for the argemone oil. My thanks are also due to the Government of India for a research grant, and to the Carnegie Grants Committee of the University of Oxford for some financial help.

[1] Sarkar, S. L., *Ind. Med. Gaz.*, **61**, 62 (1926).
[2] Lal *et al.*, *Ind. J. Med. Res.*, **27**, 207 (1939); **28**, 163 (1940); **29**, 157, 167, 813, 839 (1941).
[3] Chopra *et al.*, *Ind. Med. Gaz.*, **74**, 193 (1939).
[4] Pasricha *et al.*, *Ind. J. Med. Res.*, **27**, 947 (1939).
[5] Sarkar, *Ann. Biochem. Exp. Med.*, **1**, 59, 204 (1941).
[6] Sarkar and Rahman, *Curr. Sci.*, **14**, 196, 200 (1945).
[7] Mukherji *et al.*, *Ind. J. Med. Res.*, **29**, 361 (1941).
[8] Sarkar, *Ann. Biochem. Exp. Med.*, **1**, 271 (1941); **2**, 101 (1941).
[9] Graebe, *Annalen*, **335**, 127 (1904).
[10] Wilson and Ghosh, *Ind. Med. Gaz.*, **72**, 147 (1937).
[11] Meyer, *Arch. Exp. Path. Pharm.*, 397 (1892).

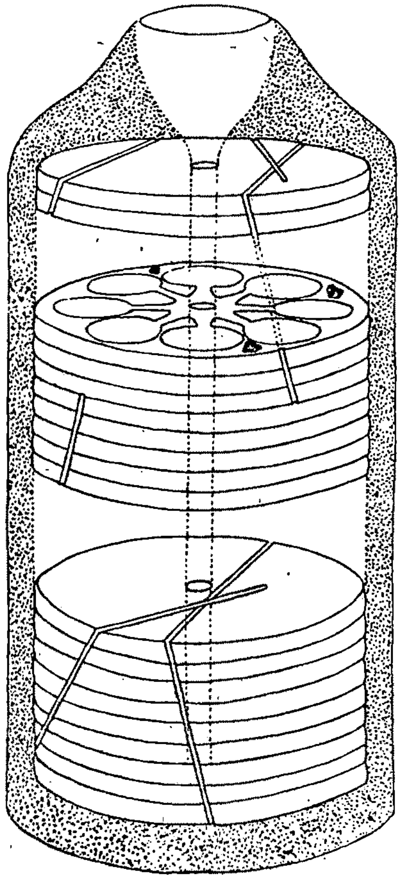
THE TECHNIQUE OF CASTING COINS IN ANCIENT INDIA

THE chance discovery by Prof. Birbal Sahni at Rohtak, some forty miles west-north-west of Delhi, in 1936, of a clay mould for the casting of a coin, later led to the discovery of many thousands of fragments of similar moulds. The bronze coin, about 19 mm. in diameter, of the Yaudheya series, has been dated about 100 B.C. From the very large amount of material available, Prof. Sahni has been able to work out in the greatest detail the entire story of the casting technique employed[1].

The accompanying figure illustrates the manner in which the mould was constructed. A pouring basin at the top leads to a central vertical runner, 7 mm. in diameter, from which, at successive levels, eight radial runners communicate with moulds for the same number of coins. The disks containing these moulds were 87 mm. in diameter and were built up into a pile, perhaps a foot or so in height. Around this there was a jacket of clay admixed with fragments of unhusked grain. When the mould was complete it was heated up to a surface temperature of the order of 600°–650° C., as a result of which the organic material was charred, leaving the jacket in a porous condition through which the gases could escape.

There can be little doubt that the moulding technique was carried out in the following manner. Around a wooden baseboard of the same diameter as the disks, and with a central peg 7 mm. thick fixed in the centre, a cylindrical container was placed, and a slab of plastic clay, sufficient for one disk, introduced. On this the side runners were first moulded from an 8-spoked metal pattern about 1½ mm. thick. At the ends of the spokes the coin moulds were pressed into the clay, a very large number of such patterns being employed, and any obstruction between the individual runners and the mould being removed. This disk was then dusted with a parting powder, such, for example, as wood-ash, and a second one prepared on top. In order to ensure exact register of the two surfaces of the disks, small irregular fragments of stone or brick were introduced into the lower disk while still plastic, producing a corresponding depression in the overlying surface. In this way a set of up to a dozen disks was produced, the upper and lower surfaces of each complete set being blank. On the removal of the surrounding cylinder, an oblique groove was marked across the upper surface of the disks and obliquely down the side. In most cases two such grooves are marked and the re-assembly of the disks (after drying) in their correct order thus facilitated. After air drying, the disks were re-assembled and a series of sets piled one on another to produce a mould of appropriate size.

This, after being covered with the jacket, was baked in some sort of furnace and the casting carried out while the mould was still hot, probably while still in the fire, with the pouring basin alone exposed.



When cold the mould was broken open and the coins broken away from the runners. The author suggests that on one of the two opposing faces an obstruction was often deliberately left between the side runner and the coin mould, providing a small notch which enabled the coin the more easily to be detached.

The question as to whether this coin foundry was legitimate or not is discussed by the author, who concludes—possibly on somewhat scanty evidence—that these moulds were not, in fact, the product of a forger. Whether this be so or not is quite immaterial, however, from the point of view of the most interesting information provided regarding a technique employed at this very early date. A comparison is also made with other conjectured reconstructions of Indian and other coin moulds of different dates and localities. In the latter cases, however, more material is needed to settle the details of the process with the same certainty which has been possible in the case of the Rohtak procedure. To the metallurgist and numismatist alike, this contribution is one of outstanding interest.

F. C. THOMPSON

* "Memoirs of the Numismatic Society of India", No. 1, Bombay, 1945.

ATOMIC ENERGY EXHIBITION: THE ATOM TRAIN

AFTER a tour lasting six and a half months, during which the Atomic Energy Exhibition, organised by the Atomic Scientists' Association, visited twenty-five of the main centres in England, Scotland and Wales, the exhibition came to a close on May 28. Efforts to secure an extension in Great Britain failed; but the exhibition will continue its existence abroad. The Council of the Atomic Scientists' Association, as well as the Ministry of Supply and other owners of equipment, have agreed to lend the exhibits to the United Nations Educational, Scientific and Cultural Organisation and the Lebanese Government for incorporation in an exhibition at the Unesco Conference in Beirut in October. Later it will probably tour several countries in the Middle East and, possibly, various European countries. Although the administration of the tour is left to Unesco, the Atomic Scientists' Association will be closely connected with it, and the atomic energy part of the exhibition will be known as that of the British Atomic Scientists' Association.

In Great Britain the exhibition was an outstanding success and excelled all hopes. It was visited by more than 146,000 people, making an average daily attendance of 1,000, which is 80 per cent of the maximum capacity. In many places people were queueing up for several hours. 85 per cent of the visitors came especially to see the exhibition, many of them making long trips for this purpose.

The reaction of the public was learnt from the answers of more than 1,100 people to a questionnaire handed out to a random sample of visitors. They show that the visitors represented a fair cross-section of the British public as regards occupations, with a slight bias in favour of the intellectual classes. 95 per cent of the public thought it worth while coming, and 91 per cent said that they had learnt something from the exhibition. The most interesting parts were found to be the counters and models (32 per cent) and the peaceful uses (24 per cent); the atom bomb section was the main item of interest for only 7 per cent. Quite a large number of people expressed surprise that atomic energy could be used for constructive purposes as well. The main criticism of the exhibition was that it was not big enough and too crowded.

The guide book to the exhibition sold extremely well. Altogether more than 50,000 copies were sold or presented, making it the most popular and widespread publication on atomic energy.

The performance of the technical equipment, most of which was very delicate and tricky to operate, was extremely satisfying. Some of the experiments were demonstrated publicly for the first time and only a few years ago could not have been made to work reliably even with the best care in the laboratory. Here they were subjected to the most adverse conditions, to the movement of the train on a 1,900-mile journey, to differences of temperature ranging from 30° to 100° F., to a wide range of voltages in the various places and, above all, to the heavy hands of about 130,000 adults and 16,000 inquisitive children.

Not only has the equipment withstood the test magnificently, but also it has beaten all records for endurance of this type of apparatus. The scaling units are supposed to have a life-time of 200 hours, and yet during the 1,600 hours of operation of five scaling units, only one valve had to be replaced. Throughout the whole tour, each Geiger counter had to be replaced only once. The total time when the exhibits were out of commission amounted to less than 1 per cent and the total expenditure on maintenance of equipment, including replacement of films, fluorescent tubes, etc., was less than £50.

All this is evidence of the good quality and high-class workmanship of the British firms who manufactured it; it is also a tribute to the technical staff who looked so well after the maintenance of the equipment.

The Atomic Energy Weeks, which were organised in conjunction with the exhibition, were also very successful and the lectures and film shows were well attended.

Summing up, it can be concluded that the exhibition achieved its main object—that of educating an appreciable fraction of the British public in matters of atomic energy.

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1946

THE return to peace-time activities at Rothamsted Experimental Station enabled much of the fundamental and long-range work to be resumed, and the report for 1946 now issued includes a short account of such investigations, as well as of new work undertaken by the various departments. There are departments of physics, chemistry, soil microbiology, botany, crop physiology, statistics, plant pathology, biochemistry, entomology, insecticides and fungicides, and one for the study of bees. This list of departments indicates the very wide scope of the work at Rothamsted, and it is impossible not to be impressed by the advantages that must accrue from the ready contacts that are possible between the workers in the various sections. The experimental farm, together with that of Woburn, one on heavy and the other on light soil, offers every facility to the research worker, and the work of the Statistical Department enables field-work to be carried out with the maximum of effect. Field-work is not confined to the two farms, many careful experiments being carried out at various centres in the country; thus the main set of tests on the manuring of sugar beet, for example, involves some twenty commercial farms annually.

In a note of this length, it would be impossible to do justice to the work of so many departments; a reviewer can but mention one or two out of many significant lines of work. The experiments on deep ploughing and on cultivations have interested scientific men and farmers for some years, and the resumption of this work is welcomed. Results available before the War indicated that much time and money are lost on the farms of Britain in excessive cultivations; but farmers and Rothamsted workers alike felt that such unexpected results needed more corroboration. It has generally been considered that, in so far as yield of crop is concerned, the more and the deeper the cultivation the better; we used to point out the large, if expensive, crops raised in some gardens, where trenching is carried out, etc., and where no expense is spared on the preparation of the seed bed. The work at Rothamsted, however, which included experiments at many centres in 1944 and 1945, did not indicate any advantage from deep ploughing or from sub-soiling for potatoes or beet, and very little for wheat. Observations of root development and of the physical properties of the soil showed that none of the properties was influenced by deep cultivation.

The theoretical and experimental work on the movement of water in soils, and on evaporation, is also of great interest. Most of us have had the experience of observing small patches of a crop that have made far better growth than that of the surrounding plants, due to some physical character of those portions of the seed bed; for example, consolidation as the result of pressure from a tractor wheel, or greater pulverization on a headland where some implement may have been turned round, and where upward movement of water in the soil was presumably facilitated. On other occasions, under different weather conditions, these excessively consolidated or pulverized areas have carried the poorest plants. It is not easy for even the most experienced farmer to achieve the optimum seed-bed condition every season, and there will always be an element of chance about this until more fundamental knowledge is available about the physical properties of the soil, particularly in regard to water.

The Department of Chemistry commenced work in 1945 on forest nurseries, and interesting results are already available. It is interesting to note, for example, how the growth of Sitka spruce was improved by acidifying a slightly calcareous soil on which this species had consistently failed for a number of years. Work already carried out is sufficient to indicate that fruitful lines of research lie ahead in this field.

Work carried out in the Department of Soil Microbiology on the micro-organisms capable of the selective destruction of soil bacteria may be noted as of particular interest. The maintenance of satisfactory biochemical activity in a field soil depends on several factors, not the least important of which is the existence of micro-organisms that limit the numbers of useful organisms, either by competing with them for nutrients, or by producing toxic secretions, or by directly eating them. A number of strains of bacteria were subjected to attacks by five predatory organisms, and by three species that are destructive to bacteria by virtue of their secretions. It was found that any one species of organism could attack about half the bacterial species tested; the organisms, however, differed markedly as to which particular bacterial strain they attacked. It seems likely that very few species of bacteria exist in the soil that are immune to attack by some of the micro-organisms.

Current advances in the use of insecticides lend great interest to the Rothamsted investigations in that field. Experiments are in progress on various aspects of the use of D.D.T. and of benzene hexachloride, including the effect of these on bees.

Tables giving the detailed results of the experimental work have been omitted, since it is intended to issue these separately. The report includes a list of the scientific papers from each department, with a short note on the contents of each, and also a list of the publications of the Rothamsted Experimental Station.

PACIFIC SCIENCE BOARD

FIRST ANNUAL REPORT

THE first annual report of the Pacific Science Board (National Research Council, Washington 25), set up as a result of the Pacific Science Conference 1946, covers the year 1947, and outlines the steps being taken under the project for the co-ordinated investigation of Micronesian anthropology to fill gaps in our scientific knowledge of the Marshall, Caroline and Mariana Islands, and to provide the basic information required in setting up civilian government in these trust territories of the United States. A permanent Insect Control Committee has been appointed for Micronesia, and five entomologists have been sent to survey the distribution and destruction of coco-nut palms caused by the rhinoceros beetle (*Oryctes rhinoceros*), to study the coco-nut beetle (*Brontispa mariana*) and the giant African snail (*Achatina fulica*) and to search for parasites or natural enemies for the control of these pests. An entomological survey of the Palau Islands is also in progress.

Approval was given for eight other field projects and in general the Board's policy is to give stronger endorsement and higher priority to proposals for intensive and long-range research than to those for extensive but superficial surveys or short-term projects. In accordance with the desire to strengthen Honolulu as a centre for research in the Pacific, the Board generally recommends that reference collections from the area should be deposited with appropriate institutions in Honolulu.

The Pacific oceanic biology project is now actively engaged in studying, analysing and evaluating the data already available, with headquarters at the Woods Hole Oceanographic Institution; and plans are now being developed for establishing a new Hawaii Marine Laboratory on an island in Kaneohe Bay, Oahu. The Board also hopes to co-operate with the research council to be set up by the South Pacific Commission in developing plans for research in that area, and conservation planning in the Pacific should be greatly assisted by three forthcoming international conferences: the meeting of the Standing Committee for the Protection of Nature in and around the Pacific, at the Seventh Pacific Science Congress to be held in New Zealand in February 1949; the Economic and Social Council of the United Nations Scientific Conference on the Conservation and Utilization of Resources, to be held in the United States in May 1949; and the United Nations Educational, Scientific and Cultural Organisation's Conference on the Protection of Nature also to be held in the United States in May 1949.

Future activities contemplated include the encouragement of oceanographic and fisheries research in various parts of the Pacific, the initiation of a conservation programme for Micronesia, and the initiation of field studies in the Pacific area to further research bearing on problems in cancer and heart disease.

CARNEGIE UNITED KINGDOM TRUST

THE thirty-fourth annual report of the Carnegie United Kingdom Trust for the year 1947 emphasizes the increasing rate of expenditure, which rose from £120,000 in 1946 to £160,000 in 1947, thus exceeding the annual expendable income of about £133,000. The quinquennial policy for 1946–50 was framed on the assumption, however, that during the period a substantial part of the accumulated savings of the war years would be applied as annual revenue, and the Trustees are more concerned at a second feature of the period—the increasing proportion of expenditure allocated to the provision of services rather than buildings or capital assets.

The largest bulk allocations, totalling £150,000 each, for the Bureau of Current Affairs and for the development of amateur music and art, are wholly concerned with services, and this is also true of the £25,000 allocated to enable local organisers to be appointed by County Federations of Young Farmers' Clubs. Although the 'village hall' allocation of £100,000 is designed to help capital expenditure, payments have amounted to less than £7,500 in two years. Past experience of the Trustees indicates that grants for capital purposes have been more certain in their operation than grants for the early maintenance of services, and accordingly they regret the present restricted opportunities in the capital field. In view of the unsatisfactory position of the village halls scheme, it has been decided that when the Trust allocation of £100,000 has been exhausted by promises, subsequent schemes shall be eligible for consideration for Exchequer grants under the Physical Training and Recreation Act. For the village planning competition, forty-seven entries were received and the winning design is regarded by the adjudicators as quite outstanding. The Trust has also agreed to find up to £400 a year for a two-year programme of pioneer work for young women from the Channel Islands, partly by visits of expert organisers from England and partly by courses of instruction in England.

The report refers to the passing of the Irish Central Library for Students under an independent governing body, the Library Council established by the Public Libraries Act of 1947 (Eire). Grants to three county libraries in Eire have also been agreed in principle, and the committee set up to consider the future of the Scottish Central Library reported unanimously in September 1947 that the Library should not be merged with the National Central Library, although continuing to work in the closest co-operation and consultation with that Library. Some form of constitutional link between the two Libraries was recommended; but it was considered that the time was now ripe for establishing the Scottish Central Library on an independent basis, with its own trustees and governing body and an initial income of £5,000, in new premises in Edinburgh. The grant to the National Central Library has been progressively decreased to £3,000, £2,000 and £1,000 for the three ensuing years and will become extinct on December 31, 1950.

Sufficient progress has been made with the Shropshire Community House at Attingham Hall, near Shrewsbury, to justify the appointment of a warden, and the Highlands and Islands Film Guild has made a very satisfactory start and is now working on a programme of six mobile film units.

STANDARD FREQUENCY TRANSMISSIONS IN GREAT BRITAIN

THE question of radiating standard frequency transmissions from Great Britain has recently been under consideration. Such transmissions are of great value in connexion with the calibration of industrial and scientific frequency sub-standards, in connexion with work on radio wave propagation and also for survey purposes. At present, standard frequency transmissions of guaranteed accuracy are emitted by the U.S. National Bureau of Standards[1] continuously on the eight frequencies 2·5, 5, 10, 15, 20, 25, 30 and 35 Mc./s. from station WWV. Unfortunately, on account of radio propagation conditions, it is often difficult to make good use of the American transmissions in Europe and farther east. At the recent meeting of the International Telecommunications Union at Atlantic City, it was agreed that the first six of the above frequencies (namely, 2·5, 5, 10, 15, 20 and 25 Mc./s.) should be allocated on a world-wide basis for all future standard frequency transmissions. Hence, if undesirable interference between such transmissions is to be avoided, all new services of standard frequency transmissions will require very careful co-ordination with existing services.

In Great Britain, an experimental low-power transmission from station GMT, on a frequency of 2 Mc./s., has been set up by the Royal Observatory at Abinger, Surrey, to facilitate comparisons between quartz clocks used in the operation of the Greenwich time service. Details of this service have been published recently[2]. Since no other British standard frequency service is at present available, these transmissions have been fairly widely used, and a substantial increase in power is under consideration.

In existing circumstances the provision in Britain of a comprehensive service on a number of the available frequencies will take some considerable time; but arrangements are now under consideration whereby a limited standard frequency service on three frequencies will be operated by the General Post Office. It is hoped that experiments connected with the new service will demonstrate the feasibility and value of covering the United Kingdom and Europe in this way, and also the degree of interference from and with the WWV transmissions.

Details of this experimental service will be announced later; but meanwhile it may be mentioned that the frequencies of the following transmitters of the General Post Office and of the B.B.C. are maintained at their nominal values to a tolerance better than ± 1 part in 10^6.

Station's call sign	Nature of service	Location	Nominal frequency kc./s.
GBR	Telegraph	Rugby	16
—	Broadcast	Droitwich	200
GRO	Broadcast	Skelton	6,180
GSB	Broadcast	Daventry	9,510
GSV	Broadcast	Daventry	17,810

The B.B.C. medium-wave transmitters, with the exception of that on 583 kc./s. (514 m.), are also maintained on their nominal frequencies to a tolerance of approximately ± 1 part in 10^6.

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[1] National Bureau of Standards (U.S.A.). Letter Circular LC886, January 30, 1948.

[2] *Wireless World*, 53, 439 (Nov., 1947).

ELECTRIC CONDUCTIVITY OF ROCKS AT HIGH TEMPERATURES

H. P. COSTER has described the results of measurements of the electric conductivities of various rocks (*Mon. Not. Roy. Astro. Soc.*, Geophys. Supp., **5**, No. 6, January 1948). The conductivity was determined on specimens of rock cut in the shape of a cylinder, by measuring the resistance between the electrodes in a D.C. bridge circuit; the current in the bridge was reversed after balancing, with the object of detecting potentials due to polarization of the rock by electrolysis. Although a small effect was usually found, its influence on the resistance was never more than a few per cent. The conductivities determined for different rocks showed that they could be classified as semi-conductors, and in many semi-conductors the relation between the conductivity and the absolute temperature T is given by

$$\sigma = A_1 \exp(-\varepsilon_1/kT) + A_2 \exp(-\varepsilon_2/kT) + \ldots,$$

where k is Boltzmann's constant, $\varepsilon_1, \varepsilon_2$, etc., are the activation energies of the various processes to which the conductivity is due, and A_1, A_2, etc., are constants.

The results of the experiments are shown graphically, $\log_{10} \sigma$ being plotted against $10^3/T$, for eight different rocks—all Scottish—which Prof. C. E. Tilley placed at the disposal of the author. The curves show that the conductivity of most of the rocks is due to at least two mechanisms: one with an activation energy of about 0·7 volt and the other with an activation energy of the order of 2 volts, the latter appearing at higher temperatures; experiments on the nature of the conductivity suggest that in this case it is caused by moving ions.

The theoretical implications of the results with regard to the conductivity in the interior of the earth are discussed, and the following suggestions are made. At a depth of a few kilometres where the rocks are probably dry, the conductivity is lower than it is nearer the surface; but as greater depths are reached, where the temperature is higher, the conductivity should start to increase. Assuming that pressure has no effect on the conductivity, a value of 0·01 ohm^{-1} cm.$^{-1}$ should be reached at a temperature of 1,200–1,400° C., possibly at a depth of 160 km. The effect of pressure is, however, a serious source of uncertainty in the investigation; but using the temperatures and pressures given by Bullard and Bullen, respectively, Coster has compiled a table which shows the variation of temperature, pressure and conductivity with depth, though the relation cannot be regarded as anything more than an approximation. At depths greater than 200 km. the increase in conductivity is rather small, because the effect of increase in temperature is almost compensated by that of increase in pressure. The figures, though giving only a rough idea of the variation of conductivity with depth, nevertheless can account for the increase of conductivity with depth found by Chapman and Price.

MEXICAN VILLAGE LIFE

THE monograph under notice*, the sixth of a series dealing with the sociology of Latin America, returns to the Mexican Highlands and to the Tarascan pueblo of Tzintzunzan. This village, which at the time of the Spanish conquest was the capital of an empire second only to the Aztec in size, has now become a sleepy Mestizo community of 1,500 souls which is "probably typical of a vast number of small rural Mexican pueblos". "Empire's Children" is a very readable account of this engaging and happy-go-lucky community of potters and farmers where "the great majority of the villagers get down to work only with a tremendous exertion of will power and stop on the slightest pretext", and where "Russia, Communism, the United States and Protestantism are conveniently lumped together as enemies of the inalienable rights of man".

The author's purpose is to convey a general and comprehensive impression of the social and economic life of these people, and he has been more than usually successful in achieving this. The reader is neither overwhelmed with masses of unnecessary detail nor mystified by technical anthropological jargon, and yet practically every aspect of village life is covered—its history and prehistory, its domestic and its material culture, its trade and commerce and its social, political and religious institutions. His summing up and conclusions are not so impressive, probably because of his short acquaintance with the country (two years) and possibly because although he admits the essential unity of the Mestizo culture, he remains too preoccupied in distinguishing the Spanish and Tarascan traits which contribute to its 'total configuration'. However, this summary only takes up eight pages at the end of the monograph and is probably inserted for the benefit of the Mexican Government rather than for the general reader.

It is to be hoped that this preliminary survey will be succeeded by detailed studies of the more striking aspects of rural Mexican society, in particular, of the part played by the Church, a role so vital that Foster considers it the "socio-spiritual focal point of the culture".

G. I. JONES

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* Empire's Children. The People of Tzintzunzan. By George M. Foster assisted by Gabriel Ospina. Pp. v+297+16 plates. (Pub. No. 6, Institute of Social Anthropology, Smithsonian Institution. Washington, D.C.)

See also *Nature*, 161, 697 (1948) for notice of Pub. 2–5 of this series.

SOIL IMPROVEMENT FOR FORESTRY

THE Reports of the Forest Research Institute of Sweden, Vol. 36 (Centraltryckeriet, Esselte AB, tockholm, 1948) contains papers of considerable terest. Omitting those dealing with volume and ther measurements made in different parts of the ountry, sample plots and yield tables, and papers n forest pests, an article of importance to other untries is that of Carl Olof Tamm entitled "Soil-mproving Measures Tried on a Poor Site". The ork is described as a final report on work started n 1922 by the Swedish Institute of Forest Research n co-operation with the Forest Protection Board of he district of Jönköping, following an initiative aken by W. Lothigius, who was at that time the oard's executive forest officer. The aim of the work as been to try some possibilities of raising the poor orest yield frequently found on sandy soils within the istrict and elsewhere in the province of Smaland. arlier reports have been published by O. Tamm, ho planned the experiments and was responsible for llecting data on the plots as long as he remained ith the Institute (up to 1938).

The plots are at lat. 57° 34′ N., long. 22° 12′ E. hey occupy an area known as the Mölna Field on a and flat that was formerly mostly covered by old orest. In the experimental field, the forest was felled uring 1918–19.

After describing the area and its previous vegetative overing, the methods of re-afforestation are treated y means of a number of experimental plots. Nine trips were laid out, numbered III–XI, each 50 mm. ide. Furthermore, the main experiment is divided n ten rows, crossing the strips at right angles. Row No. 7 is 37·5 m. wide, Row No. 8 is 62·5 m.; all other ows are 25 m. wide.

Strips Nos. III and V were sown in 1923 with pine ixed with spruce. In strip No. III the mor cover round each seedspot was loosened and mixed with he sand: no positive effect of this treatment was ver observed. At the same time, strip No. IV was lanted with birch (about 1,000 per hectare, side-hole lanting) and then sown with pine mixed with spruce. trip No. VI was planted with *Alnus incana* instead f birch, and sown with pine.

Strip No. VII and the following strips were planted n 1922, the former with pine 1/0 and spruce 2/0 ratio 2 : 1), No. VIII with birch as No. IV and pine nd spruce, No. IX with pine and spruce, No. X with *Alnus incana* as No. VI and pine, and No. XI with pine only. The conifer seedlings were planted y the slit method.

The number of seedspots per hectare was intended o be 6,000 all over the field, but this figure is rather pproximate. All pine and spruce seed used came rom the same province; but the birch and *Alnus ncana* seedlings originated from Bastad (Skåne).

In Strip No. VII each planting hole was manured with peat from a birch carr; seven or eight litres of eat were mixed with the earth in each hole before lanting. The other treatments were done in different ows. The rows Nos. 1, 3, 5 and 7 were controls no treatment). Within rows Nos. 2 and 6 the soil was ripped by a kind of harrow. Within row No. 4 bout 400 gm. lime (calcium carbonate was used rom the sulphate mill at Gotafors) was mixed in each ole. Within rows Nos. 8 and 10 tree-debris from the lear felling were removed and taken to row No. 9.

Most of the pines, planted or sown, grew well in the first few following years. The planted spruces grew well, too; but the spruce seed used had a poor capacity of germination. The birches and alder seedlings generally did not stand the hard conditions at Molna Field, especially the frosty climate. Within small areas seedlings of all kinds suffered, either from fungus injuries or from starvation. Attempts were made to fill blanks by repair plantings in 1926 and 1930.

Two diagrams give results from observations in 1932. The brush-manured row (No. 9) had a small number of seedlings but a high percentage of good pine. Many seedlings were spoiled by capercailzies that found shelter in the brush cover. The peat strip (No. VII) showed a slight excess over the others, both in number of seedlings and in percentage of good pine. None of these deviations is significant.

The paper should be consulted for full details. In summing up, the author writes: "The Mölna experiment has been helpful in drawing attention to some factors determining forest yield on poor sandy soils. Yet, in order to have a more definite idea of the parts played by humus conditions, on one hand, and by geology on the other, fresh data must be obtained on plots where the conditions at the start of the experiments are carefully determined. The problems at issue have proved much more complicated than was realized in 1920."

SOME FUNGI OF INDIA

SIX new species of fungi occurring in Mysore have been described by M. J. Thirmulachar (*Trans. Brit. Mycol. Soc.*, 31, 1; July 1947). *Sphaceloma santali* attacks the leaves of the sandal tree; *S. osyridis* parasitizes leaves of *Osyris Wightiana*; *S. oleanderi* produces an anthracnose on oleander, and *S. curcumæ* causes leaf-spot of wild turmerics. *Cladochytrium aneuræ* is an interesting species weakly parasitic within the thallus of a liverwort (*Aneura* sp.), and *Leptosphæria porellæ* causes wilting of the bryophyte *Porella*. Mycological descriptions of the new species are given. Two further new species of *Physalospora* attacking *Pterolobium indicum* and *Heterostemma tanjorense*, two species of *Septoria* parasitizing *Erythrina* sp. and *Thespesia populnea*, with *Cereospora adinæ* on its name host, are fully described by T. S. and K. Ramakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, No. 1, 7; July 1947).

Several papers have also been published on *Phytophthora palmivora*, which causes a fruit rot of tomatoes and a seedling blight of *Hibiscus esculentus*. T. S. Ramakrishnan and C. K. Soumini have studied the fungus on tomatoes (*Proc. Ind. Acad. Sci.*, B, 25, No. 2, 39; Feb. 1947). They isolated the fungus, proved its pathogenicity, found it could enter unwounded fruits, and, as infection appears most readily on fruits in contact with the soil, suggested proper support of tomato plants as a simple means of prevention. M. S. Balakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, No. 4, 142; Oct. 1947) established the pathogenicity of *P. palmivora* on *Hibiscus* seedlings. A minus strain was isolated, and did not form oospores until paired with a plus strain of the same species. Further studies on this heterothallism have been made by K. M. Thomas, T. S. Ramakrishnan, C. K. Soumini and M. S. Balakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, 147; Oct. 1947).

R. P. Asthana has investigated several characters of *Sclerotium cepivorum* and *S. tuliparum* (*Proc. Ind.

Acad. Sci., B, 26, No. 3, 93; Sept. 1947). *S. cepivorum* grows best on an acid medium, whereas *S. tuliparum* favours neutral or slightly alkaline conditions. Both species have an optimum temperature of 20° C. Neither species is able to attack the host of the other; but *S. tuliparum* can infect several bulbous plants in addition to the tulip. Both species secrete pectinase, though there is evidence that each host type is more sensitive to the enzyme of its specific parasite than to that from the other.

A threefold chain of parasitism is described by S. Y. Padmanabhan (*Proc. Ind. Acad. Sci.*, B, 26, No. 3, 77; Sept. 1947), who found a species of *Fusarium* attacking pupæ of *Epipyrops*, which in the larval stage is a parasite of *Pyrilla*, a pest of sugar-cane. The fungus is variable in culture, but is regarded as *F. moniliforme* var. *subglutinans*. Six new hosts of the ergot fungus *Claviceps* are given by T. S. Ramakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, No. 4, 136; Oct. 1947), who also describes the fungus upon each. Miss H. Sunanda Kamath investigated the life-history of *Puccinia ruelliæ* on *Ruellia prostrata*, a common perennial weed in south India. It was found to be a macro-cyclic, autœcious rust, and the sequence of development of all the spore forms was followed by inoculation experiments.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN BOTANY—The Registrar, The University, Nottingham (August 21).

DAVID BROWN SCHOLARSHIP IN AGRICULTURAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (August 21).

PAINT AND VEGETABLE OIL CHEMIST (graduate) to take charge of research and to teach a small post-graduate class, and a GRADUATE TECHNOLOGIST to teach vegetable oil extracting and paint manufacturing processes, at the Instituto de Oleos, Rio de Janeiro—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (August 21).

PHYSIOLOGIST (male) with an Honours degree in Science, and a BACTERIOLOGIST with Honours degree, or an Honours Graduate in Science with experience in Bacteriology—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (August 21).

LECTURER (man or woman) IN AGRICULTURAL SCIENCES at the Cheshire School of Agriculture, Reaseheath—The Director of Education, County Education Offices, City Road, Chester (August 21).

FORD MOTOR COMPANY SCHOLARSHIPS IN AGRICULTURAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (August 21).

LECTURER (Grade III) IN THE DEPARTMENT OF GEOGRAPHY (with special qualifications in Meteorology and/or Geomorphology)—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (August 21).

DEMONSTRATOR OF PHYSICS—The Dean, Medical School, Guy's Hospital, London, S.E.1 (August 23).

SCIENTIFIC OFFICER (Zoologist, for work especially on plankton) at the Millport Laboratory—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (August 24).

LECTURER or ASSISTANT LECTURER IN STRUCTURAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (August 30).

ASSISTANT IN ZOOLOGY FOR RESEARCH IN ENTOMOLOGY, with minor teaching duties—The Secretary of University Court, The University, Glasgow (August 31).

AGRICULTURIST IN THE SOUTHERN RHODESIA GOVERNMENT SERVICE—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (August 31).

LECTURER IN CHEMISTRY with special qualification in physical chemistry—The Secretary, The University, Old College, South Bridge, Edinburgh (September 1).

LECTURERS IN MATHEMATICS, and LECTURERS IN SCIENCE (physics, mechanical or electrical engineering, or chemistry), at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 2254 (September 4).

LECTURER IN SOCIAL SCIENCE and Supervisor of Studies for the Diploma Course in Social Science—The Registrar, University College, Singleton Park, Swansea (September 11).

CARGILL CHAIR OF NATURAL PHILOSOPHY, tenable in the subject of Theoretical Physics—The Secretary of University Court, The University, Glasgow (September 11).

ASSISTANT INSPECTORS OF MINES AND QUARRIES under the Ministry of Fuel and Power—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2246 (September 11).

DIRECTOR OF MUSEUMS to take charge of the Museum Section of the Art Galleries and Museums Department—The Town Clerk, City Chambers, Glasgow, C.2 (September 15).

CHAIR OF APPLIED MATHEMATICS—The Registrar, University Colleg Southampton (September 20).

LECTURER IN GEOLOGY, within the Department of Agricultur Chemistry, and an ASSISTANT LECTURER IN PLANT DISEASES in th Department of Agricultural Botany—The Secretary and Registrar University College of North Wales, Bangor (September 25).

SMITHSON RESEARCH FELLOWSHIP—The Assistant Secretary, Roya Society, Burlington House, Piccadilly, London, W.1 (October 30).

TUCKER-PRICE SCIENTIFIC RESEARCH FELLOWSHIP in mathematic science or an allied subject—The Secretary, Girton College, Cambridg (January 15).

CHEMIST IN THE DEPARTMENT OF CHEMISTRY, Tanganyika—Th Director of Recruitment (Colonial Service), Colonial Office, 2 Sanctuar Buildings, Great Smith Street, London, S.W.1.

UNIVERSITY GRADUATES and QUALIFIED TEACHERS, with qualifications in mathematics, science, engineering, or in geography wit mathematics up to intermediate degree standard, for Short Servic Commissions in the Education Service, Royal Navy—The Director (P Education Department, Admiralty, London, S.W.1.

LECTURER IN MATHEMATICS to B.Sc. standard, a LECTURER I CHEMISTRY to B.Sc. standard, and a LECTURER IN PHYSICS to B.S (Special) standard—The Clerk, Northern Polytechnic, Holloway London, N.7.

TECHNICIAN FOR THE DEPARTMENT OF ZOOLOGY—The Clerk Birkbeck College, Breams Buildings, London, E.C.4.

LABORATORY TECHNICIAN (bacteriological technique essential) I THE PATHOLOGY DEPARTMENT—The Secretary, Welsh Nationa School of Medicine, 10 The Parade, Cardiff.

SOIL SURVEY OFFICER—The Secretary, Rothamsted Experiments Station, Harpenden, Herts.

RESEARCH METALLURGIST, and a SENIOR ASSISTANT IN THE INFORMATION DEPARTMENT—The Secretary, British Non-Ferrous Metal Research Association, 81–91 Euston Street, London, N.W.1.

ASSISTANT TECHNICIAN for university laboratory involving botanica and chemical work—Dr. J. W. Fairbairn, School of Pharmacy, 1 Bloomsbury Square, London, W.C.1.

SCIENTIFIC ASSISTANT with a knowledge of electronics for work i X-Ray crystallography—Dr. W. A. Wooster, Cavendish Laboratory Cambridge.

TECHNICAL OFFICER (with a degree or diploma in, and a soun practical knowledge of, horticulture)—The Curator, John Inne Horticultural Institution, 31 Mostyn Road, London, S.W.20.

VETERINARY RESEARCH OFFICERS (2) in the Sudan Veterinary Service, for supervising the preparation of various biological product and carrying out general research—The Sudan Agent in London Wellington House, Buckingham Gate, London, S.W.1, endorse 'Veterinary Research Officer'.

SCIENTIFIC OFFICER and EXPERIMENTAL OFFICER Grades in Ministry of Supply Research Establishments in the following fields of work Chemistry—Inorganic, Organic, Physical, Analytical, and Chemica Engineering (Ref.F.355/48A); Biochemistry, Physiology, Pharmacology (Ref.G.184/48A); Aerodynamics—subsonic and supersonic i wind tunnels and in flight (Ref.A.160/48A); Aircraft Structural Theor (Ref.C.301/48A); Gas Turbines, jet and rocket propulsion at supersonic speeds (Ref.C.299/48A); Physics, including optics, gas kineti and thermodynamics (Ref.A.159/48A); Radar (Ref.A.161/48A) Aircraft Instrumentation and electrical and radio accessories, etc (Ref.C.300/48A); Metallurgy, X-Ray diffraction, electron microscopy inter-crystalline corrosion, high temperature materials (Ref.F.356/48A) Mathematical Applications, including ballistics, statistics (Ref.A.158 48A)—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2.

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THE ROCKEFELLER FOUNDATION

THE reviews of the work of the Rockefeller Foundation which we are accustomed to receive from its President are far more than mere summaries of the activities of the Foundation during the year under review. They represent an intellectual stock-taking—an assessment of the position of the creative forces of civilization, its moral and spiritual, as well as scientific, resources, and an attempt to appraise the directions in which special efforts are required. Dr. Fosdick's review of 1947 is no exception, and with insight and courage delineates the challenge which Western society faces to-day and the points at which special efforts are necessary to avert pressing danger.

Dr. Fosdick starts his review with a glance at the appropriations of the Foundation during 1947. Amounting to 23,413,615 dollars, or nearly four million dollars more than those in 1946, they represent the largest annual appropriation in the history of the Foundation. They include a single grant of ten million dollars to the China Medical Board for the support of the Peiping Union Medical College, another 2,225,000 dollars for public health, and 1,500,000 for medical sciences, 1,700,000 for natural science, 3,000,000 for social sciences and 1,500,000 dollars each for the humanities and for the General Education Board. Of this total 39 per cent was for work in the United States and 61 per cent for work in other countries.

The central issue to which Dr. Fosdick directs attention in this report is that of the misuse of knowledge, and while he recognizes that in the present situation an element of physical force is essential he insists that that alone will be of no avail unless we meet the challenge on an intellectual and ethical plane. Here the emphasis on the task of raising the material standards of living can be an obstacle. A solid material foundation may be an essential basis for a high civilization; but Dr. Fosdick points out that it is a basis and not a superstructure. So, too, our reverence for the physical sciences and acceptance of the doctrine that civilization can be bred to greatness and splendour by science hinders our responding to the challenge at a higher level. The gap between the physical sciences and the humanities and social studies, in terms of endowment, research facilities and teaching staffs, needs to be closed, whereas in fact it is growing wider.

Dr. Fosdick recognizes the debt which mankind owes to science in giving us the methods and patterns of research in human relationships; but he insists that to the problem of discovering a new set of human purposes, to the art of human relations, to the winning of wisdom, physics, chemistry and engineering contribute little. They are ethically neutral, and the issues of our time and of human destiny will be determined not at the physical but at the ethical and social levels. If this age is to achieve greatness it will not be through its physical triumphs, but through the discovery of an enlightened humanism and of new spiritual and moral values that lead men forward.

The immediate task, in Dr. Fosdick's view, is to discover the common interests, the areas in which collaboration is possible, where curiosity and sympathy, aspiration and mutual advantage overlap. The search for these rallying points, the development of new techniques and areas of co-operation where ideas and experience can be pooled and combined, lays the foundation of the ultimate structure of a unity never yet achieved in the world. In this connexion it should be noted that while representatives of the Rockefeller Foundation visited practically every country in the world in 1947, visas to enter Bulgaria and the Soviet Union could not be obtained and no contact could be established with their scholars and scientists. And in all the countries which representatives of the Foundation visited the passionate desire for peace, security and a better life formed the universal pattern of thinking and planning, whatever the differences of opinion as to the means by which these ends are to be achieved.

We have already noted in these columns Dr. Fosdick's comments on the unhappy effects of isolationism on science and the major responsibility which here rests on the Soviet Union. It is because medicine stands so clearly above political ideology that Dr. Fosdick justifies the large appropriation for the development of modern medicine in China at the present time, as he does the increasing support given in the field of public health. There also the widening horizons, the fading of the borderlines between curative and preventive medicine, are giving public health the stature of a social science in the service of society. Dr. Fosdick clearly looks upon the World Health Organisation of the United Nations as a real unifying force in the world and one vehicle through which our new knowledge and widening conceptions of public welfare may make health, if not infectious, at least within the reach of all men.

Another unifying factor, at least in the world of science, is what Dr. Fosdick describes as the cross-breeding of biology with physics as well as chemistry. Biophysics, in particular, with its demands for such expensive equipment as ultracentrifuges, X-ray equipment, spectrophotometers and cyclotrons, demands co-operation across national frontiers, and the Foundation made a number of large grants in this field in 1947, including 250,000 dollars to the Massachusetts Institute of Technology, 50,000 dollars to the California Institute of Technology, 85,000 dollars to Prof. W. T. Astbury at Leeds, and 21,000 dollars to Prof. J. T. Randall, director of the Biophysics Unit of King's College, London.

Of the grants in the field of social sciences and in the humanities, Dr. Fosdick observes that they are intended to assist a more adequate analysis and understanding of the issues in international relations, to widen the horizons of the political and economic life of men, to extend the frontiers of the mind in time as well as in space. The programme of research assisted from this point of view also has claims upon the interest of the physical as well as of the social scientist. One particular problem is of exceptional interest at the present moment and is a challenge to this country which is unmistakable.

During 1947 Dr. R. J. Havighurst, of the Universit of Chicago, made an extensive study for the Found tion of the situation in Germany as regards tl universities, primary and secondary schools, librarie youth problems and policies, teacher training, co tacts with the outside world and so on. Dr. Fosdic summarizes very briefly the observations and recon mendations of this report, stressing the poverty Germany and the utter isolation which affects mar men of goodwill in Germany, and asserting th nevertheless the foundations for a peaceful ar productive democratic society are present in Germar to-day. Moreover, the two prerequisites to tl development of such a democratic society—t restoration of communications between the Germa and the people of other countries, and the develo ment of younger leaders who know the world outsi of Germany—are steps no less needed in Austria ar Italy, as well as in all the countries where peop have been cut off from free and natural intercour with the people of other countries.

In addition to its regular European programm the Rockefeller Foundation in 1947 set aside 500,0 dollars for work in this field of European reconstru tion. The examples of these appropriations cited Dr. Fosdick indicate the challenge that the Found tion's work represents to Britain, which no less th the United States bears responsibility for administr tion in Germany. The sum of 120,000 dollars h been given to the University of Chicago to set up American faculty in the University of Frankfu From six to ten university professors from Chicag selected primarily from the field of the social scienc and the humanities, will be constantly in residence Frankfurt for periods of at least six months. grant of 60,000 dollars over three years to tl Germanistic Society of America is for the supp of scholarly periodicals to fifteen German and thr Austrian university libraries, and a grant of 25,0 dollars to Columbia University is intended to facilita the establishment of German radio as a public servi free from political control by bringing to Gre Britain, the United States and Canada, leadi German personnel from German radio stations acquaint them with the rights and responsibilities British, American and Canadian radio.

These are precedents which deserve to be mark and studied by the British Government and unive sities as well as men of science. As Mr. Kenne Lindsay has urged, it is a time to increase and not restrict, as has been done, for example, with bo imports, cultural relations of all kinds, at lea between those countries within the Marshall plan a the United States. To be fully effective, politic and economic organs must be matched with t acceptance of common values which in general ter must permeate the schools and the universiti Moreover, the universities carry a large measure responsibility for establishing a community of ide and ideals.

An important factor to both these ends is t interchange of teachers and students. That int change has been sadly interrupted during the pa year by travel restrictions, direct and indirect, a though the British Council is doing something in this field, as has been pointed out in *The Universities Quarterly*, its postgraduate courses for American and other overseas students at British universities are prohibitive in their cost for most students from European countries. Here it would seem is an opportunity for Government action to relax restrictions at least. Again, it may be asking too much of any one British university at the present moment to establish faculties in German universities on the scale which, through the Rockefeller Foundation, the University of Chicago has done at Frankfurt. But can nothing on these lines be done corporately by the combined universities ? Rather we might ask, can this country afford not to do so ? General Robertson has recently set up a Commission of eleven members, of which the Master of Balliol is the one British member, to examine the state of the universities and technical schools in the British zone in Germany. That Commission will function with essentially the same freedom as a Royal Commission in Britain and may be expected to address itself with wisdom and energy to the task of university reform. Its composition should dispel any fears that reforms will be recommended which break drastically with the past and the German idea of a university as a home of mature learning and research.

But if the German universities are to meet the demands which will be made upon them in the reconstruction period, if the younger teachers are to be enabled to take the part which they could usefully play in the government of academic life, if that isolation to which all observers bear witness is to be removed, interchanges on such lines must make a large contribution. Books and periodicals have their place; but the interchange of staff and of students is as important for the revival of learning and the development of the German universities to meet their new opportunities as it is for the presentation and interpretation of the constructive side of British policy and of the British way of life.

Significantly enough in the recent debate on Overseas Information Services that aspect of the question escaped notice, though it might well have been one compelling reason for the Government to relax some of the restrictions hampering such interchange if not for encouraging them by direct financial support.

Large as is the measure of responsibility resting upon the Government here the main driving force to action must come from the man of science and those nurtured with him in the universities who in those seats of learning have not only entered on the great heritage of Western civilization but have understood how great are the issues in the threat to liberty of thought, of investigation and of utterance in the modern world. In his passage dealing with the problem of Germany Dr. Fosdick crystallizes the essence of that challenge not only to Germany and Western Europe but also to the rest of the world, and he indicates some of the ways in which the man of science might work to overcome the lack of will and the lack of light by which, as John Masefield has warned us, 'one great land after another may be herded into a Dark Age in a very little time. The misuse and disuse of knowledge will only be averted as men of science answer that call, and, no longer content to enlarge the boundaries of knowledge in the laboratory, insist also on clearing the blocked channels of communication of knowledge and ideas, and seek to foster that cultural fellowship and intercourse in which the greatest and noblest elements in the heritage of the West find full and free expression.

REACTION KINETICS IN SOLUTION

The Kinetics of Reactions in Solution
By Dr. E. A. Moelwyn-Hughes. Second edition. Pp. viii+424. (Oxford : Clarendon Press ; London : Oxford University Press, 1947.) 25*s*. net.

WHEN the first edition of this book appeared in 1933, it was not generally believed that reaction kinetics in solution could be profitably interpreted on a molecular basis, and there was relatively little planned experimental work of high accuracy. The author then attempted to show that a simple kinetic picture would account for a large number of the observed facts, and the success of this attempt provided an important stimulus for later theoretical and experimental work on reaction kinetics in solution. The amount of such work during the last fifteen years is very large, and the task of producing a second edition of the book must have been a formidable one.

In many respects the new edition reflects the great expansion which the subject has undergone : thus it contains 144 tables of numerical data, and references to original papers by more than a thousand authors. It is an admirable feature of the book that the data for many reactions are examined in detail, with a clear analysis of possible experimental errors and complications due to reversible, competing and consecutive reactions. The book thus provides a valuable and critical guide to a large range of experimental work, including related topics such as reactions taking place at a liquid–solid interface, reactions in surface films, and enzyme reactions.

On the theoretical side it is no longer necessary to wage a crusade for the application of molecular kinetics to reactions in solution, and the task is rather that of conducting a comprehensible tour through the many alternative formulations and refinements which have arisen since 1933. Dr. Moelwyn-Hughes has given pride of place to a particular type of development, namely, the elaboration of the simple collision theory by adding electrostatic terms for the mutual interactions of ions and dipoles, the solvent being regarded as a continuous medium. This procedure produces at least the appearance of a quantitative theory, and the present book derives and compares with experiment a large number of electrostatic expressions. Unfortunately, most of these expressions contain one or more adjustable parameters which have to be derived from the kinetic data, and all that can be demonstrated is that these parameters usually have a physically plausible value. In these circumstances many would prefer to adopt a superficially more qualitative treatment, which gives a picture of the part played by the individual molecules of solute and solvent and avoids the use of a macroscopic dielectric constant of doubtful significance.

It is remarkable that the terms 'transition state' and 'critical complex' do not occur in an index with more than 700 entries, and that the quasi-thermodynamic method is scarcely used at all in the book. It is true that the statistical equations of the transition state method are worked out in an appendix, but (as the author himself points out) they are of little service in predicting absolute reaction-rates in solution. The value of thermodynamic analogy does not lie in detailed calculation, but in the insight which it gives into the parallel effects of various factors (temperature, pressure, solvent, etc.) on reaction velocities and on equilibria. This aspect of the matter has not been clearly dealt with, and the chapter on "Equilibria" is concerned chiefly with the reverse process of explaining equilibrium constants in terms of kinetic considerations. At best, this procedure provides a derivation of familiar relations which is cumbrous and of limited validity, and at times it produces some curious results, for example (p. 196), an expression for an electrolytic dissociation constant which involves the viscosity of the solvent. This chapter might with advantage have been curtailed, or even omitted altogether.

It is possible to criticize a number of the author's detailed statements; for example, that an observed reaction order of two shows the slowest step to be bimolecular (p. 49), and that the slowness of esterification reactions in the gas phase must be due to a low collision factor (p. 242). However, in spite of this, and the more general criticisms indicated above, the author has given a useful survey of much recent material. If he has at times failed to give a clear picture of its significance, this is due, at least in part, to the great bulk of experimental work, and to the many and diverse interpretations which have been advanced.

R. P. Bell

PROPERTIES OF SLOW ELECTRONS IN GASES

Electrons in Gases

By Sir John Townsend. Pp. viii + 166. (London: Hutchinson's Scientific and Technical Publications, n.d.) 25*s*.

DISCHARGE phenomena, which may be as varied as lightning, the operation of counters, or the growth of photo-electric currents, all depend upon the mechanics of electrons in gases. Any picture of those processes which involve electron and atom collisions must be built upon experimental determinations of such factors as the atomic cross-section and the fractional loss of energy in collision. Further, the related entities of electron-drift speed and energy of agitation, or temperature, and probably the process of attachment also, depend upon those factors through the electron-energy distribution function. This function depends upon the electric intensity, the gas concentration, and on the variation of atomic cross-section with velocity, and thus varies from gas to gas in a manner which, for any given case, is at present best found experimentally.

For this reason the subject-matter of "Electrons in Gases" is of fundamental significance. The experimental work described is mainly that carried out by Sir John Townsend and his collaborators in Oxford since the publication of his treatise "Electricity in Gases"; and the present book, which is a research monograph, makes an interesting sequel. The description of the determinations of the mean electron energies and the atomic cross-sections for slow electrons by the diffusion method is very useful, as this technique has proved to be powerful and of wide application. In the higher energy range the results are fundamental in discharge physics; but recent work on the interaction of radio waves in the ionosphere shows that the technique is also capable of giving important data in this field, where the electron energies are comparatively low and do not greatly exceed thermal values.

The book is confined mainly to giving the theory of the experimental methods and the results obtained: space does not permit full discussion of theoretical derivations of energy-distribution functions when considerable excitation and ionization occur. Except for a treatment of the electric spark at low pressures, other discharge phenomena lie outside the scope of the book: such applications have been treated in Townsend's earlier treatise and in later books on the subject by others. On the other hand, valuable data on the ionization coefficients in pure monatomic gases are given, and the book, which unfortunately lacks an index, can be strongly recommended to those engaged in research in this field.

F. Llewellyn Jones

PARTHENOGENETIC PATERNITY IN CENTRAL AUSTRALIA

Aranda Traditions

By T. G. H. Strehlow. Pp. xxii + 181 + 10 plates. (Melbourne: Melbourne University Press, 1947.) 17*s*. 6*d*. net.

IN the early days of the discovery of Australia by the whites, the aboriginals, or black fellows, were stigmatized as degenerate, treacherous and quite untamable. More sympathetic study of these people has, however, rather changed this uncompromising attitude, and once the language difficulty is overcome a far juster estimate of their character can be made. The author of this book was brought up in close contact with the Aranda, able not only to speak their language, but even to think in it. He is able, therefore, to describe their ceremonies and transcribe their chants and folk-tales accurately and feelingly, combining the point of view of the participant with that of the observer. Some previous students of the Aranda have not realized the extent to which the northern, western and southern divisions varied from each other, so that little generalization can be made as to customs and ceremonies as a whole. But by limiting the study to one area (in the first section of the book the northern Aranda area in Central Australia) the author is able to give a reasonably full account of the myths and religion of a strongly patriliniar group.

These myths are mostly brief accounts of the lives of totemic ancestors handed down by word of mouth by the old men to young initiates, usually on the occasion of a visit to the local spot where the *tjurunga* or sacred sticks and stones are hidden. By the power of their superior knowledge, the old men hold absolute authority in all matters of religion and custom, and there is no outlet for any creative impulse in the younger generation. Every possible site in the territory has already been assigned its own spirit or myth, and there is nothing left to the oung men but to follow the traditions of their ders—a stultifying state of affairs.

Mr. Strehlow gives a detailed account of the visit initiates to one of these sacred caves, an account hich recaptures the spirit of the occasion, and he llows this with a number of northern Aranda myths. is interesting to see various threads running through em all, or at least through the majority. For ample, the manner of origin of men from their temic ancestor, in these cases so 'patrilinial' as to spense altogether with any female intermediary, e sons being 'born' from the armpits of the father, if the original inventors of the myth were unwilling admit any possible claim on the part of women. nother point which is brought out is the hostility tween the original father and his sons, leading to oss cruelty and frequently even to cannibalism.

The second part of the book deals with the three anda sub-groups already mentioned, distinguishing e customs of each group, especially those connected th *tjurunga* and initiation ceremonies.

The third part is concerned with *tjuruŋga* ownership, arrels about which were frequent during the rformances of the sacred ceremonies. The term *uruŋga*, as differentiated from *tjurunga*, is very definite and covers at least eleven different items, jects of stone or wood, sacred ground paintings or en sacred chants. In this section the author gives ncise accounts of initiation festivals and also tails of the laws governing *tjuruŋga* ownership.

The photographs illustrating the book are rather all and not very clear, but nevertheless give a od impression of the scenes they portray. The ok itself is a valuable addition to our rather iguous knowledge of this interesting and diminishing ce.

K. RISHBETH

LTERNATING-CURRENT POWER TRANSMISSION

grandi linee di trasmissione d'energia
lcolazione elettrica. Per A. Dalla Verde. Pp. xi + 6. (Milano: Cesare Tamburini, 1947.) 1700 lire.

AT present, the all-important problems of power transmission are those relating to long-distance ergy transport and interconnexion of high-power tworks. Examples of the first class are transission from Norway to the Continent of Europe or Great Britain, from the Victoria Falls to the dustrial areas of South Africa, from Tasmania to stralia, from the Lower Danube to Central Gerany. In the second class the realization of a ropean Grid system is the most imminent.

Quantitatively, these problems resolve into the ansmission of total powers of the order of 1,000 to 00 MW. over distances of 600 km. and upwards. ansmission by alternating current at high voltage the method which has been most fully developed. is system has become commonplace at voltages up 220 kV. The maximum voltage at which extensive actical experience is available is 287 kV.—the volte used for transmitting power from the Boulder Dam Los Angeles. Sweden is constructing a 380 kV. wer line more than 600 km. long, and a 220 kV. e in France has been designed with the view of ilitating its conversion to 400 kV. in the future. progressing from 287 kV. to 400 kV., detail oblems relating to the conductors and insulators ve to be examined, such as corona losses, and transient voltages arising from switching or from natural causes.

Costs of transmission lines and apparatus rise so rapidly with voltage that every component has to be examined with the view of attaining maximum overall economy. The costs of the transmission lines themselves are so great that there is also incentive to study alternatives to the established three-phase, 50-cycle systems, such as D.C. transmission.

These generalities should make it evident that new authoritative work on electrical transmission is worth serious examination.

The appearance of an Italian treatise is specially opportune as Italy has done much individualistic pioneer work in electrical transmission at very high voltages, in conditions which demand the closest attention to economy. The volume under review deals with alternating-current transmission in seven main sections: fundamental line constants, electrical calculations of line characteristics, vector and circle diagrams, voltage regulation, static and dynamic stability of three-phase systems, and choice of the fundamental elements of a transmission system.

Two appendices—hyperbolic functions and symmetrical components—give an easy review of the mathematical aspects of the subject.

The treatise is remarkably clear and objective, and in the reviewer's opinion takes a very high place among works of the kind. There are minor blemishes in printing, and some of the illustrations are difficult to decipher; but on the whole it is a pleasure to read the book. It covers adequately all electrical aspects of alternating-current transmission, and enables any conscientious reader to design a high-voltage transmission line which would be both safe and economical. Even with the best guidance from books, it has to be recognized that special tests must be made on site before finalizing designs of transmission lines. Two examples illustrate this point. In the case of 70 kV. lines erected more than twenty years ago on the coast of French Morocco near Casablanca, early experience showed that no normal type of insulator would withstand the salt-laden atmosphere which provoked flash-over on such a scale that it appeared probable that the transmission project would have to be abandoned. A remarkably bold and successful solution was found by the local engineers, who improvised oil-filled insulators which saved the situation.

The second case is that of the British 132 kV. Grid lines, which were originally insulated in accordance with the requirements of the empirical formula $(U/15 + 1)$ = number of disks per chain recommended by Signor Dalla Verde. Even with 20 per cent additional insulation, which was provided for in the mechanical clearances, flash-over troubles were so prevalent during fog in industrial areas that the degree of continuity of supply was altogether inadequate. In this case the situation was saved by the use of specially shaped anti-fog insulators which a British firm had developed. The lesson to be deduced is that experience at lower voltages in Great Britain and at the same voltage in other countries proved insufficient warning of the electrical difficulties arising from our peculiar atmospheric conditions.

It is to be hoped that engineers will have an opportunity of bringing to reality some of the projects mentioned at the beginning of this review. Young engineers who may be interested in them could find no better guidance than that provided in Signor Dalla Verde's book.

C. W. MARSHALL

Chymia

Annual Studies in the History of Chemistry. Tenney L. Davis, Editor-in-Chief. Vol. 1. (Edgar F. Smith Memorial Collection, University of Pennsylvania.) Pp. xiv + 190 + 16 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1948.) 3.50 dollars.

THIS handsome volume, which is a worthy memorial to the late Prof. Edgar F. Smith, well known for his publications in the field of the history of chemistry, contains fourteen articles covering various aspects of the subject. All but one are in English. After a foreword, the essays take up the subjects of Frederick Accum, C. A. Browne, an English alchemical poem, Thomas Thomson, French chemists about 1840, Mendeléeff, potassium chlorate in pyrotechny, the early history of calomel, the concepts of substance and element, the water controversy, Scottish alchemy, the Karlsruhe Congress, and Dulong. There are several plates, and the text is unusually well printed, which, with the attractive binding, makes it a pleasure to read the volume. It is proposed to issue a volume annually, and if further volumes are as good as the first, the editor-in-chief, Prof. Tenney L. Davis, whose own historical publications set a very high standard, may well feel satisfied. All concerned in the production deserve the thanks of chemists who are interested in the history of their subject. The series should be acquired by all chemical libraries, and is a notable contribution to scientific literature.

Chemical Synonyms and Trade Names

A Dictionary and Commercial Handbook. By William Gardner. Fifth edition, revised and enlarged by Edward I. Cooke. Pp. viii + 558. (Kingston Hill: Technical Press, Ltd., 1948.) 50*s*. net.

THE only satisfactory method of reviewing a reference book such as this is to make continued use of it over a period of time, for only in that way can its value really be determined. Following this course, the reviewer has been surprised at the frequency with which trade names turn up during the course of a day, and has been equally surprised at the completeness with which the dictionary has met all demands made upon it. Only very occasionally has it failed; for example, it makes no mention of sulpha drugs, such as sulphapyridine; but the constancy with which it succeeds makes its failure a notable event.

The book will prove of great value to all who have to deal with chemistry and chemicals, and its information is not confined to any particular field of chemistry but embraces all. It is well printed on good paper and is stoutly bound, as a reference book should be.

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. By R. L. Shriner, Editor-in-Chief. Vol. 27. Pp. vi + 121. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 13*s*. 6*d*. net.

TO the large number of organic chemicals for which reliable preparative methods have been given in this invaluable publication a further list of thirty-nine is now added. As typical examples may be mentioned 3,5-dimethyl-2-cyclohexen-1-one from acetaldehyde and acetoacetic ester, ethyl α-isopropylacetoacetate from isopropyl alcohol and acetoacetic ester in presence of boron fluoride, 3-penten-2-ol from magnesium methyl chloride and crotonaldehyd stearolic acid from methyl oleate, and tetraiodop thalic anhydride from phthalic anhydride and iodi in presence of fuming sulphuric acid. The stateme of directions and precautions, the bibliography f each preparation, and the printing of text a formulæ are all admirable and remarkably free fro errors. The cumulative index covers volumes 20–2

J. R.

The Rare-Earth Elements and their Compounds

By Prof. Don M. Yost, Horace Russell, Jr., a Asst. Prof. Clifford S. Garner. Pp. ix + 92. (N York: John Wiley and Sons, Inc.; Londo Chapman and Hall, Ltd., 1947.) 15*s*. net.

THIS little book on the elements of the rare ear group, or lanthanides as they are now calle contains chapters on (*a*) electronic structures a oxidation states, (*b*) magnetic properties, (*c*) abso tion spectra, (*d*) evidence for the existence of eleme No. 61, (*e*) separation of the rare earths, and (*f*) chem cal and physical properties of these elements. The is also an appendix on nuclear properties of the ra earth elements. Since the chapters noted above cov only 69 pages, it is inevitable that the subject-matt has been very much condensed, a fact more evide in descriptions of chemical than physical properti Apart from this limitation, the volume contains mu useful and interesting information about this gro of elements. The rare earths have received m attention from chemists following the discovery th some of them are formed directly or indirectly nuclear disintegrations. This book provides a use introduction to the study of a very interesting ser of the chemical elements.

Elements of Nomography

By Prof. Raymond D. Douglass and Asst. Pr Douglas P. Adams. Pp. ix + 209. (New York a London: McGraw-Hill Book Co., Inc., 194 3.50 dollars.

THAT a straight-edge laid across three coplan linear scales will serve to express a multiline functional relation between the indicated sc readings is obvious; if the linear scales are n uniform, more complex relationships can be de with. But the step from these simple ideas to t construction of the alignment charts used increasing in engineering, industry, business and other fields considerable, and demands skill in design a draughtsmanship as well as in orderly computati Profs. Douglass and Adams are anxious that t young nomographer should not try to run before can walk, that he should realize "how small a porti of his entire problem the theoretical solution rep sents". Thus they begin with a painstaking discussi of scales, occupying six chapters, before starting th discussion of the simpler alignment diagrams in series of nine short chapters, the last of which de with the hexagonal diagram for the relation

$$1/x + 1/y = 1/z.$$

There is a short chapter on the use of a circul nomogram for the relation $xy = z$, and a final lengt chapter on a variety of more complex alignme diagrams, wherein curved scales are employed.

The casual reader who merely wishes to learn little about nomograms would probably find the pa of this book too slow. But a novice with some stro incentive urging him to master the topic should pro from the careful and detailed discussion, with i valuable practical illustrations.

THE ROYAL SOCIETY SCIENTIFIC INFORMATION CONFERENCE

Introduction

THE Scientific Information Conference held by the Royal Society during June 21–July 2, which was attended by about a hundred and thirty delegates from organisations in the United Kingdom and thirty from the Overseas Commonwealth and the United States in addition to about a hundred observers, was the outcome of a recommendation passed by the Royal Society Empire Scientific Conference of 1946 to examine, in this way, the possibilities of improvement in existing methods of collection, indexing and distribution of scientific literature and of the extension of existing abstracting services.

The importance of the questions involved arises from the overwhelming mass of the literature, which is estimated to total anything up to one million published items a year, apart from the unpublished reports and memoranda which multiply within every scientific establishment and may locally be even more important. This makes it impossible for any individual to scan more than an infinitesimal fraction of what currently appears even within a limited field, or to be sure of finding retrospectively those references which are the most apposite to his own work, unless the indirect means of doing so are highly organised.

Various aspects of the problem have, over many years now, been receiving attention on behalf of the scientific worker through such bodies as ASLIB (a union of the Association of Special Libraries and Information Bureaux with the former British Society for International Bibliography), the International Federation for Documentation, the British Standards Institution and latterly the Technical Information Services Panel of the Committee on Industrial Productivity appointed by the Lord President of the Council. Much useful discussion is to be found in the published proceedings of the first two of these organisations; but along some lines of development—as, for example, mechanical methods of selecting literature references—the position reached is that inventors of machinery and documentary devices have progressed ahead of the ability of the users to tell them what they actually want done. Hence the value of a conference representing primarily the beneficiaries rather than the organisers of information services, and particularly of one at which the special problems that beset scientific men working at isolated posts overseas could receive their due share of attention.

The Conference was organised in four sections to appreciate and discuss what can be done to improve and rationalize the arrangements for:

(1) Publishing and distributing original scientific papers (Editor: Prof. J. D. Bernal).

(2) Issuing and using abstracts to convey current awareness of the availability and relevance of such papers (Editor: Sir David Chadwick).

(3) Consolidating abstracts or other forms of reference into continuously cumulative indexes and using these and other library services for the retrospective searching of the literature (Editor: Dr. J. E. Holmstrom).

(4) Producing and utilizing periodical reviews of progress in designated fields of science (Editor: Prof. H. Munro Fox).

The editors were appointed some months beforehand to take charge of each of the four sections, and they had, with assistance from others, prepared much material for consideration. Terms of reference had been drafted for forty-two specific subjects of study by sixteen working parties. At the opening plenary sessions of the Conference the background to these questions was explained by the editors and the membership of the working parties was made up, each consisting of six to eight persons having special knowledge of the groups of questions they were to answer. In some cases panels of consultants were also listed from which the working parties could co-opt additional members when considering particular questions. The working parties then met separately—except for a few joint meetings where the interests of several overlapped—until the final plenary sessions, when their conclusions and draft recommendations for action on each question were reported to the Conference as a whole for adoption, amendment or rejection. In this way altogether some seventy recommendations were finally sent forward by the Conference to the Royal Society, proposing positive actions either by the latter directly or through appropriate named organisations.

Section 1: Publication and Distribution of Papers Reporting Original Work

Section 1 of the Conference had to deal with the publication and distribution of papers containing reports of original work. Papers referring to this prepared for the Conference were essentially of two kinds: those setting out suggestions or expressing opinions, and those containing numerical and statistical information on publication and reading habits. In the first category were the group of papers on Prof. J. D. Bernal's proposed scheme for centralized distribution of scientific papers, criticisms of it by the Physical Society and by the editors of some biological societies, and comments on these views. In the second category were studies on the average length and scatter of papers in different periodicals, on the variety of formats in journals taken at the library of the Royal Botanic Gardens, Kew, on delays in publication; and lists were prepared, after consultation with societies, of the chief journals published in different fields in the United Kingdom and the Commonwealth.

In addition to these, the results of two surveys, one organised by Mr. Urquhart on papers inquired for at the Science Library, and the other of a special questionnaire sent out to research workers in Cambridge, the Department of Scientific and Industrial Research, Rothamsted Experimental Station, the Medical Research Council and various industrial firms. The steering committee of the Section eventually drew up a set of terms of reference for five working parties:

Working Party I/A: (i) To examine the present format of scientific publications and to make recommendations as to the adoption of suggested standards. (ii) To review methods of reproduction of scientific papers and to make recommendations as to the applicability of each.

Working Party I/B: To study the importance of editorial distribution and other factors in relation to the length of scientific communications and to make recommendations as to any desirable changes.

Working Party I/C: To consider whether any advantage would be gained from a more rational subject grouping of scientific communications within existing journals.

Working Party I/D: To consider the general question of the organisation for publication of original papers and the mechanism for their distribution, and to recommend any steps which may be taken through the co-operation of existing bodies towards achieving any desirable improvements.

Working Party I/E: (i) To examine the present causes of delay in publishing original scientific work and to make recommendations. (ii) To review existing difficulties in the availability of scientific information to men of science, and to make recommendations.

In order, however, to give greater coherence to the work of the Section, the first and last meetings of 'working parties' were joint working parties, and joint meetings of working parties of different sections were arranged on the subjects of photographic reproduction methods and classification.

At the opening plenary session on June 21, with Sir Alfred Egerton in the chair, short statements were made by the editors and the leaders of the working parties and a general discussion followed, with the purpose of conveying to the 'working parties' the views of the members of the Conference. On June 23 there was a special plenary session to consider the replies to the questionnaire already referred to, and to another sent out by Sir David Chadwick on abstract services.

The major conclusions of the questionnaires were of a very decisive character and modified considerably the type of proposals put before the Conference. The most important of these results was that emphasizing the large reliance of research workers on libraries, principally departmental libraries, three-quarters of their reading being derived from this source and the relatively small proportion of reading derived from journals subscribed to by the research workers themselves. It would appear that the average research worker looks through some nine papers a week and reads three carefully, making notes and usually keeping a card index. The paper was read, in 37 per cent of the cases, on account of a reference in another paper and only in 18 per cent on account of an abstract. Reprints furnished 6 per cent of the general reading, but 12 per cent of the careful reading. There were some significant differences between the reading habits of the different sections, those in the applied sciences reading on the whole fewer papers than their more academic fellow workers, and senior workers looking through more papers, but reading fewer carefully, than junior workers. The distribution of reading in various journals was significant: 2,000 papers described as carefully read during the course of the inquiry were derived from 430 different journals; but the distribution of papers consulted among journals varied enormously, one-quarter of the papers being found in six journals, half in thirty, and the last quarter in 330 different journals. This emphasizes a law derived by Bradford from studies of the actual distribution in journals of papers covering particular topics, and shows that his conclusions apply equally strongly to papers actually read. It is also notable that more foreign papers were read than British, and that the great majority of these were American. The major conclusion that can be drawn from these results is that, in the absence of any rational system of distribution of papers by subject, the libraries are the essential agents in the distribution of scientific publications.

The 'working parties' each held a number of meetings which were on the whole remarkably free from controversy, and came to conclusions and recommendations for the most part unanimously. The position of working party I/A was fortunate in that its chairman, M. Lemaitre, had just returned from a meeting of the International Standards Organisation at Geneva and was able to refer the Conference to resolutions already taken on the standardizing of the format of periodicals. The advantage of a limited number of sizes was admitted, and the resolution passed that once these standards were accepted societies would be urged to adopt them whenever they were changing their format. Similar considerations were given to the layout, particularly on such questions as the form of reference and the desirability of beginning each separate paper on a right-hand page to facilitate the issue of reprints and the division of the journal into papers for reference purposes. On questions of reproduction, it was agreed for the most part that printing is the most suitable for large numbers, but that new methods, particularly lithography and the diazo reflex process, might be increasingly used when small numbers are required. The 'working party' put its weight behind the general recommendation for further research on, and development of, methods of reproduction.

'Working party I/B' was on much more controversial ground in its study of the lengths of papers. While there was general agreement that too many papers of a repetitive nature are written, and that papers are longer than they need be, results incorporated in the general resolution of the Section, there was more discussion on the suggestion of extending the practice, already adopted by the Institution of Electrical Engineers and some other bodies, of issuing with the journal a full précis of a length from one-twentieth to one-quarter the original length of the paper, to be issued together as précis-journals covering a cognate group of sciences. The argument for such précis-journals was that they would provide digests of material lying outside the immediate field of any particular worker which would not, in fact, be read unless presented in this shortened form. The argument against it was that the proposal involved the issuing of still further publications and that the field would be covered as adequately by informative abstracts. The 'working party' finally agreed to put forward the suggestion for consideration by the proposed consultative committees of editors suggested by 'Working party I/C'. 'Working party I/B' further considered the need for making provision for the preservation and permanent availability on demand of copies of scientific documents and reports which are too long for publication in the ordinary way. It recommended that some system of deposit similar to that of the Science Service in the United States should be established.

'Working party I/C' was concerned with the grouping of scientific communications within existing journals. This question is very closely connected with that of the classification of science considered more particularly in the other Sections. It was recognized that the scatter of papers on essentially the same subject in journals is very wide; but the 'working party' did not feel competent to indicate precisely how it should be reduced. It is suggested, however, that this could best be done by the setting up of standing consultative committees of editors in cognate subjects, as is already the case for the Biological Council. These editors might by negotiation arrange among themselves what subjects fell properly within the scope of the particular journal, and which might equally well appear in a small number of journals. In the latter case some provision of exchange of lists of forthcoming papers might present the reader of any particular journal with information as to what is going on in his field far wider than he gets from the journals he can take and far more rapidly than he can get from abstracts. This 'working party' also considered the whole question of the formation of new journals or the extension and division of old ones. It concluded that the latter procedure is on the whole preferable, and that in any event it should not be penalized through the present control of paper supplies.

'Working party I/C' also dealt with two other questions of a more financial nature. It is clear that additional functions for editors, together with the responsibility of producing a paper in a better form (discussed above), would increase the work laid on them. It was recommended that means should be found to provide secretarial and other assistance to editors of journals, particularly smaller journals. The weak financial position of nearly all publishing bodies is clear from the proposal to extend the practice already prevalent in the United States of asking authors to pay for insertion of papers in journals ; this was supported by the 'working party' only in exceptional cases, while the Conference itself by a decisive vote was against requests for payment in any circumstances. This, of course, leaves the position exactly where it stands, and if rising costs are not to mean actual restriction of the amount published without regard to quality, the only solution can be through increased grants, either direct from Government or by some form of levy.

'Working party I/D' dealt with the very wide question of organisation of publication of original papers and mechanisms for their distribution. It was originally thought that this working party would deal with the detailed proposals of Prof. Bernal on reprint circulation ; but as he himself (as he explained), in the light of the questionnaire on the subject, considered that distribution through libraries is far more important than distribution to individual research workers, this did not come up for discussion. Instead the 'working party' concentrated on the means of obtaining separates directly from publishing bodies or by subsequent copying. The resolution as finally passed by the Conference, after emphasizing the importance of separates to scientific workers, called for a special exploration of the possibility of societies, libraries or commercial enterprises acting as agents for obtaining and distributing such separates. The question of copying separates, which is widely practised in individual cases, came up under the general question of copyright, at a special discussion at the Conference. 'Working party I/D' also emphasized the importance of library and information services, and particularly stressed the need for immediate Government action to provide for the enlargement of central scientific libraries and information services, and for providing for the effective functioning of these by an adequate staff having special qualifications in librarianship and science. It here made special reference to the Patent Office Library, the space in which has not been increased for many years, and to the Science Library. To increase the effectiveness of libraries it also proposed that library committees should co-operate to a greater extent than at present to prevent duplication.

'Working party I/E' had the task of exploring delays in publication and the availability of already published scientific material. It came to the conclusion that the best way of eliminating the former was by closer co-operation between the printing trades and the scientific societies, and in a resolution called on the Royal Society to organise a permanent liaison committee between industry and scientific publishing bodies. The technical means of more rapid publication by alternative methods, particularly lithography, were discussed and the matter referred to a proposed standing committee on the development of reproductive methods (referred to below). Another point stressed by this 'working party' and incorporated in the general resolution of Section 1 was the need to increase the speed of every stage of the process of the production of a scientific paper, beginning with its actual writing, and passing through its examination by heads of departments, its refereeing and the various stages of actual reproduction and correction. Delay at any stage was felt to have a psychological effect, increasing the probability of delay at other stages. As to availability, particularly in the Commonwealth, this matter was felt to be very largely one of discovery of the whereabouts of the material, and therefore depended on indexing and abstracting. Here proposals for the preparation of lists of titles and abstracts, particularly those emanating from Dominions and Colonies, were made and incorporated in other resolutions of the Conference.

In the general meetings of the Section many points were raised by different 'working parties' so interrelated as to make it desirable to include them in one general resolution. It was proposed that the Royal Society should initiate a vigorous and sustained campaign to improve the preparation and presentation of papers. This would involve action all along the chain of preparation, beginning with the research worker himself, who should be better trained than at present in the technique of writing and preparation of papers for publication. In turn, directors of research might be able to save very much editorial time and trouble at a later stage by careful pre-editing. Editors themselves, or the publication committees of their journals, were urged to take a more severe line than at present on the acceptance of papers for publication, eliminating so far as possible those that were merely repetitions with variations of papers appearing elsewhere, or those lacking in brevity or clarity of expression.

The recommendations of the 'working parties' were communicated to the plenary session of the Section on June 29, where they were subjected to lively but on the whole friendly discussion. They were for the most part, after certain amendments, accepted by the Conference as a whole, the only point of dispute being the question of the proposed précis-journals which, being a relatively new idea, certain of the delegates would have preferred to be omitted altogether from the resolution.

The full bearing of the recommendations of Section 1 can only be fully appreciated in relation to the general work of the Conference ; but it may be claimed that although no radical changes were proposed, the sectional recommendations indicate in a precise manner what should be done by other bodies to improve the production and distribution of original scientific material. The technical questions were appropriately referred to representative committees which have some reasonable chance of getting their recommendations accepted. On the more general issues of improved distribution of reprints and a more concentrated and more rational grouping of papers in journals, much will depend on how far it is possible in practice to set up effective working committees of editors who, with the greatest knowledge of their respective subjects, will be most able to set their particular house in order. It is to be hoped that members of scientific societies will also, as a result of the Conference, take more interest than they have in the past in the mechanism of publication, realizing that it is in their own hands to modify, and that it is not some divinely imposed order which they must accept without complaining.

J. D. BERNAL

Section 2: Abstracts and Abstract Journals

On the shelves of the Athenæum Club is a series of annual volumes, politely styled, "The Works of the Learned". The date of the first is 1699. They are informative abstracts, longer than those now usual yet true to type. Abstracts of scientific papers are certainly not new. Yet the decision of the Royal Society to devote one main section of its Conference to the consideration of abstracts and abstracting services is likely to prove timely.

The keynote of the Conference was service to science and to the scientific worker. Abstracts exist to serve the scientist. That is their sole justification. The English-speaking peoples are the chief producers of scientific abstracts. The journals of some of the United Kingdom abstracting services have appeared without a break for more than seventy years. The number of those services has increased markedly in the last twenty to thirty years. Yet this Conference was the first occasion on which representatives of most of those services had met together as a group to consider how far they were serving the needs of science as a whole, how their methods and techniques agreed or differed and in what respects such variations detracted from extended use of their journals and labours. What also was most certainly new was to have available at such discussions the assistance and criticism of scientific workers of most varied interests and of representatives from the Dominions overseas, from the United States and from the United Nations Educational, Scientific and Cultural Organisation. This alone ought to make this Conference worth while in the long history of abstracts; but what was really surprising came out in the early days of preparation for the Conference, namely, the almost complete lack of factual information about the existing abstracting services, and of how scientific men, in their differing circumstances and in their different branches of science and its applications, actually used abstracts and for what purposes. Was their chief purpose to provide 'current awareness', making speed of issue the prime requisite and their useful 'life' comparatively short? Or were they often consulted over periods of five, ten or even twenty years, in which event obviously good subject indexes, and where possible consolidated five- or ten-year indexes, were a great advantage? Was it broadly true that while an informative abstract is invaluable to the scientific worker far from a good library, as one working in a Colony, the indicative type of abstract generally meets the needs of anyone in the United Kingdom? Precise answers to such questions must vary in different branches of science, but are enough facts known to afford any general guidance or lead to abstracting agencies as a whole?

Opinions were numerous on how abstracts should be written, how indexed, on their type, on their excellence in some cases and failures in others, on their 'gaps' and 'overlaps' and on the difficulties in borderline subjects; but facts were few. This was inevitable, for surprising though it may seem, no list of the abstract journals published in the United Kingdom was readily available; consequently, no ready information on the branches of science and of its applications they, as a whole, presumed to cover. It is not suggested that any scientific men could or would have occasion to refer to all the abstracting journals. He knows one or two, and may at times be referred by his librarian to others; but if no ready information of their general coverage is available, he can scarcely be expected to refer to a journal the title of which may be vaguely familiar to him although he may be ignorant of its scope. The plight of a scientific man overseas wishing to use United Kingdom abstracts is greater.

Factual information had been collected from many of the abstracting agencies. This was presented to the Conference in condensed form, also the results of some inquiries into the use of abstracts. The Conference, however, realized broadly how the present services had grown up, their general character, the experience gained and knowledge orderly accumulated. It referred the whole subject to three 'working parties'; one to examine the place of abstracts in the service of scientific workers, their relation to other forms of service, such as reviews, bibliographies, etc., and to review the existing services; a second composed mostly of representatives of the abstracting agencies to compare their methods, techniques and practices; and a third to look to the future.

A paper presented by the Science Library, London, showed that notices in abstracts probably cause most inquiries for copies of original papers (possibly a third of the total), closely followed by references to papers in other papers. Prof. J. D. Bernal's pilot survey in Cambridge and elsewhere placed it lower at one-sixth. A small-scale but very welcome voluntarily organised inquiry in the University of Birmingham showed a preference of more than three to one for informative abstracts, and that about one-third of new papers were discovered through abstracts. Other information suggested that informative abstracts were more used in the United Kingdom than might have been thought. But all these inquiries were on too small a scale to give any reliable indications. Also, to be useful, they would need to be broken down according to the different branches of science and its application. A diagrammatic representation of the inter-relations of science and the scope of existing abstract agencies which Dr. H. J. T. Ellingham had prepared showed at a glance present gaps and overlaps. Gaps, time-lag and indexing were the chief subjects of complaint.

One fairly recent change in the type of user came out, arising from the extended use of science in organised industry. This is the increased reliance of many scientific workers on the 'information officer' for help in searching and in obtaining literature. The information officer thereby becomes another and constant user of abstract journals. Also, such are the extensions of the use of science in industry that many abstracting agencies may not have included these officers as users of their journals. Abstracts have always been designed to serve particular groups of scientific workers directly, and the various abstracting services look on their work from that angle; but as his tendency extends, consideration of the needs of hese information officers as potential users of their ournals becomes important.

As regards the abstracting services, the facts ollected brought out several points. Most of the ublished abstracts are of the informative, that is, nger, more detailed, type. *British Abstracts*, the rgest single service, are of the brief, or indicative ind. Nearly all are on a non-profit earning basis. his means that behind each is some sponsor society r department. It thus follows that the phrase abstracting agencies or services' cloaks many variaions of functions or duties. The functions of any gency are those laid down or approved by its ponsor society or department. These may be onfined to the preparation and issue of abstracts, as ith *World Abstracts of Medicine*; or, as with the ropical Diseases Bureau and the Commonwealth gricultural Bureaux, they may be those of centres f information entailing aid in preparing reviews, in btaining reprints or copies of papers, or translations r even in identifications. The issue of the abstract ournal then becomes one of several duties and not a ole function. The agencies are not thus all of one ype or origin, capable of easy recasting or reshuffling. hey differ in function, type, scope and finance. But hey all have this basal characteristic in common: ach has been called into being at the instance of cientific men, engaged in some branch of science r of its application, to serve their particular eeds; each is responsible to (and ultimately conrolled by) scientific men in its sponsor society or epartment.

In each case responsibility for the abstract journal ests on scientific workers trained in that subject. ontrol may become difficult in particular cases; but he identification of a service with those engaged in particular branch of science or of its application hould foster service of a type suitable to its needs nd the maintenance of quality and accuracy. This dentification of a service with a particular group arries a corollary. The primary loyalty or allegiance f any abstracting agency is to the scientific workers n its sponsor society or department. The Conference howed no desire to disrupt such associations, or to ubject them to outside authority, for the sake of a eneral uniformity. To have done so would have een to ignore differences between the needs of ifferent branches of science, and the fact that in some gencies overseas interests are active participants; et an indefinite increase in the number of isolated ndependent services must lead, in the ever-increasing nter-relationships of science, to overlapping and onfusion rather than to clarification. Responsibility o a particular group or branch is in no way incomatible with better service to science as a whole. The perative portions of the Conference's terms of eference to the third working party, that looking to he future, were then: "To consider and report, with ecommendations if desired, on the advisability, cost, rganisation and functions for a Council on Abstracting, not to centralize all abstracting, but as a continuing agency, to promote co-operation between abstracting services, the elimination of gaps . . ."

It was with this background of facts and ideas that he 'working parties' started on their labours. It was impossible in the few days at their disposal to solve efinitely all the points which arose. This was especially so in the second 'working party' where, for the first time, abstracting agencies had met to examine their methods. Differences undoubtedly existed. To adjust those so as to secure a wider use of their journals is a continuing task and not one to be settled in a few preliminary meetings. They therefore presented their findings to the Conference chiefly in the form of conclusions, rather than recommendations. The first 'working party' also presented most of its findings by way of conclusions. The conclusions and recommendations were placed later before the Conference, were discussed, passed, amended, or rejected by it. The leaders of the three 'working parties' were Dr. H. G. Thornton, Mr. B. Fullman, and Dr. G. M. Findlay; the recorders Dr. M. A. Vernon, Mr. J. Beak and Dr. B. M. Crowther. All 'working parties' had the help of representatives from the countries overseas and from the United States. Mr. J. B. Reid, of the United Nations Educational, Scientific and Cultural Organisation, brought to Working Party No. 3, looking to the future, the latest information on international developments.

The conclusions reached by the Conference should, if followed, improve the general usefulness of abstracts. A few only can be mentioned here. Some overlapping between abstract services is desirable, when the services cater for readers having different interests. Such overlap is distinct from duplication. For this reason a single set of abstracts produced by a central agency would not suffice for universal use. Publication of abstract journals, covering identical fields and directed to the same type of user, constitutes duplication and is to be deplored. The quality of abstract indexes is frequently unsatisfactory. Abstracting services, unless combined with an information service, as is often desirable, cannot be expected to answer specific inquiries on literature. By way of comment on this point, it may be explained that this conclusion merely reflects the differing functions of these services, as already explained. All realized that the usefulness of abstracts is gravely impaired if the means for obtaining copies of the original papers are inadequate. This question kept reappearing in all sections of the Conference, and is undoubtedly one of prime importance.

Among the recommendations was a strong emphasis on the need for comprehensive subject indexes to be provided with each volume; and a recommendation that consolidated subject indexes be provided at intervals. But the chief recommendation adopted by the Conference was that on co-operation in the future. It was to the effect that the Royal Society be invited to consult the abstracting agencies to set up a standing consultative committee of abstracting organisations for mutual exchange of views and generally to promote co-operation. The Committee should consist of representatives of bodies responsible for the production of journals of abstracts. It should work on a voluntary basis and the cost be kept low. Among earlier matters for its attention were listed, increasing uniformity in the services in the methods of bibliographical citation, the maintenance of a comprehensive list of journals of abstracts, the question of its publication and the possibility of including in it an indication of the general scope of each journal, the possibility of co-ordination of systems of indexing, the determination of fields where readers' needs are inadequately met, and the maintenance of a panel of abstractors with special linguistic knowledge.

If this standing committee is formed—and all the main abstracting services were in favour of it—many questions besides those tabulated will come before it, though those when worked out should greatly extend the knowledge and usefulness of abstracts. Not only will this be the first time that these agencies have met to exchange information and experience, but also such meetings and consultations will have a definite object, namely, to promote co-operation in the service of science generally. An aim has been given. This recommendation may thus become among the most constructive from the Conference in this Section. It is certainly timely, in the light of the increase in the number of these services, the increased efforts in applying science, the general stir for better organised dissemination of information and the revived interest of the possibilities of co-operation on the international level. On this the Conference, while recognizing the difficulties, urged organisations covering similar fields to make efforts at closer collaboration.

The conclusions and recommendations of the Conference in this matter of abstracts may not seem so wide or so drastic as some might have wished; but though much testimony was given to the utility of present services, the striking characteristic of the Conference was this—no question was approached from a particularist point of view. The obvious desire of all was to secure better service to the scientific worker; to build on what had been learnt, but to harmonize and adapt it so as to be even more effective in the service of science. The long history of abstracts to meet the needs of science is not closed—perhaps, indeed, a new phase is opening; the particular services will continue, for the needs of scientific men in different branches and in different circumstances must vary. But while preserving all that is most useful in that respect, conscious collaboration in the interest of science as a whole will constantly grow, so that the journals become more widely known, more easily used, borderline cases provided for, and needless diversities of practice eliminated.

In all this the visitors from overseas played an active and stimulating part. When discussing abstracting, the needs arising from one's own local conditions and circumstances are apt to be so prominently and even fatally in one's mind as to distort the conception of what must be in some degree a general and not an individual service. The overseas delegates helped to keep this needed balance.

DAVID CHADWICK

Section 3: Indexing and other Library Services

Whereas Section 2 of the Conference was concerned in securing awareness of current publications, Section 3 dealt with the provision for retrospective searching: the problem of how to dispose literature references in such a way that those among them which may help to satisfy any particular quest for information liable to arise in the future will be turned up, when the time comes, with certainty and speed.

This problem includes what is normally understood by librarianship, and also goes far beyond it in magnitude and complexity. A librarian in the traditional sense is occupied with the procurement, store-keeping and cataloguing of books as complete units; but not with analysing their contents or indicating their relevance. Yet a single book, journal article or patent specification may touch on many subjects and be important from many points of view; and the mere fact that a library which holds a copy of it has catalogued it under its author and title, or even under such multiple subjects as may be implicit in the title goes only a very little way towards what is required. The problem of documentation is, in fact, to ensure that when a scientific man needs to find out what has already been done and thought regarding any topic whatever, he can quickly be given the most apposit references not only among the hundreds of thousands collected in his own departmental library but also among the millions available to him, by way of loan or photo copy, from the libraries of the world a large.

Any one of these may turn out to be the one which would best serve the interests of some future inquirer if only he knew of its existence, by enabling him to begin his own researches from a more advance starting point. There being no means, however, o foreseeing which item that will be, there are neede economical techniques for the mass processing of the greatest possible range of literature references to mee the contingency that any one of them may be of value. Fundamentally, there are four ways, each with its variations and its advantages and disadvantages, along which this central problem can be attacked:

(1) Indexing the names of subjects in alphabetica order. This is the usual system in books and at the end of each year's run of a journal; under certain conditions it is satisfactory also for card indexing But it involves many more difficulties and moot points than are apparent at first sight. It has the effect of dispersing logically contiguous items according to the letters of the alphabet with which their names happen to begin, and as the names are not standardized so as to make them mutually exclusive, a searcher is liable to look in vain for something which the indexer has buried elsewhere under a synonym.

(2) Classifying the subjects themselves under symbols which serve to pinpoint their positions in a logically constructed map of knowledge. Many such classifications are in use, some locally for special fields of subject-matter and some general like the Universal Decimal Classification, which is an internationally standardized extension of the Dewey system developed by librarians for shelving books. On this system, knowledge as a whole is divided into ten primary branches each denoted by a first decimal number, each of these into ten subdivisions denoted by a second decimal, each of the latter into ten sub-subdivisions denoted by a third decimal, and so on to whatever degree of particularization is required. As the sequence of subjects is ideographic, not alphabetic, an alphabetically arranged key (corresponding to the gazetteer in an atlas) is necessary for locating subjects when only their names are known.

(3) Coding the subjects under symbols which can be represented by patterns of holes punched in a card, or by patterns of dots detectable by optical means alongside a microfilm of the document under reference. Items so coded can be stored in random order and run through a machine, when required, which automatically picks out those of them which have been coded in any particular way.

(4) Coding the shapes of certain classes of objects under symbols which can be treated as above. The Dyson and the Gordon–Kendall–Davison systems of chemical notation enable this to be done for the arrangement of atoms in a complex molecule, which makes possible the mechanical selection of references to chemical compounds according to their molecular structures.

As staff and resources for bibliographical work are limited, the application of any of these methods must be governed by a proper balance of time and effort between indexing or classification on one hand and searching on the other. The greater the chance of references of a given kind being of future interest, the greater the justification for the labour of analysing them minutely and of consolidating those of different dates and sources into a single cumulative index. Where, however, a subject is unlikely or seldom likely to be of interest, it is more economic to rely on making an *ad hoc* search if and when the occasion for it arises, even though this may involve the tedious job of consulting the separate annually published indexes of many separate journals in which references might be found. Elaboration of indexing is, in fact, an insurance, and just how big a premium it is worth must depend on circumstances.

Two of the working parties in Section 3, dealing respectively with classification and with mechanical methods, drafted recommendations which the Conference adopted on various practical aspects of this central problem.

The Universal Decimal Classification, it was held, has both advantages and limitations. Among its assets are the millions of existing references so classified and the many thousands being published every year with the class numbers already printed on them; these are among the justifications for continued extension in its use. But the criticisms to which it stands exposed were recognized also and led the Conference to favour setting up a standing committee for fundamental research into subject classification of science without pre-commitment to any particular system. Further study and research on alphabetical arrangement were also recommended.

Similarly a full-scale experiment on mechanical methods of selection was urged, as well as encouragement of the Aslib committee which is studying and collating progress in this field. A particular device, exhibited at the Conference, which the working party found of interest though no positive recommendations was made about it at this stage, was the invention of Dr. J. Samain of Paris: this has a typewriter-like keyboard whereby up to 24 six-letter words can be punched directly in a single card, and a selector able to pick out those cards which carry any desired word or combination of words regardless of the position or sequence in which these occur on particular cards.

On the question of chemical notation suitable for punching on cards, the Conference recommended that the attention which appropriate bodies are giving to one system be extended also to others proposed.

Another working party studied photographic and other new methods of reproduction. These have many important uses in bibliographical work, and the Conference recommended the establishment of an advisory committee to stimulate and watch developments in Great Britain and in other countries. As an example, it is an obvious economy if index items or abstracts which are required to be circulated sequentially in page form and also to be cumulated separately in card form can be reproduced in both forms without having to typeset or typewrite them (and check them) twice over. In the United States this is now widely practised. Another recommendation of the Conference which depends for its economy on suitable methods of reproduction was the issue from a central source of guide cards bearing Universal Decimal Classification numbers, for insertion direct into card indexes instead of having to copy them locally from a list. Again, in the United States the Library of Congress issues printed catalogue cards for all the books it handles, which hundreds of other libraries can use instead of having to do the work over again locally. Steps to develop such a service in Great Britain were recommended.

Among the new methods of reproduction studied and commended by the Conference was a Dutch process of diazo-printing (much cheaper than photography using silver chemicals) which enables not only direct copying from single-sided translucent originals but also, by a reflex method, copying from double-sided or opaque originals including the pages of bound books. This system has the further immense advantage that processing of the exposed paper is dry (or practically so) and therefore instantaneous, so that one or many copies of any document can be obtained, as and when required, in an ordinary office.

Various questions affecting the use of microphotography were studied, including the supersession of continuous lengths of film by strips or other more convenient units. Apart, however, from technical points like this, the great possibilities latent both in microphotography and in full-sized photo-copying for assisting the dissemination of scientific literature are governed more than anything else by restrictions resulting from the present copyright law. To give only one instance: if these could be removed by legislative reform, or circumvented by some form of agreement with authors' or publishers' organisations, the production and distribution of separate offprints of articles printed in journals would be greatly facilitated. The copyright question was discussed by the Conference at considerable length, and a recommendation was put forward stating the necessity for the provision of single copies of extracts from books and periodicals for purposes of scientific research and inviting the Royal Society to initiate action in the matter.

A fifth working party, which considered data tables, reference books and guides to information services, compiled a useful bibliography of these works. The Conference recommended continued action to ensure that scientific compendia in all fields of science were available and up to date, and to assist their publication where necessary. Financial aid to speed a new edition of the "ASLIB Directory" was urged, and a hope expressed that the "World List of Scientific Periodicals" might be re-issued as early as possible. The Conference recommended compilation of a British work corresponding to "Industrial Research Laboratories in the United States and Canada", and also of a subject index to the research activities and specialized knowledge of individual men of science.

Some 40 per cent of the world's scientific publications are in languages other than English; hence the importance of the questions referred to the sixth working party of Section 3, which considered translation services. As a result of its labours the Conference recommended greatly increased publicity for the ASLIB Register of Specialist Translators, which enrols only persons who combine linguistic knowledge with knowledge of particular branches of scientific or technical work; also its extension to those qualified to act as interpreters, by the simultaneous method, at international scientific conferences. Other recommendations included the institution of university or other suitable diplomas in translating and interpreting, the establishment of a central location index to unpublished translations, and that the Government be asked to consider action to modify the Berne Convention on international copyright so as to allow organisations such as the Science Museum Library to make available any translations deposited with them.

J. E. Holmstrom

Section 4: Reviews and Annual Reports

Reviews of a critical and constructive nature, written by leaders in particular branches of science, are of the greatest value, and senior investigators should regard the production of these as an important ancillary to the pursuit of new knowledge. The fields covered by critical reviews depend upon the first-class reviewers available at any given time. Such reviews, written by specialists, can be made very informative to workers in allied fields by the inclusion of an introduction and conclusion of a general, and as far as possible non-technical, nature. The desirability of the inclusion of the titles of papers in the bibliography of reviews and other scientific papers varies with the science; it is desirable in biology, possibly less so in chemistry.

Annual or biennial reviews, progress reports and books on recent advances serve a useful purpose, especially if prepared as critical reviews rather than synoptic summaries. Reviews written by specialists for workers in other branches of science are of great importance and at present are insufficient. In the applied sciences there is also a need for more review publications. In this connexion considerable material could perhaps be made available for publication by the larger industrial concerns.

Reports on 'symposia' are recognized as a valuable contribution to the recording of progress in science but are not a substitute for reviews or annual reports. A wider distribution of copies of the more important review lectures is desirable.

H. Munro Fox

THE PALESTINE FLORA

By ERIC HARDY

THE trouble in Palestine sets back the clock on the recent efforts of both Arab and Jewish gardeners to develop the horticultural attractions of the Holy Land, for the palm boulevards of Jaffa, and the flower-growing settlements at Mishmar-Hasharon, etc., had attracted much praise and attention. The danger, however, goes deeper, for modern Palestine was not the primitive wilderness of brigand and bedouin as depicted in most of the Western religious books. Several excellent gardens and plant collections were in the country, and their future is threatened by the bitterness of war. There is, for example, the best of the attempts to create a typically English garden, with its lawns and roses, its rockery and its pergola, which was in the grounds of Government House on the dry and dusty hill outside Jerusalem. On besieged Mount Scopus the botanical department of the University of Jerusalem housed the finest herbarium of the Near East flora, with more than 300,000 sheets of specimens collected not only in Palestine, but also in Syria, Arabia, Transjordan, and in particular the desert regions. There was also the private collection of Palestine and Transjordan plants collected in the American Colony in Jerusalem by J. E. Dinsmore, editor of the second edition of Post's "Flora of Palestine and Syria", where also the garden of a score of varieties of Palestine irises was a famous feature in April. Another internationally famous private herbarium, the largest outside the University, is the Herbarium Boyko, housed at the village of Talpioth, between Jerusalem and Bethlehem, in the home of Dr. Hugo Boyko, its compiler, an official of the Mandatory Government's Department of Forests.

At Rehovoth, which has been subject to several air raids, are housed the laboratories, collections, trial gardens, etc., of the country's main horticultural research. Here Dr. Oppenheimer, Dr. Samech and others maintained the vast organisation of the citrus research and the fruit-growing industry, where East Malling ideas were developed and plants acclimatized and tested. The horticultural edition of the *Palestine Journal of Botany* is produced here under Dr. Oppenheimer's editorship, while the purely botanical edition is produced at the University of Jerusalem under Prof. Zohary's editorship.

In recent years the University of Jerusalem had established a botanic garden on Mount Scopus, mainly for shrubs and trees typical of the country's flora, and including a coppice of cedar of Lebanon. Under the Mandatory Government, the Departments of Forests and Agriculture maintained several stations existing from Turkish times, like the vineyards, date palms and orchards at the old Turkish horticultural station in Jericho, and they established others. Near Acre the Mandatory Government established its main stock farm and horticultural and field crop station; its station for deciduous trees, carobs, vines and pruning instruction was near Safad. At Farawana, near Beisan, in the middle Jordan Valley, it had a station for sub-tropicals, olives, vines and dates; another near the historic Jacob's Well at Nablus for olives, vines and pomegranates; an experimental station for miscellaneous work was at Majdel, and a forestry station at Gaza that has been planting a large acreage of wind-blown sand with tamarisk to check the inroads of the Sinai sandstorms. From these stations, Arab gardeners were taught Western ideas of grafting and pruning, particularly for olive cultivation. The famous Arab olive orchards at Beit Jala near Bethlehem, and their pomegranate orchards near Ramallah, were a tribute to the work.

On the cool and fertile shores of southern Galilee, the Jews maintained a remarkably interesting nature study and agricultural institute called Beth Gordon, in memory of a pioneer settler, Aaron Gordon. This was at Degania settlement, in the vicinity of much of the recent fighting between Tiberias Jews and the Iraqi Army. Beth Gordon (or Gordon House) was open to any visitors interested in natural history or horticulture irrespective of membership. It maintained laboratories, lectures, a card-indexed library of 12,400 books in several languages, a museum with 18,500 animal specimens and a herbarium of 3,400 named plants, all under the direction of M. J. Palmoni. This was mainly a teaching centre, whereas Rehovoth was the main centre of horticultural research and plant acclimatization.

For several years the European colony in Jerusalem maintained a Jerusalem Horticultural Society, and in 1928 it published an instructive little booklet on the cultivation of gardens under those high, dry, chalky conditions. But war has sapped much of its energy and activity. The municipality of Jerusalem had initiated a few excellent little public gardens in recent years, gardens of begonias, *Lantana*, *Iris* and a strange mixture of Western formality and sub-tropical flowering shrubs, together with a small nursery for re-stocking these gardens, placed at the foot of the Mount of Olives.

It is true that in recent years Palestine-grown flowers were on exhibition in London and at Detroit; but Palestine has nothing to compare with Egypt's famous Gardens of the Nile near the Delta barrage. Jerusalem is a difficult place for the gardener, as its high position entails a seasonal variation from almost sub-tropical summer to winter snows and frosts. But since the mandate the temperature of Jericho in the hot lower Jordan Valley has been made much cooler for its inhabitants by the extended cultivation of trees, for both their floral effects and their fruit, irrigated with the sparkling waters of Elisha's spring. The first cultivators of the Jericho desert were the Greek monks, whose monastery orchards adjoining the tamarisk thickets just north of the Dead Sea are several hundred years old. In more recent years the Jewish settlement at Beth Ha'arava, beyond the recently destroyed Palestine potash plant on the north shore of the Dead Sea, 1,300 feet below sea-level, has cultivated a former salt-desert by leaching the soil with pipe-borne sweet water pumped from the nearby Jordan. The French Trappist monastery at Latrun, scene of bitter fighting for the Jerusalem–Tel Aviv highway, has developed some of the finest vineyards and orchards in the country, and its wines are nationally famous.

The main problem facing horticulture in Palestine was lack of water; but in recent years I saw how much of this difficulty had been conquered by the establishment of concrete aqueducts in the middle Jordan Valley, pumping sweet-water on to the Dead Sea salt-lands, and damming up by earth and concrete reservoirs the occasional but heavy winter rain that filled the wadis in the southern Negev desert. Artesian wells were much used in the coastal area, where practically all the great citrus-growing orchards were cultivated; but a generation or two ago, sandy wastes covered this area.

The pomegranate, the vine and the fig were already under cultivation by the native Arabs when the ancient Israelites first invaded the Holy Land. The Israelites introduced the apple, the first fruit to be mentioned in any historical writings, for Ramsis II had planted this native of the Black Sea in his gardens in the Nile Delta. The Jews traditionally introduced the citron to Palestine from their Babylonian captivity, and the Arabs are said to have brought the lemon and the orange to the Mediterranean coast from Iraq in the tenth century. Modern research into the history of the citrus fruits has, however, shown that oranges and lemons were known in Palestine in Mishnaic times, and the coins struck by Simon Maccabæus shortly after he conquered Jaffa in 136 B.C. show the citron was then in cultivation there.

The Western world has been indebted to Palestine for many of its irises. I have seen iris Grant-Duffii, the laurel and *Lilium candidum* growing wild in the Carmel area. The profusion of the garden anemone, *A. coronaria*, *Cyclamen persicum*, *Tulipa montana*, *Narcissus Tazetta*, the golden *Sternbergia aurantiaca* and of *Cistus* shrubs has borne offspring to grace countless gardens in Europe and America.

OBITUARIES

Profs. Friedrich Oltmanns and Adolf Pascher

SOME tribute should be paid to Profs. F. Oltmanns and A. Pascher, both of whom died in 1945 after making substantial contributions to the advancement of algal studies during the present century.

The name of Oltmanns, who for many years occupied the chair of botany in Freiburg in Baden, will be remembered as that of the author of the first comprehensive account of the Algæ. His "Morphologie und Biologie der Algen", published in 1904, constituted a landmark in the study of the Algæ and, by making available an authoritative account of the group, stimulated and had a far-reaching effect upon algal investigation in many different directions. The more extensive second edition, which appeared in 1922–23, was less inspired, and its utility was marred by the inadequate and frequently erroneous literature citations. The extensive treatment accorded to algal biology in the third volume failed to give a clear insight into the many outstanding problems.

Oltmanns, however, has other claims for inclusion among the outstanding algal workers of his period. He was the first to elucidate clearly the role of the auxiliary cells in Florideæ, and we owe to him considerable contributions to the knowledge of the Fucales and of the conditions of life of seaweeds. A special volume of the *Zeitschrift für Botanik*, which he edited for many years, was published in 1930 when he reached the age of seventy years.

Pascher, who was born in 1881, spent the whole of his academic life at the German University of Prague, where, during the latter part of his life, he occupied the chair of botany. His influence on algology was of a different and more profound nature than that of Oltmanns. One of his earliest researches, published in *Bibliotheca Botanica* in 1907, was concerned with the morphology and behaviour of the swarmers of diverse filamentous Chlorophyceæ. It was probably these studies that aroused his interest in flagellate organisms, to the knowledge of which he was to make so great a contribution. His investigation of the rich flagellate and algal flora of the Central European uplands extended over a period of more than thirty years, and resulted in the description of innumerable genera and species new to science.

An early outcome of these studies was the recognition of the fact that flagellate groups like the Chrysomonadineæ and Dinoflagellata (Peridinieæ) include also coccoid and filamentous types, comparable to those already known among the Chlorophyceæ and Xanthophyceæ (Heterokontæ), though Klebs in 1912 had already to some extent advanced this point of view for the Peridinieæ. In the brief memoir entitled "Ueber Flagellaten und Algen", published by Pascher in 1914, however, the Flagellata as a whole were placed in their correct relation to the Algæ, and the theory of the flagellate origin of Green and Yellow-green Algæ, first propounded in 1901 by Bohlin, was extended to the new classes Chrysophyceæ and Dinophyceæ. Emphasis was also laid on the remarkable degree of parallelism evident between the various algal series emanating from flagellate sources. These diverse theses were more fully elaborated in a series of papers published during the next twenty years, dealing with Chrysophyceæ, Dinophyceæ, and Xanthophyceæ, in which fundamental knowledge of each class was appreciably extended.

The great debt which botanical science owes to Pascher is the elucidation of the diverse lines along which algal evolution from flagellate stocks has taken place and of the definite pattern followed in this evolution. His numerous papers, however, include many other important contributions to the knowledge of Protista. Outstanding among these are the extensive studies of amœboid and rhizopodial forms of Algæ, which first disclosed clearly the significance of amœboid organisation, the exposure of the manifold relations between pigmented and colourless flagellate organisms, and the recognition of the affinity between Diatoms, Chrysophyceæ and Xanthophyceæ.

Later generations will no doubt also acknowledge the debt owed to Pascher in respect of the publication of the "Süsswasserflora", which probably gave an even greater stimulus to freshwater algology than did Oltmanns' book. Pascher's own contribution to this series of volumes was very considerable, and includes some of the most valuable parts. It is much to be deplored that he did not survive to produce a second edition of the volumes dealing with the Flagellata, of which he had so unrivalled a knowledge. His last comprehensive publication was the volume on Heterokontæ in Rabenhorst's "Kryptogamenflora", which was completed in 1939.

Pascher's numerous papers are characterized by lucidity and by the excellence of the accompanying illustrations, although sometimes a little marred by hasty editing. Most of his work was published in the *Archiv für Protistenkunde* and the Beihefte of the *Botanisches Centralblatt*, of both of which he was editor for a long period of years. His was a lovable, though sometimes rather impetuous, personality.

F. E. Fritsch

Mr. H. Brearley

Mr. Harry Brearley, the inventor of stainless steel, died on July 14 at the age of seventy-seven. A native of Sheffield, and the eighth child of a family brought up in "Ramsden's Yard", of which he has given a vivid account in a delightful autobiography, "Knotted String", he had only an elementary school education and then worked as a cellar lad in a crucible steel works. He was fortunate in being taken from this to be a laboratory boy under a capable and kindly analyst, who persuaded him to attend evening classes. He married young, and quite early collaborated with Fred Ibbotson in a book on the analysis of steelworks materials. In 1914 he went to Riga, then a Russian town, as chemist in a steel works associated with Messrs. Firth of Sheffield, where he improved the technique of hardening armour-piercing shells, having also to act as managing director when the Russian Revolution came and many members of the staff left. On returning to Sheffield he took charge of the Brown–Firth Laboratory, installed jointly by two neighbouring firms. Difficulties in the making of armour plates led him to the further study of the thermal treatment of alloy steels.

His introduction of a steel containing chromium with low carbon was intended to provide a more durable lining for gun barrels, and it was the observation that specimens in the laboratory, under certain conditions of heat treatment, were highly resistant to corrosion that suggested their use for cutlery. A Sheffield firm, R. F. Mosley, produced knives made of this steel which were not stained by fruit acids or similar solutions. Difficulties arose over the ownership of the invention, and in 1915 Brearley left the firm and joined Messrs. Brown Bayley, also of Sheffield. For a time, the patents were controlled by a special organisation, the Firth–Brearley Syndicate. Patent litigation involved a visit to the United States. Brearley retired in 1925 to Torquay. He and his brother devised the method of studying ingot structure by casting and sectioning wax models. He was awarded the Bessemer Gold Medal of the Iron and Steel Institute in 1920.

Without a university training, Brearley had a remarkable command of lucid English, and his books are models of their kind. A man of sturdy independence, a lover of good literature, and a metallurgist who rendered great services to the steel industry and to the men employed in it, he has a strong claim to be remembered among pioneers in industry.

C. H. Desch

We regret to announce the following deaths:

Dr. William Cullen, well known for his work in mining engineering and explosives, on August 14, aged eighty-one.

Prof. Beatrice Edgell, emeritus professor of psychology, Bedford College, London, on August 10, aged seventy-six.

Dr. Alexander Smith, assistant mycologist at the Ministry of Agriculture and Fisheries Plant Pathology Laboratory, Harpenden, on July 23, aged fifty-four.

NEWS and VIEWS

Chair of Entomology, University of Illinois: Prof. G. Fraenkel

Dr. G. Fraenkel, lecturer in physiology in the Department of Zoology and Applied Entomology at the Imperial College of Science and Technology, London, has been appointed professor of entomology in the University of Illinois, Urbana, Ill., to take charge of the newly founded sub-section of insect physiology. Dr. Fraenkel, who was educated at the University of Munich, was an assistant in the Department of Zoology in the Hebrew University, Jerusalem, during 1928–30. During 1931–33, he was *Privatdozent* in zoology in the University of Frankfurt. From 1933 onwards, he has carried out research in insect physiology and the orientation of invertebrates at University College, London, and the Imperial College. Dr. Fraenkel has held his post as lecturer in physiology in the Imperial College since 1938. Most of Dr. Fraenkel's researches have been confined to insect physiology, including reflexes, pupation hormone of flies, function of halteres of flies, properties of cuticle and respiration. Since 1940 he has made a comprehensive study of insect nutrition supported by the Royal Society and, later, by the Medical Research Council. During the spring and early summer of 1947 he was guest professor in the University of Minnesota, where he gave a course of lectures on insect nutrition.

The National Radium Trust and Commission

With the coming into force of the National Health Act on July 5, the affairs of the National Radium Trust and the Radium Commission are being wound

p. The two bodies were established by Royal Charter issued under Letters Patent of July 25, 1929. The functions of the Trust were primarily to augment the supply of radium (and later, by supplemental Charter, other radiotherapeutic apparatus) for use in relation to the treatment of the sick in Great Britain" and "the advancement of knowledge of the est methods of rendering such treatment". The main duty of the Commission was "to make arrangements for the proper custody, equitable distribution, and full use of the radium . . . of the Trust with the object of promoting the treatment of the sick . . . and o make such arrangements for the supply on loan of the radium . . . as are necessary". When the Commission started work it was generally admitted that radium treatment in Great Britain had not ttained the standard then reached by such centres as the Fondation Curie and the Radiumhemmet. During the last nineteen years, however, some of the ational (university) radium centres set up by the Commission have achieved a reputation equal to the best anywhere in the world. At the same time, the standard of radiotherapy in general has been raised y the policy of centralization pursued by the Commission. Hospitals with small radiotherapy departments have been advised to make agreements with national centre for the treatment of their patients, nd the formation of small independent centres has been consistently discouraged. The present health organisation requires that the work hitherto done by the Trust and the Commission shall in future be undertaken partly by a Ministry of Health committee, nd partly by the regional hospital boards. It is deemed advisable, therefore, that the radium and other radioactive substances, apparatus, appliances, funds nd property belonging to the Trust and the Commission shall be dealt with by vesting them in the Minister of Health, or the Secretary of State for cotland, as may be appropriate. The Royal Charter and the three Supplemental Charters are to be surrendered.

Market Research

THE report of the Conference arranged by the Manchester Joint Research Council in Manchester on October 22, 1947, on "Market Research", has now been published (Manchester Joint Research Council. Market Research : Report of the Conference held on Wednesday, October 22, 1947, at the Albert Hall, Manchester. Pp. 108. (Manchester: Manchester Joint Research Council, 1948.) 2*s*. 6*d*.). It includes the full text of the three papers "The Technique and Applications of Market Research", "The Investigation of Trends of Consumer Tastes" and "Market Research and the Seller" submitted by Mr. O. W. Roskill, Mr. L. R. England and Mr. D. S. F. Vernon, respectively, together with their statements in presenting these papers and reports of the discussions. Summing up the discussions and the papers Mr. C. C. Renold said that, according to this composite picture, the broad purpose of market research was to provide answers to the questions, what does the customer, in fact, want, and, what is he likely to want in the future? These two questions immediately led to four others: who is the customer, what does he, in fact, buy, what is it that determines or influences his choice, and how much does he buy? The answers to some of these questions can be sought by statistical means; but, especially with consumer goods, other questions lead us into problems of psychology. The answers, too, have to be in two tenses—present and future—and they are determined not only by general movements of economics, trade or social habits, but also by the position of the manufacturer in relation to his competitors. The essential in market research was to select the subject most worth close examination by the techniques available. Mr. A. H. S. Hinchliffe, pointing out that the Manchester Joint Research Council did not itself undertake market research, referred to its information bureau as of possible service to firms unaware of sources of information or market statistics and as possibly able to advise firms on the best sources and consultants for carrying out particular pieces of market research.

Recently Introduced Fungicides

LIME-SULPHUR and Bordeaux mixture, both discovered in the last century, are still very effective and relatively cheap sprays for the control of fungus diseases. It is natural, however, to investigate the possibilities of other substances which might be either more effective or more economical. R. W. Marsh has carried out an extensive series of fruit-spraying trials with various new fungicides (*J. Pom. and Hort. Sci.*, **23**, 3 and 4, Dec. 1947). Phenyl mercury chloride was approximately equal to standard lime sulphur for the control of apple scab; in Grade E oil emulsion, it also gave promising inhibition of sporing of *Monilia fructigena.* Ferric dimethyldithiocarbamate and tetramethylthiuram disulphide are not phytotoxic, but are inferior as fungicides to lime sulphur. Heptadecylglyoxalidine equalled lime sulphur for apple scab control, and did not damage sulphur-sensitive varieties. The last substance, with dichlornaphthoquinone and dithiocarbamate sprays, gave satisfactory control of *Pseudopeziza* leaf-spot of black currants. Spread of brown rot infection of apples was reduced by ferric dimethyldithiocarbamate; but hydroxyquinoline sulphate showed no fungicidal value for apple scab.

Diseases of Mushroom Cultivation

THE Mushroom Growers' Association is a body formed by a particular section of the horticultural industry in order to solve its own pressing problems. Some interesting features relating to mushroom diseases have recently appeared in the Association's Bulletin (Nos. 11 and 12, April and July, 1948). 'Cobweb', caused by overgrowth of beds by *Dactylium* species, is briefly described by Fred C. Atkins. The control of 'bubble', caused by the fungus *Mycogone perniciosa*, is outlined by Edmund B. Lambert. He regards as necessary a complete programme: burning sulphur and fumigating with formalin before the mushroom houses are used, taking water direct from uncontaminated deep wells, attaining a temperature of 120° F. for 48 hr. in the final fermentation of manure and casing soil, and general methods of hygiene. A new leaflet of the Association (No. 3) describes the general characters of *Mycogone* disease. A detailed account of the invasion of mushroom beds by truffles is contributed by A. M. Kligman, and, as control of most mushroom diseases involves rigid methods of hygiene, the necessary measures are considered in detail by R. L. Edwards and C. J. la Touche.

Cosmic Phenomena of the Past

IN a paper, "Further References to Cosmic Phenomena in the Kitāb Al-Muntazam of Ibn Al-Jauzī, and a Few in Tārīkh-E-Rāḥat Afzā (India)", a reprint from *Islamic Culture*, April, 1948, Mohd. Abdur Rahman Khan provides a short account of thirteen fireballs from A.D. 983 to A.D. 1031; three comets from A.D. 974 to A.D. 1056; a comet in A.D. 1741, a detonating fireball in A.D. 1742, and another one in A.D. 1757 and an earthquake at the same time (it is conjectured that the earthquake may have been due to the impact of a large meteorite with the ground), and a slight earthquake in A.D. 1759. This information is additional to that published by the same author in his brochure "Meteoric Showers, Past and Present", some of which was discussed by him in the *Islamic Culture Magazine*, **20**, 4 (1946).

Scottish Conference on Road Research

An all-day conference to discuss road research problems will be held in Glasgow at the Royal Technical College on September 24. The conference is being called, with the collaboration of the Ministry of Transport, by Dr. W. H. Glanville, director of road research of the Department of Scientific and Industrial Research, in association with the Glasgow and District Association of the Institution of Civil Engineers, the Scottish branches of the Institution of Municipal Engineers and the County Surveyors' Society, and the Scottish Accident Prevention Council. The chairman of the conference will be Sir Patrick Dollan. The purpose of the conference is to bring the work of the Road Research Organisation before Scottish engineers and others concerned with roads and road traffic, and to provide an opportunity for discussing which research problems are of particular interest to Scotland. In addition to short papers by the director of road research and senior members of his staff, followed by an open discussion, there will be an exhibition of some aspects of the work of the Organisation. The morning session (deputy chairman: Colonel T. U. Wilson) will be devoted to materials and methods of construction, and the afternoon session (deputy chairman: Mr. G. J. Sherriff) to road safety and traffic flow. Owing to limitations of space, admission will be by ticket, obtainable from the Director of Road Research, Road Research Laboratory, Harmondsworth, West Drayton, Middlesex.

University of London: Appointments

The following appointments in the University of London have recently been announced: Dr. T. Crawford, University professor of pathology in St. George's Hospital Medical School as from October 1. Since 1946 he has been director of pathological services at St. George's Hospital and Medical School; Mr. D. V. Davies, University professor of anatomy in St. Thomas's Hospital Medical School as from October 1. Since 1944 he has been fellow and College lecturer at St. John's College, Cambridge, and in 1945 was Arris and Gale Lecturer at the Royal College of Surgeons; Mr. A. V. Judges, University professor of history of education in King's College as from January 1, 1949. Since 1938 he has held the title of reader in economic history in the London School of Economics and Political Science; Dr. R. T. Williams, University professor of biochemistry in St. Mary's Hospital Medical School as from October 1. Since 1942 he has been senior lecturer in biochemistry and during 1943–44 was in charge of the Department of Biochemistry at the University of Birmingham; Dr. G. L. Clark, University reader in mathematics in Bedford College as from October 1. Since 1947 he has been senior lecturer in mathematics at University College, Cardiff; Mr. T. A. Rodger, University reader in psychology in Birkbeck College as fron October 1. He is at present senior psychologist t the Admiralty, consulting psychologist to the Centra Juvenile Employment Executive and a lecturer i Birkbeck College.

Announcements

Mr. Derek Allan Hough has been appointe general secretary of the Institute of Petroleum wit effect from September 1. Mr. George Sell has bee appointed as editor of the Institute's publication with effect from August 1. Mr. Sell has been publications secretary since March, 1946.

Prof. Walter H. Bucher, of Columbia Universit has been elected president of the American Geophy ical Union to fill the unexpired term of the lat Oscar E. Meinzer. This term will expire on June 3 1950.

Mr. F. A. Secrett has resigned his position a honorary adviser to the Ministry of Agriculture an Fisheries on vegetable production, with effect fro August 1. Mr. Secrett, who is himself a leadin vegetable grower, has held this appointment sinc August, 1942. He will continue his membership the Agricultural Improvement Council.

In recognition of his studies on "Sludged Blood the College of Physicians of Philadelphia has awarde the Alvarenga Prize for this year to Dr. Melvin I Knisely, of the University of Chicago. Th Alvarenga Prize was established by the will Pedro Francisco da Costa Alvarenga, of Lisbo Portugal, an associate fellow of the College, "to b awarded annually by the College of Physicians o each anniversary of the death of the testator, July 1 1883".

The Electronics Division of the U.S. Electr chemical Society is making preparations for symposium on luminescence, to be held during i meeting in Philadelphia, from May 5 until 7, 194 Further information can be obtained from Dr. R. M Burns, Electrochemical Society, 235 West 102 Stree New York 25, New York.

The Nuffield Foundation has provided funds f the establishment of a research fellowship in extracti metallurgy, which will be awarded in consultati with the Institution of Mining and Metallurgy a the Royal School of Mines, London, and will tenable at the Royal School of Mines for a period five years. The funds are sufficient to provide small specialist staff and the necessary equipment addition to adequate remuneration for the fello Further information can be obtained from t Secretary, the Institution of Mining and Metallurg Salisbury House, London, E.C.2.

The Medical Research Council announces that has awarded Rockefeller travelling fellowships medicine to the following, for the academic ye 1948–49: Dr. K. W. Donald, Medical Professor Unit, St. Bartholomew's Hospital, London; D L. P. R. Fourman, Nuffield Department of Clinic Medicine, University of Oxford; Dr. R. H. Girdwoo Department of Medicine, University of Edinburg Dr. A. Isaacs, Department of Medicine, University Sheffield; Mr. A. I. S. Macpherson, Department Surgery, University of Edinburgh; Dr. H. Stoner, Department of Pathology, University Sheffield; Mr. S. F. Taylor, Department of Surger Postgraduate Medical School, London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Origin of Some Plant Viruses

POTATO paracrinkle virus, discovered by Salaman and Le Pelley[1], has been found in every plant of the variety King Edward that has been examined, but never in other varieties in the field, although it can be transmitted to them by grafting. The inference is that it has no natural means of spreading, and must have been present in the original seedling from which the variety King Edward came.

It is reasonable to infer that the virus was in the seedling because it was a seedling, and either is part and parcel of the clonal variety, or arose during some phase in the life of the seedling not shared by plants propagated vegetatively. The first alternative is ruled out because the virus is not transmitted by seed and behaves in general like other viruses, as Carson *et al.*[2] pointed out in reply to Darlington's suggestion[3] that the virus was a protein constituent of the variety. This leaves the second, which means that the virus arose in the germinating seed or very young seedling, because these are the only phases in the life of a seedling that are not shared by plants propagated vegetatively.

There is evidence for the belief that potato paracrinkle virus is not unique in its origin, and that other plant viruses may have arisen in germinating seed. The biochemical processes during germination are to some extent the reverse of those during the formation of the seed—food reserves built up in the seed are broken down during germination—and if viruses arose during germination there would be a fair chance that they would be destroyed in the seed as it forms. This is precisely what happens, for destruction of those viruses that manage to enter the seed seems universal, even if it is sometimes incomplete. The suggestion that viruses have arisen from occasional syntheses during germination is the simplest explanation of this destruction.

It might be argued that the prevalence of viruses in plants propagated vegetatively is against the suggestion; but this is not so, because one can usually trace a connexion with propagation by seed. Consider the largest two groups of plant viruses: those of stone fruits and of potatoes. Stone fruits are usually (but not invariably) budded on seedling stocks; and, granted a susceptibility of *Prunus* towards viruses, there is (on the present suggestion) the ideal combination for the establishment of new viruses: seedling stocks to produce them and vegetative propagation of varieties to give them a less poor chance of survival. Potatoes are nowadays raised from seed only for the production of new varieties (with the consequence in King Edward already noted). But the raising of new stocks from seed was once common in Europe as well as in the original home of the potato; and it may be significant that, whereas several of the viruses of stone fruits discovered in recent years were not only previously unrecorded but, on local evidence, apparently new, there is no evidence that outside South America the potato viruses, with the exception of paracrinkle virus, are modern.

On following the line of thought in the second half of the previous sentence, it was found that the number of virus diseases first recorded in the literature after the publication of K. M. Smith's "Textbook" in 1937, relative to the number recorded before, is significantly greater for plants usually grown from seed or on seedling stocks than for plants usually propagated only by vegetative means. Details of the test of independence are given in Table 1, which is based on the 156 viruses contained in Wiltshire's[4] list published in 1946, the classification being made on the host plants which give the viruses their common names, and on the dates when the diseases were first recorded, irrespective of whether they were then ascribed to viruses or not. An identical trend is also shown in Table 2, which, to remove any bias that vegetative propagation may give to the detection of virus diseases, is confined to vegetatively propagated plants, and compares plants like peaches, which are usually on seedling stocks, with plants like potatoes, which are usually propagated by simple vegetative means, or, like roses, on stocks raised vegetatively. The records of plant virus diseases are still fragmentary and perhaps unrepresentative, and the host plants after which the viruses are named are sometimes clearly not the original hosts, but the difference between the two sets of records as they now stand is unquestionable. Closer analysis of the effect of time revealed no evidence that the choice of date, 1937, had much to do with this difference.

Table 1. Number of first records of plant virus diseases. Figures in parenthesis are for woody and herbaceous plants respectively

	Plants grown from seed or on seedling stocks	Plants propagated vegetatively	Total
Before 1937	68 (19, 49)	52 (18, 34)	120 (37, 83)
1937 and after	31 (13, 18)	5 (3, 2)	36 (16, 20)
Total	99 (32, 67)	57 (21, 36)	156 (53, 103)

χ^2 for all plants = 10·35; for woody plants = 4·17; for herbaceous plants = 6·80. The 1 per cent and 5 per cent points are 6·64 and 3·84 respectively.

Table 2. Number of first records of virus diseases of plants which are usually propagated vegetatively

	Usually on seedling stocks	Usually vegetative propagation only	Total
Before 1937	12	52	64
1937 and after	11	5	16
Total	23	57	80

χ^2 = 15·62; 1 per cent point = 6·64.

It is not supposed that all diseases recorded since the beginning of 1937 are new, even if, to allow for the inevitable lag in time between the synthesis of a virus and the discovery and record of the disease it causes, one interprets the adjective as covering the last few decades. But it is possible that enough viruses are new enough to influence the date of discovery of the diseases they cause, and thus, if they arise in the seed, to give the records the trend they have. Fortunately, the analysis is one which will automatically improve as records become less fragmentary, and time will allow one to give the possibility a better test.

To conclude, it is suggested that the synthesis in healthy tissue of enough virus to effect further multiplication is a rare event which happens in the protein-rich seed during the intense chemical activity of germination. Rarity is a clear demand of the statistical argument, one successful synthesis followed by successful dispersal being all that is really needed for each virus; and this demand allows a theory of heterogenesis to conform with the substance of the teachings of Pasteur.

J. E. van der Plank

Division of Botany and Plant Pathology,
Department of Agriculture,
Pretoria.
March 2.

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[1] Salaman and Le Pelley, *Proc. Roy. Soc.*, B, **106**, 140 (1930).

[2] Carson, Howard, Markham and Smith, *Nature*, **154**, 334 (1944).

[3] Darlington, *Nature*, **154**, 164 (1944).

[4] Wiltshire, *Rev. Appl. Mycology*, **24**, 515 (1946).

Rh Genes Allelomorphic to *D*

Stratton[1], in 1946, described an *Rh* gene allelomorphic to D and d, to which he gave the name D^u. He demonstrated that this allelomorph was inherited in the same way as the other *Rh* genes. During the last two years we have had the opportunity of testing twenty-eight samples of blood of the genotype $D^u d$, nineteen of which were from unrelated English persons.

The tests were exhaustive; they included titrations in saline and in albumin against numerous anti-D sera, and tests by the anti-globulin and by the elution techniques. We consider a sample of blood to be $D^u d$ if it gives some of, but not all, the reactions expected of D when tested by these various methods against the battery of agglutinating and incomplete anti-D sera. The homozygote $D^u D^u$ must be very rare in England, and in the heterozygote $D^u D$ the presence of D^u is masked by that of D.

Red cells		12 anti-*D* Sera											
Da.	CD^ue/cde	–	–	–	–	+	+	–		–	–	–	–
Sh.	,,	–	–	–	–	+	+			–	–	–	–
Am.	,,	–	–	+	+	+	+	+	+	+	+	–	–
Br.	,,	–	–	+	+		+	+		+	+	+	–
Ma.	cD^ue/cde	–	–	+	+	+	+	+		+	+	+	+
Bl.	CD^ue/cde	–	+	+	+		+	+		+	+	+	+
CDe/cde control		+	+	+	+	+	+	+	+	+	+	+	+
Lo.	CD^ue/Cde	–	+	+	+		+	+		+	+	–	–
Mar.	cD^uE/cde	–	+	+	+		+	+	+	+	+	–	–
Ab.	,,	–	+		+		+	+	+	+	+	–	–
Gr.	CD^ue/cde	–	+	–	+		+			+	–	–	–
Cu.	CD^ue/Cde	–	–	–	+		+	+		+	–	–	–
Th.	CD^ue/cde	–	–	–	+	+	+	+		+	–	–	–
Gl.	CD^ue/Cde	–	–	–	+	+	+	+	+	+	–	–	–
Se.	cD^uE/cde	–	–		+		+	+		–	–	–	–
Le.	CD^ue/cde	–	–	–	+		+	+	+	–	–	–	–
Jo.	,,	–	–	–	–	+	+	+		–	–	–	–
Po.	CD^ue/Cde	–			–	–	+						–
Ho.	CD^ue/cde	–	–	–	+		–	–	–	–	–	–	–
Pi.	,,	–	–	–	+		–	–	–	–	–	–	–

The reactions of the blood of the nineteen unrelated English persons with twelve anti-D sera are shown in the accompanying table. The twelve sera had each disclosed slight variations in the specificities of their anti-D when they were tested against the nineteen samples of blood. About thirty antisera were used; but the rest appeared to give the same reactions as one or other of the twelve. Conversely, the antisera defined twelve different types of $D^u d$ blood, and presumably if the battery of antisera had been larger, more of the nineteen samples of D^u blood would have been distinguishable.

Examination of the families of ten of the nineteen persons confirmed Stratton's views of the inheritance of D^u; but it went further, and left very little doubt that the fine distinctions between the different types of D^u are also genetically determined, for with one exception the blood of related persons gave identical D^u reactions.

The apparently unlimited number of D^u allelomorphs, together with the very arbitrary way in which the antisera were reacting with them, recalled the work of Dubinin on the many allelomorphs at the scute locus in *Drosophila melanogaster* (as described by Waddington[2]). The problems seemed to have sufficient in common to stimulate us to seek, by rearranging our results, for some such pattern as that into which the scute results apparently fitted. This could be done by cutting up the original most bewildering table first vertically for the sera; then, having decided on their order, redrawing the table and cutting it horizontally for the ordering of the cells. The result was the striking pattern shown in the table. It will be seen that two samples of blood do not fit in at all, but that the remaining seventeen show a horizontal and vertical contiguity of positive reactions uninterrupted by intervening negative ones. There is only one exception to this, in the horizontal direction, about halfway down the table.

It is difficult to decide whether the pattern is a chance one. If it is significant, then the horizontal conjunction of positive signs seems to impose a linear order on the different forms of D^u. It suggests that if the differences between the D^u's are due to mutations, then the mutations may be additive in nature. The vertical conjunction of positive reactions would suggest that an anti-D antibody is built up according to a progressively expanding plan.

It should be mentioned that D^u is much too rare to have been the antigen responsible for the immunization of the twelve mothers whose sera are shown in the table. Probably all these anti-D sera were made in response to the antigen D. It should also be made clear that all twelve antisera would agree in giving positive or negative reactions with at least 99 per cent of blood samples. It is only over the rare D^u bloods that they disagree. The range of an anti-D serum in agglutinating D^u cells is not wholly dependent on the titre of the serum, though there is a positive relationship between range and titre.

The different D^u samples can be graded from those that are agglutinated in saline by most anti-D sera down to those which can only be recognized as having any D^u component by giving a positive anti-globulin test with incomplete anti-D serum. Blood of the latter type will usually have been classified as Cde/cde or cdE/cde.

The C or c, E or e genes with which D^u is usually combined in England strongly suggest that the mutation to D^u, if it is a mutation, occurs to a D gene rather than to a d gene.

The type of blood called $R'r$ (and the same applies to $R''r$) consists of two groups probably differing fundamentally in origin. One group, perhaps the larger, is really antigenically low-grade D^u and is of the genotype CD^ue/cde, which we consider has arisen by mutation in a CDe chromosome. The other group contains the true Cde/cde, which, according to the suggestion of Fisher for which there is some striking support, has arisen as a cross-over between CDe and cde chromosomes.

A detailed account of the family and serological investigations will be reported elsewhere.

We are indebted to many *Rh* workers for sending us samples of D^u blood and anti-*D* sera. Particularly we would like to mention Dr. F. Stratton, Dr. F. S. Stewart, Mr. I. Dunsford and Dr. A. E. Mourant.

R. R. RACE
RUTH SANGER
SYLVIA D. LAWLER

Medical Research Council,
Blood Group Research Unit,
The Lister Institute,
London, S.W.1.
April 10.

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[2] Waddington, C. H., "Introduction to Modern Genetics" (London, George Allen and Unwin, 1939).

IN 1945 a cell sample was discovered reacting with only a proportion of anti-*D* sera. This suggested a new allele of *D* which was called D^u [1]. 209 *Rh* antisera stored at − 20° C. for periods up to several years have been tested with D^u cells of types CD^ue and cD^uE, selecting the appropriate cell to avoid the effect of anti-*C* and anti-*E* agglutination in sera containing more than one antibody. 102 of these sera contained anti-*Rh* agglutinins, and 37 of these (36 per cent) agglutinated D^u cells, some weakly, some very strongly. These sera all contained anti-D + D^u agglutinins; anti-D^u by itself has not been detected. 71 of these agglutinating sera were free from anti-*C* and anti-*E* agglutinins, and 27 of these (38 per cent) agglutinated D^u cells. These 27 comprised 13 per cent of all the sera tested. The remaining 107 sera contained incomplete antibodies, many of which were weak; and 36 of them (34 per cent) gave positive Coombs tests with D^u cells. Eight of these gave positive albumin tests also, and five sera gave positive albumin tests only. In addition, strong incomplete *Rh* antibodies from ten cases of incompatible transfusion all gave positive Coombs tests with D^u cells, as did ten agglutinating sera which gave negative agglutination with D^u cells.

D^u cells vary in the strength of their reactions and in the number of agglutinating sera with which they react; and some are negative with all agglutinating sera, so that R_1 (CD^ue) and R_2 (cD^uE) may only be distinguishable from R' (*Cde*) and R'' (*cdE*) by the positive Coombs tests which they give with certain incomplete anti-*D* sera, especially those from cases of incompatible transfusion. A series of strongly positive albumin tests, on the other hand, suggests that the cell is an ordinary *Rh* positive one and does not contain D^u, since D^u only rarely gives positive albumin tests with incomplete anti-*D* sera.

The best method of investigation has proved to be the comparison of the reactions of various cells with a large number of sera, and we have examined fifty cell samples mostly thought to be R' (*Cde*) and R'' (*cdE*) in the first instance. They were tested with forty-nine agglutinating sera, and with fourteen incomplete anti-*D* sera, employing the Coombs test and albumin test. Detailed results will be published elsewhere; but a selection is given in the accompanying table. D^u cells vary in strength from very weak reactors to those which are scarcely distinguishable from ordinary *D* positive cells.

It will be observed that the D^u antigen in cell No. 39 can only be detected by the Coombs test. This cell gave negative albumin tests even with three specially selected incomplete anti-*D* sera which gave strong albumin tests with more strongly reacting D^u cells, such as cell No. 13.

Several samples of maternal blood of group R' (*Cde*) or R'' (*cdE*) containing *Rh* antibodies were examined; but no evidence of the presence of D^u was found. For this reason, and since van Loghem[3] found that D^u could be antigenic to an *Rh* negative person, D^u is considered to be *Rh* positive and should be excluded when selecting *Rh* negative blood donors. The most practical way to do this as a routine is by the use of anti-*C* and anti-*E* sera in addition to the use of several anti-*D* sera. This will exclude the vast majority of D^u positive cells. D^u also has a practical importance in that R_1 (CD^ue) and R_2 (cD^uE) cells are readily mistaken for R' (*Cde*) and R'' (*cdE*); and if such cells are used for testing purposes, one may falsely be led to suppose that agglutinating or blocking sera contain anti-*C* or anti-*E* antibodies in addition to anti-*D*.

Inheritance of D^u has been demonstrated, but we are at present making more family studies to substantiate the hypothesis that D^u is a term covering a series of alleles or modifications of the *D* antigen at the *D*—*d* locus.

Since sera which agglutinate D^u cells do so to a lower titre than the same sera agglutinate cells containing the ordinary *D* antigen, and since absorption of sera with either *D* or D^u cells does not effect any separation of the antibodies anti-*D* and anti-D^u, it might be thought that the phenomena were quantitative and dependent on a varying amount of the *D* antigen in the cell. However, this cannot be the case since the sera which agglutinate the greatest number of D^u cells are not always those with the highest titres when tested against cells containing the *D* antigen, and since cases have been found where, of a pair of sera, only one agglutinated one sample of D^u blood while the other agglutinated the second.

	Agglutinins								Incomplete antibodies						
Type of serum	Anti-*C*	Anti-*D*						Anti-*E*	Coombs test Anti-*D*			Albumin test Anti-*D*			
Serum No.	19	35	37	40	20	28	16	43	11	7	9	11	7	9	
Cell No.															Conclusion
1	−	64	64	4	16	16	4	++++	++++	++++	++++	+++	+++	+++	R_2 (*cDE*)
13	−	8	8	1	1	−	−	++++	++++	++++	+++	−	−	−	R_2 (cD^uE). Strong reactor
23	−	2	1	1	−	−	−	++++	++++	+	++++	−	−	−	R_2 (cD^uE). Medium reactor
15	++++	W	−	W	−	−	−	−	++++	−	++++	−	−	−	R_1 (CD^ue). Weak reactor
39	−	−	−	−	−	−	−	++++	+++	−	++	−	−	−	R_2 (cD^uE). Weak reactor
14	++++	−	−	−	−	−	−	−	−	−	−	−	−	−	R' (*Cde*)
8	−	−	−	−	−	−	−	++++	−	−	−	−	−	−	R'' (*cdE*)

Number of +'s indicates strength of reaction. W = weak. − = negative. Figures indicate the titre of strongly positive reactions.

Nevertheless, it was found that the sera with the highest titres for D cells were frequently good agglutinators of D^u, so that it does appear that a serum containing a strong anti-D agglutinin is more likely to react strongly with D^u.

When antigens like D and D^u are closely related, the possibility of a cross-reaction of each antigen with antibodies produced against the other is high. This shows that while a quantitative element is involved, there are also distinct qualitative differences between D and D^u.

F. STRATTON
P. H. RENTON

Blood Transfusion Service,
Manchester Royal Infirmary.
May 27.

[1] Stratton, F., *Nature*, **158**, 25 (1946).

[2] van Loghem, *Brit. Med. J.*, ii, 958 (1947).

Viropexis, the Mechanism of Influenza Virus Infection

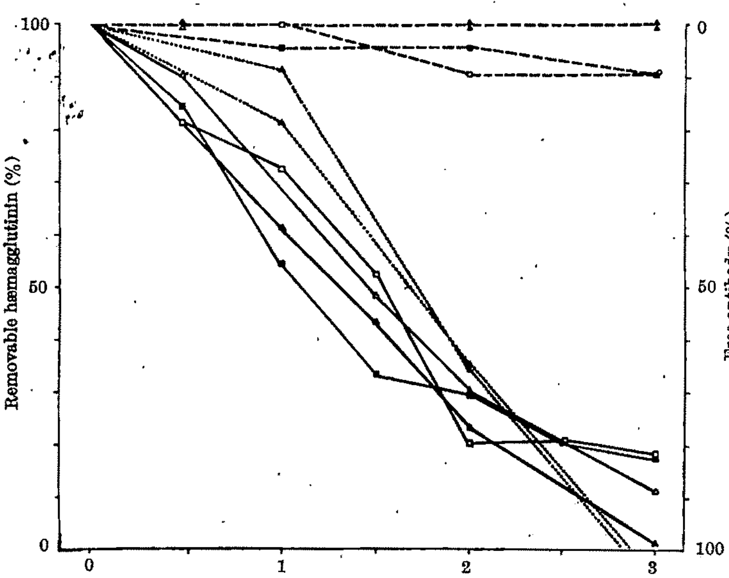
CELLULAR receptors capable of reacting with influenza viruses (such as those on erythrocytes, and the cells lining the respiratory tract of the mouse or the allantoic cavity of the chick embryo), when treated with appropriate amounts of periodate, still adsorb virus; but spontaneous elution does not occur nor can artificial liberation be induced by the 'receptor-destroying enzyme' of *V. choleræ*, an agent known to remove bound virus from normal receptors. On the basis of a detailed study, it was concluded that the substrate for the receptor-destroying enzymes of the virus or vibrio is altered by periodate ions without significant change in the adsorptive capacity of the receptor area, so that the contact of such treated cells with virus results in an irreversible receptor-virus combination[1]. In further experiments it was shown by four independent methods, both in mice and developing chick embryos, that despite 'modification' by periodate, infection takes place through such receptors; obviously, these conditions do not allow of any enzymatic action of the virus on the receptor substance[2]. The uptake of the particle adsorbed to the exoplasm of the future host cell is believed to be a process essentially similar to the phenomenon of colloidopexis.

Since the objection may be made that this mechanism is at work only on receptors previously modified by periodate, further experiments using heat-killed virus and normal receptors were carried out.

The allantoic fluid of living eggs was removed, and replaced by physiological sodium chloride solution containing a standard amount of active or heat-killed (30 min. 56° C.) Lee virus. At intervals ranging from 0 to 180 minutes, a potent receptor-destroying enzyme preparation was inoculated to remove virus still present at the surface of the cells. The fluids were harvested at the end of the fourth hour, and titrated for their agglutinin content. The experiment was repeated with eggs the allantoic lining of which had been killed by formaldehyde. The percentage of removable virus at different intervals is given in the accompanying graph.

In a second series of experiments, use was made of the fact that specific antibody combines with virus only outside the cell. The second inoculum in this case contained antiserum sufficient to neutralize the amount of virus—active or heat-killed—given in the first inoculum, and the drop in anti-hæmagglutinin titre served as a measure of virus present at the surface of the cells or in the fluid. The experiments were performed on normal, formolized and periodate-treated eggs.

From the graph it is clearly seen that both active and heat-killed viruses disappear from allantoic cavities with living cellular lining, irrespective of whether the receptors are normal or modified by periodate. In formolized cavities, that is, cavities lined with dead cells, all the virus is recovered. Obviously, the penetration by the virus of the cell membrane does not depend on the viability or enzymic activity of the infective particle, but only on the functional integrity of the host cell.



Percentage of recoverable virus (active and heat-killed) in allantoic cavities lined with living or dead cells

—— Untreated eggs, living; .... periodate treated eggs, living; - - - formolized eggs, dead.

□ active virus
■ heat-killed virus } receptor-destroying enzyme liberation technique

△ active virus
▲ heat-killed virus } antibody neutralization technique

Each point represents the average from 36 eggs

The 'enzyme-substrate combination hypothesis', recently reiterated by Hirst[3] on no better evidence than originally proposed[4], cannot be accepted in the light of the above findings. All Hirst's experiments to elucidate the mechanism of infection were performed on non-living systems or on non-host cells, the strongest proof in favour of his assumptions being the momentary lack of contradictory evidence.

The above results, taken together with the fact of influenza infection through periodate-modified receptors, suggest a different mechanism. Specific adsorptive combination between the cellular 'receptor area' and the viral 'combining area' ('B-spots' in the terminology of Burnet[5]) is followed by the ingestion of the infective particle. This phenomenon strongly recalls the uptake by cells of colloidal dyes, and may therefore be termed 'viropexis'. Enzymic activity and destruction of receptors—formerly postulated as prerequisites for the penetration of the virus into the interior of the host cell—do not seem to be essential, though possibly the invariable occurrence in natural infections with enzyme-possessing viruses.

S. FAZEKAS DE ST. GROTH

Walter and Eliza Hall
Institute of Medical Research,
Melbourne, N.2.
June 27.

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Polyploidy in Bacteria?

IN the course of experiments on the bactericidal action of X-rays on the *R* and *S* phases of *Escherichia coli*, it was found that the survival-rate in three stocks (76, 111, *Ida*), irradiated twenty-four hours after seeding, was different[1]; one of them (stock *Ida*) was more resistant to the radiation as compared with the other two stocks. No significant differences were found between *S* and *R* phases of the same strains. According to the hit-theory of biological effects of radiation the survival-rate is a measure of the target volume, which has been assumed to represent the bacterial 'nucleus'[2,3]. If in the case of bacteria the so-called nucleoplasmic ratio of plants and animals holds true, and if, on the other side, the target volume obtained from X-ray experiments really represents the size of the bacterial 'nucleus', one would expect the size of the bacterial cells to be correlated to the target volumes. A biometric analysis of twenty-four hours old bacteria, carried on the projected images of photomicrographs of bacteria stained with Henrici's Congo Red method[4], has shown that *E. coli* with a larger target volume are larger than the ones with smaller target volume. The variability curves obtained for the three stocks were almost normal, and the differences found between their means were statistically significant. It is suggested that such correlation might indicate the presence of polyploidy among different stocks of the same bacterial species, as it has previously been found in other organisms. A detailed description of such experiments will be published elsewhere.

A. BUZZATI-TRAVERSO
N. VISCONTI DI MODRONE

Department of Biophysics of the
National Research Council,
Pallanza (Novara), Italy.

L. L. CAVALLI

Istituto Sieroterapico Milanese,
Serafino Belfanti,
Milano, Italy.
May 18.

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Occurrence of *Talorchestia brito* on the Coast of Northumberland

Talorchestia brito was originally described by Stebbing in 1891 from specimens collected on the north Devon coast[1]. No further records of its occurrence on the coasts of Britain can be found, though, according to Chevreux and Fage[2], it has been recorded from a number of scattered points on the Continent from the eastern English Channel to the western Mediterranean. It has now been found about three hundred miles north of any previous record near Blyth, Northumberland, being moderately common between high-water neap and high-water spring tides in the coarse sand to the south of the town. The species appears to be restricted to this stretch of about two miles, and has not been found on any other sandy beach in Northumberland or north Durham.

On July 6, 1948, the population of *T. brito* consisted of adults, including females carrying eggs, and recently hatched young. *Talitrus saltator* was also present, but was much less abundant.

DONALD I. WILLIAMSON

Department of Zoology,
King's College,
Newcastle-upon-Tyne, 1.
July 16.

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[1] Stebbing, T. R. R., *Ann. Mag. Nat. Hist.*, (6), 8, 324 (1891).

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Laminaria ochroleuca De La Pylaie Growing on the Coast of Britain

ON April 10, 1946, a *Laminaria* plant, trawled in Plymouth Sound and brought into the Plymouth Laboratory by Miss M. F. Sutton, Department of Biology, Chelsea Polytechnic, was identified by me as *Laminaria ochroleuca* De La Pylaie, a species of *Laminaria* that had not previously been recorded from the coasts of Britain. As trawling over the same ground on subsequent days failed to procure further plants of this species, the record was not published. A recent survey, however, has shown that this species occurs quite frequently in the more sheltered parts of Plymouth Sound. It is found on rocky ground from just below, down to eight metres below, low water spring tides, growing usually with *L. cloustoni* Edmondst. or *Saccorhiza bulbosa* De La Pylaie.

L. ochroleuca can be distinguished at any time of the year from *L. digitata* (L.) Lamour. and *L. cloustoni* Edmondst. by the colour of the base of the frond, which is always whitish-yellow, and by the smooth stipe which contains mucilage canals in the outer layers. During the spring and early summer, when frond growth is very rapid, the whole frond is a pale yellowish-brown; but during late summer, autumn and early winter, when growth is slower, the distal part of the frond becomes darker, the distinguishing whitish-yellow colour being noticeable only at the base.

L. ochroleuca (= *L. lejolisii* Sauvageau, *L. pallida* (Grev.) J. Ag. var. *iberica* Hamel, *L. iberica* (Hamel) Lami) is recorded from the western Mediterranean and from the north-eastern Atlantic. On the French side of the Channel it is recorded at localities from Finistère to Cotentin. There are also records of its occurrence in the Channel Islands.

Dr. Robert Lami, of the Muséum d'Histoire Naturelle, Paris, who has worked on the distribution of this species on the French coast[1], informed me in 1945 that he thought this species might have 'crossed the Channel' and invaded the south coasts of England and Ireland because of its abundance on the coast of Brittany. Plants up to five years old are now present in Plymouth Sound; but it is not known how long this species has been there. It was almost certainly not present up to 1900, otherwise it would have been recognized and recorded by Prof. T. Johnson[2], who made an intensive study of the marine algæ of Plymouth Sound during 1885–1900. I would, therefore, be grateful for any records of the occurrence of this species on the coasts of Britain, so that its distribution or its rate of migration can be followed.

Mary Parke

Laboratory, Citadel Hill,
Plymouth. July 17.

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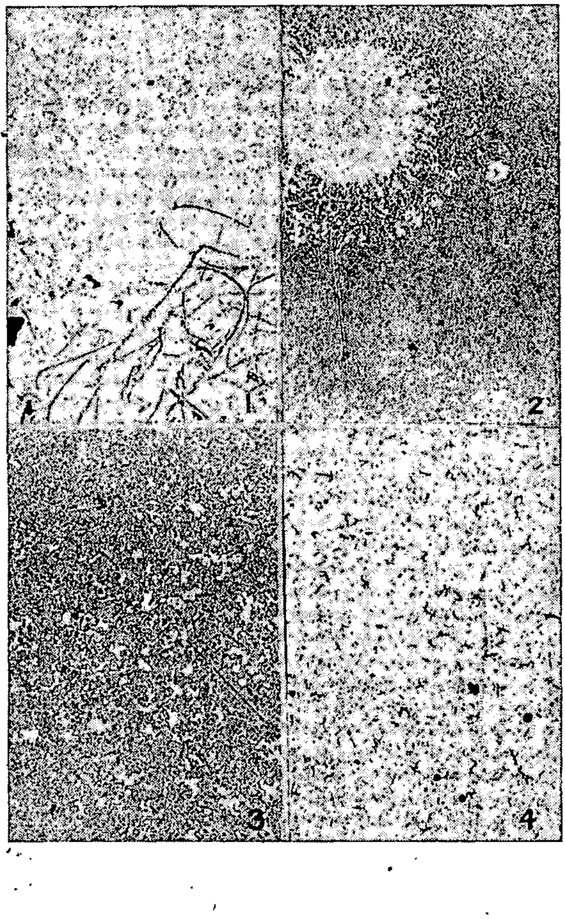
[2] Johnson, T., *J. Mar. Biol. Assoc.*, 1, 286 (1900).

Insecticidal Power and Microscopical Structure of Residual Films of Benzene Hexachloride

In some recent experiments with samples of the γ-isomer of benzene hexachloride (1,2,3,4,5,6-hexachlorocyclohexane), in which adult beetles of *Dermestes maculatus* Deg. were tested on residual films prepared on glass plates by a recently devised method[1], it was found that in films formed from chloroform solutions, a certain sample of 'technical' grade material (I) was more insecticidal than the corresponding 'refined' sample (II) and 'refined' (III) and 'technical' (IV) samples of different manufacture. These unexpected observations were the reverse of those obtained by other investigators testing the same samples by different methods[2]. Furthermore, when residual films of the insecticides in a light, refined paraffin spray oil were prepared and tested in this laboratory, samples (II) and (III) were at least as toxic as (I).



A microscopical examination of the chloroform films showed that those prepared from sample (I) were different from the others. After a few hours films of (II), (III) and (IV) had crystallized (Figs. 2, 3 and 4), whereas those of (I), prepared at the same time, under the same conditions, had not: the film was present in the form of discrete globules (Fig. 1, upper). These globules crystallized after insects had walked on them (Fig. 1, lower). Unfortunately, because of the high volatility of benzene hexachloride and the resulting short life of the films, it has not so far been possible to obtain crystals in chloroform films of (I) in any other way. Examination of residual films resulting from light paraffin solutions, where crystallization was considerably retarded in every case, showed that films of samples (I) and (IV) were most retarded.

It is of interest to compare these observations with those of Parkin and Green[3], who found, however, that crystallization of globule films of D.D.T. resulted in increased toxicity.

At this juncture no full explanation of my observations can be offered. It seems reasonable to suggest, however, that the unexpectedly high toxicity of sample (I) is not entirely due to an impurity, but may be associated with traces of chloroform retained by the film. The matter is being further investigated.

Thanks are due to Dr. R. A. E. Galley for supplying information, and to the Council of this Research Association for permission to publish.

A. J. Musgrave

British Leather Manufacturers'
Research Association,
1–6 Nelson Square,
London, S.E.1.
June 17.

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Synthesis of *l*-Sparteine

In view of the synthesis of *dl*-sparteine reported by Leonard and Beylen[1], we wish to place on record that some time ago we effected the reduction of *l*-oxysparteine to *l*-sparteine by treatment with lithium–aluminium hydride. Full details of this work will be published elsewhere in due course.

Since the total synthesis of *dl*-oxysparteine[2], the resolution of *dl*-lupanine[3], the transformation of this and its *d*-component into *dl*- and *l*-sparteine respectively[3,4] and the oxidation of *dl*-sparteine to *dl*-oxysparteine[4] have been accomplished in these laboratories, the structure of *l*-sparteine is now completely established.

G. R. Clemo
R. Raper
W. Short

University of Durham, King's College,
Newcastle-on-Tyne. July 19.

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Testicular Hypoplasia and Epididymal Cysts in the Syrian Hamster

We have observed certain definite changes in the testes of some inbred hamsters. These changes are characterized by a striking testicular hypoplasia, mostly bilateral. Such testes, represented sometimes by structures which are almost invisible to the naked eye, appeared very pale, with an apparent lack of normal vascularization. Their individual weight was only 2–306 mgm., as compared with a testicular weight of 0·900–1·400 gm. in the normal hamster. However, we have observed fertile animals the individual testes of which weighed only 0·580 gm. The hamsters with bilateral hypoplasia were, without exception, sterile. On the other hand, the animals with unilateral hypoplasia proved to be fertile. No relationship was found between the hypoplasia and the growth-rate or mature weight of the animals. Although we have also observed hypoplasia of the ovaries and sterility in some females, our data in this respect are inconclusive.

In the epididymi of some inbred and outbred hamsters we have encountered single and multiple cysts, histologically connected with the epididymis itself. Such cysts, of a yellow colour and of a sterile content, varied greatly in size: they varied from the size of a very small pearl to that of a normal hamster testis. In some animals these cysts were found in both epididymi, although most of them were unilateral. Most of the cysts were found in the tail, although a few of them occurred in the head of the epididymis. Most of them contained mainly spermatozoa.

Through the study of the reproductive capacity of hamsters with normal testes but with epididymal cysts, unilateral or bilateral, in some cases making use of surgical ligatures, we observed that the cysts impaired the fertility of the animals only when they were of considerable size, especially when such cysts were located near the beginning of the ductus deferens. This shows that these cysts can produce sterility only by mechanical blocking of the normal passage of the spermatozoa through the epididymis.

In a few cases we have also observed another kind of cyst, the contents of which are devoid of spermatozoa. They are small, yellow formations, usually flattened, round or ovoidal. These cysts are found either free, in the neighbourhood of, or loosely connected to, the tail of the epididymis.

The testicular hypoplasia was observed only in a group of inbred hamsters. They were of different age, 92–240 days, and under different dietary regimes. The epididymal cysts, found in both inbred and outbred animals, were observed mostly in very mature hamsters, 220–240 days of age. The cause of the hypoplasia seems to be of a hereditary nature, similar to that described by Lagerlöf[1,2] and Eriksson[3] in cattle. A complete report with a histological study is being prepared.

HUMBERTO GRANADOS
HENRIK DAM

Department of Biology,
Polytechnic Institute,
Østervoldgade 10 L,
Copenhagen.

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Isophosphorylase

Both pure potato phosphorylase[1] and crystalline muscle phosphorylase[2] produce from glucose-1-phosphate a non-branched polysaccharide containing only α-1,4-glucosidic links and resembling amylose. By the action of extracts of yeast[3], of heart, brain or liver[4], branched polysaccharides are obtained containing up to 10 per cent of α-1,6-glucosidic linkages and resembling glycogen. In 1942, Meyer and Bernfeld[5] reported the presence of an enzyme in yeast which brings about the phosphorolysis of the terminal α-1,6-glucosidic links of residual dextrin (the final degradation product of amylopectin by β-amylase). A purified potato phosphorylase was not able to effect this reaction. It was therefore concluded[5] that there are two different phosphorylases, one of which effects the fission or synthesis of α-1,4-glucosidic links, the other the α-1,6-glucosidic links involved in branching. Cori[6] has found an enzyme in liver extract and also in heart extract which he calls the 'branching factor', and which is able to produce glycogen by simultaneous action with the crystalline muscle phosphorylase. Haworth, Peat and Bourne[7] have described a thermolabile factor which they term the '*Q* enzyme' and to which they attribute the property of synthesizing the α-1,6-glucosidic links in amylopectin. Their '*Q* enzyme' has, in addition, an amylatic action.

We have now succeeded in finding also in potato extract an enzyme which, in the presence of inorganic phosphate, renders residual dextrin accessible to β-amylase attack (see Table 1).

Table 1. Simultaneous action of potato extract and β-amylase on residual dextrin

Addition of potato extract	Degradation by β-amylase	
	Phosphate present	Phosphate absent
Without	0 per cent	0 per cent
With	25 ,,	5 ,,

We have been able to show that, in the presence of phosphate, this same enzyme converts amylose to amylopectin and even to glycogen by simultaneous action with potato phosphorylase (see Table 2). No conversion takes place in the absence of inorganic phosphate.

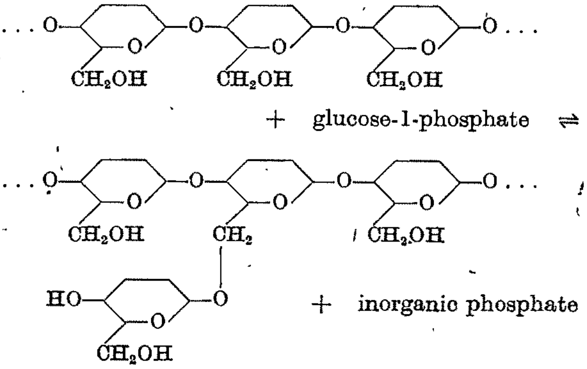
Table 2. Simultaneous action of potato extract and potato phosphorylase on corn amylose

Time in hours	Phosphate present 1·35 P/amylose*		Phosphate absent less than 0·01 P/amylose*	
	Iodine coloration	Conversion limit by β-amylase[8]	Iodine coloration	Conversion limit by β-amylase[8]
0	blue		blue	
24	violet		blue	
72	purple		blue	
144	purple	65%	blue	100%

* Mols of phosphate per glucose equivalent of amylose.

The results given in Tables 1 and 2 show that potato extract contains an enzyme capable of catalysing the phosphorolysis of α-1,6-glucosidic links and equally of their synthesis. We propose to call this enzyme 'isophosphorylase'.

Meyer and Bernfeld[5] have shown that potato phosphorylase only brings about the fission of α-1,4-glucosidic links which are proximate to terminal non-reducing groups. This has been confirmed quite recently by Katz, Hassid and Doudoroff[9]. We have found that isophosphorylase does not attack linkages in the interior of the molecule, and in this respect behaves like phosphorylase, as the viscosity of a starch paste is not reduced in the presence of isophosphorylase. The reversible catalytic effect of isophosphorylase may therefore be schematically represented as follows:



Furthermore, the behaviour of isophosphorylase with regard to the viscosity of starch paste proves the absence of any α-amylatic action in our preparations, which are thus distinct from the '*Q* enzyme' of Peat, Bourne and Barker[7].

We are indebted to Prof. K. H. Meyer for his interest in this investigation.

P. Bernfeld
A. Meutémédian

Laboratory of Inorganic and
Organic Chemistry,
University, Geneva.
April 22.

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Astaxanthin in Insects and Other Terrestrial Arthropods

In a very interesting note on the carotenoids of the locust integument, Goodwin and Srisukh[1] point out the presence of astaxanthin, besides other carotenoids, in *Locusta migratoria* and in *Schistocerca gregaria*. "The demonstration of astaxanthin in locust," they say, "is particularly interesting because, apart from its detection in the retina and eye colourings of birds, this is the first time it has been reported in land animals."

This statement is not quite exact. In 1939 I found this pigment in a mite of the genus *Trombidium*[2]. The pigment is completely extracted by acetone from the mite's body, transferred to petroleum ether and obtained, through evaporation of the solvent, as a red oily residuum (from 3 gm. of mites, 2 gm. of this oil). After saponification, the pigment is taken up again in benzene and after purification by chromatography gives crystals which are intensely violet to red violet under the microscope (2 mgm. of crystals). They give all the reactions characteristic for carotenoids and a peculiar absorption spectrum (a single band at 515 mμ in carbon disulphide and at 500 mμ in pyridine). This result and the chromatographic behaviour and solubility indicate undoubtedly astaxanthin. It is quite probable that this pigment is not infrequent in insects and in other arthropods.

Last year I found a pigment of a similar kind in the potato beetle (*Leptinotarsa decemlineata*). The benzene fraction of the carotenoid pigment gives, with benzene at 70–80°, an orange-yellow zone that splits up in two zones: an epiphasic one, rose-yellow, consisting of β-carotene; an epiphasic one, that is progressing on the column very slowly, eluted with benzene at 70–80° which shows a rose-yellow colour, rose in carbon disulphide, with a spectrum showing one large band with maximum near 497 mμ[3,4]. This pigment looks like the carotenoid pigment that I extracted and crystallized from the fat of a *Phœnicopterus roseus*, the carmin-rose feathers of which perhaps owe their colour to this very pigment. This pigment, which I called 'phœnicoxanthin'[2], shows one adsorption band near 490 mμ in pyridine and differs from astacene both in the position of the adsorption band and in the different solubility and different colour in various solvents.

A full series of investigations is being planned in order to study the metabolism of carotenoid pigments in *Leptinotarsa* fed on various Solanaceæ.

C. Manunta

Istituto di Biologia e Zoologia Generale,
Università, Sassari,
Italy.

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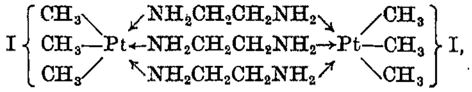
The Trimethylplatinic Group

Pope and Peachey[1] prepared diamminotrimethyl platinic iodide, $(CH_3)_3PtI(NH_3)_2$, readily soluble in alcohol, but sparingly soluble in water. We now find that pyridine added to trimethylplatinic iodide in benzene gives after concentration dipyridinotrimethylplatinic iodide, $(CH_3)_3PtI(C_5H_5N)_2$, m.p. 168°, without previous decomposition, and that similarly from all proportions of dipyridyl and trimethylplatinic iodide, dipyridyltrimethylplatinic iodide, $(CH_3)_3PtI$, dipy, is obtained, insoluble in water, but soluble in chloroform and acetone, m.p. 268–273°. It is apparently unchanged by boiling with dilute acetic acid, hydrochloric acid, ammonia or twice normal sodium hydroxide. It is, however, decomposed by ethylene diamine with formation of sesquiethylenediaminetrimethylplatinic iodide, $2(CH_3)_3PtI.3en$, which may be recrystallized from water. The latter compound can also be prepared from excess of ethylene diamine and trimethylplatinic iodide in benzene. Its structure is probably:



$$\mathrm{I}\left\{\begin{array}{l}\mathrm{CH_3}\searrow \quad \swarrow\mathrm{NH_2CH_2CH_2NH_2}\searrow \quad \nearrow\mathrm{CH_3}\\ \mathrm{CH_3{-}Pt \leftarrow NH_2CH_2CH_2NH_2 \rightarrow Pt{-}CH_3}\\ \mathrm{CH_3}\nearrow \quad \nwarrow\mathrm{NH_2CH_2CH_2NH_2}\nearrow \quad \searrow\mathrm{CH_3}\end{array}\right\}\mathrm{I},$$

recalling that of iron enneacarbonyl[2]. On refluxing ethylenediamine with excess of trimethylplatinic iodide in benzene, trimethylplatinicmonoethylenediamine iodide, m.p. 204° with decomposition, is obtained. Both ethylenediamine compounds are soluble in water. All four compounds, as also the stable association of trimethylplatinic acetylacetone into double molecules[3,4], are examples of the familiar stability of 6-covalent compounds of quadrivalent platinum.

Less easily classified is the compound obtained from trimethylplatinic acetylacetone or from dipyridyltrimethylplatinic iodide by treatment in benzene with dipyridyl or thallous acetylacetone respectively (m.p. 142–43°, separate and mixed). This compound gives good nitrogen figures for dipyridyltrimethylplatinic acetyl acetone. From a solution of the last-named compound in dilute aqueous acetic acid, dipyridyltrimethylplatinic iodide is precipitated by potassium iodide. The investigation of these and similar compounds is being continued.

The solubilities in water of trimethylplatinic halides, oxide and nitrate[1], closely resemble those of the corresponding silver salts. To use Grimm's expression[5], the trimethylplatinic group is a pseudo-atom of such a nature that other atoms or groups brought into its neighbourhood are frequently subjected to a field similar to that existing in the neighbourhood of a silver atom. We have been unable to find an explanation of this effect.

W. J. LILE
Bristol University, and
Mid-Essex Technical College and School of Art,
Chelmsford.

R. C. MENZIES
Universities of Bristol and Edinburgh.

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Glide Bands in Silver Chloride

As already reported[1], polycrystalline sheets of silver chloride show both sharp and diffuse bands of birefringence after plastic deformation. In addition to this effect, plastic deformation causes fine lines to appear on the surfaces of the sheets; these are similar to the glide lines seen on metallic surfaces which have been polished and then deformed. Examination under the microscope with oblique illumination makes it clear that they are steps. This conclusion is confirmed by using the 'shadow-casting' technique developed in connexion with electron microscopy. Measurements made with an optical microscope of the widths of the shadows cast by the steps show that the heights of the most prominent steps are of the order of 4000 A. It would appear, therefore, that the principal, and perhaps the only, mechanism of plastic deformation in silver chloride is glide. In this respect silver chloride differs from sodium chloride, which at room temperature becomes deformed mainly or entirely by kinking[2,3].

Some grains contain a system of birefringent bands with a series of surface steps running parallel to them. However, bands are frequently seen that are not accompanied by a parallel series of steps and, conversely, most surface lines do not run parallel to a system of bands. The connexion between the bands and the steps has been made clear by the following experiments. Rectangular bars of length 25 mm. and approximately square cross-section (1 mm. × 1 mm.) were recrystallized and large portions were found to consist of chains of single crystals joined up end to end. Plastic extension of these specimens produced the phenomena already observed in the sheets; but the true direction of a given set of glide planes could now be determined by measuring the direction of their traces on two non-parallel surfaces. In this way it was established that, whenever a set of glide planes is observed edgewise, sharp birefringent laminations become visible between crossed nicols. As the direction of observation becomes inclined to the glide plane, the boundaries of the glide packets become less sharp; the stress patterns in different glide packets overlap and their details are obscured.

The explanation of the characteristic appearance of deformed polycrystalline sheets may therefore be summarized as follows:

(*a*) Most of the grains in a severely deformed sheet contain two or more sets of operative glide planes.

(*b*) A set of glide planes produces steps on the surface, provided the direction of glide is not parallel to the line of intersection of glide plane and surface.

(*c*) The lamellæ which lie perpendicular to the surface give sharp birefringent bands; other lamellæ give diffuse bands or irregular patches of birefringence.

(*d*) Occasionally a single grain contains two sets of operative glide planes lying perpendicular to the surface. In such a case intersecting systems of birefringent bands are observed (Fig. 2 in ref. 1).

(*e*) In flat strips, either bent or extended by uniaxial tension, the stress system is such that the glide direction in planes lying perpendicular to the surface will tend to be parallel to the surface (at 45°, to the direction of the tension). This explains the frequent occurrence of birefringent band systems not accompanied by surface steps.

Experiments to determine the glide system in silver chloride had an interesting result. The orientations of a number of single grains in both sheets and bars were found by taking X-ray back-reflexion Laue photographs. The crystallographic plane of low indices lying nearest to the observed glide plane was not always the same. Out of six systems of glide bands observed in the bars, four were closest to {111} planes, but in the other two systems the closest plane was a {221}. Out of the eight sets of bands observed in plastically deformed sheets, six were closest to {111} planes and two closest to {112} planes. But in none of these cases was there exact coincidence between crystallographic plane and glide plane; the angle between them had an average value of 4·2°, and in one case was as much as 8·1°. This is far greater than the error of the determination (estimated at ± 1·5°). In spite of its non-crystallographic orientation, however, the glide plane was, in all cases except one, found to contain a [110] direction. This behaviour is reminiscent of that discovered in iron by Taylor and Elam[4] in which only the glide direction, [111], is fixed crystallographically, the glide plane being dependent on the stress distribution.

In the tensile experiments on bars of silver chloride, the [110] direction lying in the glide plane was always that one of the six equivalent [110] directions which lay most nearly at 45° to the direction of the tension, or, if there were two glide systems in the same grain, the two [110] directions nearest to the 45° position were selected. Moreover, the glide plane was never more than 9° away from the plane of maximum resolved shear stress containing this favourable [110] direction. This evidence strongly suggests that at room temperature silver chloride becomes deformed by 'pencil glide'[4] in the [110] direction. In iron crystals, pencil glide is connected with the fact that at room temperature the critical stress for glide is the same on three different crystallographic planes, all containing a common glide direction. It seems that this process has not been observed until now in any other crystals. A pencil glide can easily spread from one grain to its neighbour, and this explains the frequent occurrence in the silver chloride sheets of slip lines continuing across grain boundaries.

In single crystals of silver chloride extended by simple tension, Stepanow[5] found glide on planes within 5° of {110} in a [110] direction. This result is in agreement with the conclusions reached above, for in Stepanow's experiments the crystals happened to be prepared with a {100} plane perpendicular to the axis of tension and, under these special conditions, the glide elements to be expected on the present theory are just those that he reported.

J. F. Nye

Cavendish Laboratory,
Cambridge.
April 30.

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Thickness and Height of the Sodium Layer Responsible for the Strong Yellow Line in Twilight

In a communication in *Nature*[1] in 1940 I gave a short account of results of investigations on "The Atmospheric Layer from which the Yellow Line in Twilight Originates". From a series of spectrograms from the zenith followed by one from near the horizon, the effective screening height (H_s) of the atmosphere and the upper limit (H_u) of the effective sodium layer were determined. Since then, the results of extensive series of observations from Oslo and from the auroral observatory at Trömso have been published[2,3].

All observations give nearly the same value of (H_s) and (H_u). The mean values were found to be $H_s = 49$ km. and $H_u = 110$ km. The results lead to the conclusion that ultra-violet radiation in the region near 2,500 A., strongly absorbed by ozone, is essential for the excitation of the sodium line in twilight.

Photometric measurements of the intensity of the line for successive twilight spectrograms show that as a rule the intensity keeps nearly constant until it suddenly falls to a lower order of magnitude in the course of a short time (Δt), when the shadow produced by the screening layer leaves the upper limit (H_u). If the sodium layer had been evenly effective throughout the whole interval ($H_u - H_s$), the intensity should have decreased gradually during the time it takes for the effective shadow limit to pass from H_s to H_u.

It is therefore legitimate to conclude that the effective sodium layer is restricted to a thin layer, and that the sudden drop of intensity of the D-line begins when the shadow reaches the lower limit of this layer.

Using the zenith observations, the thickness (ΔX) of the layer is given by the formula:

$$\Delta X = (R + H_s) \cos \varphi \frac{\sin h}{\cos^3 h} \cos \delta \sin t \, \Delta t,$$

where R is the radius of the earth, and h, δ and t the height, declination and hour angle of the sun. The value of ΔX has been calculated for twenty series of observations taken at Oslo between October 1942 and April 1943.

The values found for ΔX vary between 8·4 km. and 27·6 km., with an average of 16·2 km. The fluctuations are greater than the possible errors and are, no doubt, to a certain extent real. The values indicate a minimum in December and January and maxima in the autumn and spring. A regular annual variation of H_u and H_s has not yet been found. On an average the sodium layer effective in producing the strong D-line in twilight seems to cover a height interval from about 90 to 110 km.

L. Vegard

Physical Institute, University,
Oslo.
April 19.

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Treatment of Paper with Silicon Esters

During an investigation of the possibility of cross-linking nitrocellulose molecules in solution with silicon esters[1,2], some experiments were also made with cellulose itself in the form of filter paper or unsized kraft paper.

The silicon esters used were tetramethyl, tetraethyl and a polymer ethyl ester (boiling range 210–360°). In a first series of experiments, ordinary filter papers (11 cm. diameter) were exposed to vapours of silicon esters at high temperatures and afterwards placed in a funnel, which was then filled with water. Treatment with ethyl ester for 16 hr. at 120° produced a filter paper which was completely impermeable to water for 11 hours. In a second series of measurements the treatment was made with liquid esters instead. Papers which had been immersed in polymer ethyl ester for 4–66 hr. showed a regularly increasing impermeability against water, improving from 1 to 50 hours. Unsized kraft paper gave similar results, whereas experiments with sized paper of different kinds were unsuccessful.

The wet strength of treated unsized kraft paper was three to seven times larger than that of untreated paper. In order to get the treated papers completely wetted, it was necessary to keep them immersed in water for about one week.

It is also possible to carry out the treatment in such a way that no water repellency is observed but a considerable increase in wet strength is obtained. These experiments were made with very thin filter papers known as 'Stilex' (used in the filtration of milk). Their wet strength is very low. With liquid methyl ester we observed in five different experiments increases in the wet strength compared with untreated paper of 16–19 times.

It was also observed that treated filter papers are very resistant towards alkaline solutions. It is possible to filter 10–45 per cent sodium hydroxide.

The water-repellency effect is probably of the same nature as that observed by treating paper or other materials with silicones[3,4,5]. The increase in wet-strength, on the other hand, is very likely caused by cross-links of silicon atoms formed between the cellulose chains.

Further details will be published elsewhere. I wish to express my thanks to Prof. The Svedberg for his interest in the work. I am also indebted to Dr. Ragnar Winbladh for including this investigation among the research projects of Centralbolaget.

INGVAR JULLANDER
Institute of Physical Chemistry*,
Uppsala.
Centralbolaget för Kemiska Industrier, AB,
(Associated Chemical Industries, Ltd.),
Stockholm.

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* Present address: Research Laboratory, Mo och Domsjö Co., Örnsköldsvik, Sweden.

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Electrical Breakdown of Organic Insulation by Electro-chemical Reactions

RECENT work on impregnated cellulosic insulating materials has shown that electrical breakdown under moderate D.C. stress is normally of an electrochemical nature. Leakage current is conveyed by ions originating from slight dissociation of the insulating material or from traces of impurities such as moisture or organic acids. The ions on discharge at the electrodes are in a chemically highly active (nascent) condition and may attack the insulation. The attack at the cathode is by nascent hydrogen and, with some forms of insulation, this has serious consequences.

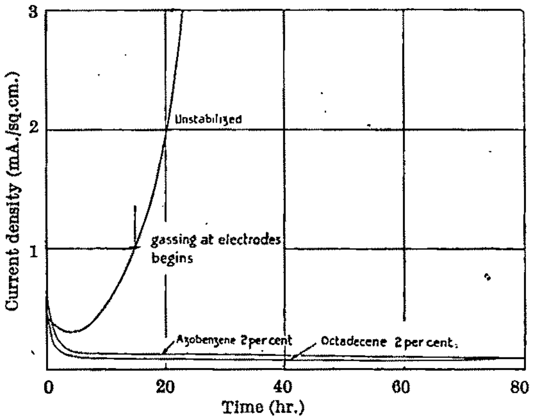
For example, when chlorinated hydrocarbons form part of a dielectric, cathodic reduction leads to release of hydrogen chloride, which itself dissociates in the dielectric, and may result in cumulative increase in current density and chemical attack upon the electrodes or other components of the dielectric.

Egerton and McLean[1] and Berberich and Friedman[2] have shown that the rate of deterioration of capacitors having a dielectric consisting of paper impregnated with a chlorinated hydrocarbon is decreased by the addition of small amounts of the following compounds: quinones, certain nitro-aromatic compounds, maleic anhydride, sulphur, aromatic azo-compounds and benzil. The action of these materials is known as 'stabilization' and has been attributed to formation of a protective film upon the electrodes[1] or a co-ordination complex between the stabilizer and aluminium chloride produced during the deterioration[2]. It is here suggested that a more likely mechanism is that the stabilizer combines preferentially with the cathodically produced hydrogen, without formation of harmful secondary products, thus shielding the dielectric medium from attack.

The experimental evidence in favour of the latter theory is as follows.

(1) All the substances listed as stabilizers are readily capable of reduction, and electrolytic reduction is found to take place under suitable conditions. Thus, we have found that when capacitors which have been stabilized with anthraquinone are opened after use under D.C. stress, under conditions which prevent reoxidation, the reduction product, oxanthranol, is produced. The same substance is found at the cathode on electrolysing acidified alcohol containing anthraquinone. Azobenzene is similarly reduced to hydrazobenzene.

(2) Trichlorbenzene – alcohol mixtures containing a little moisture, when electrolysed at room temperature, increase rapidly in conductivity, with formation of hydrogen chloride, after an initial induction period. Addition of a stabilizer greatly increases the induction period, irrespective of whether aluminium, tin or platinum electrodes are used. Mean conductivity – time curves using platinum electrodes are shown in the accompanying diagram.



Electrolysis of trichlorbenzene – alcohol mixture (50/50 vol. + 2 per cent water) with and without addition of azobenzene or octadecene using platinum electrodes. Stress, 150 volts (D.C.) per cm.

(3) Paper dielectric capacitors impregnated with chlordiphenyl are capable of stabilization, even when made with platinum electrodes. The lives of such capacitors have been extended more than ten times by the addition of azobenzene or octadecene.

(4) Readily hydrogenated aliphatic hydrocarbons, for example, octadecene (see (2) and (3) above), are effective stabilizers. Compounds of this type have not previously been cited as stabilizers and were investigated because of their unsaturated character and ease of hydrogenation.

It can be predicted that any readily reducible compound will stabilize, provided that neither it nor its reduced form appreciably ionizes in solution in the insulating material.

A detailed account of this work will appear elsewhere and further work is in progress.

H. F. CHURCH
C. G. GARTON
British Electrical and Allied Industries
Research Association,
5 Wadsworth Road,
Greenford, Middlesex.

June 23.

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Beta Spectrum of Tritium

THE β-spectrum of tritium (${}_1\mathrm{H}^3$) is of particular interest because: (1) the relatively simple structure of the ${}_1\mathrm{H}^3$ nucleus makes it well suited to a test of the Fermi theory of β-decay; (2) the unusually low energy of the β-particles means that the shape of the spectrum near the upper limit is an extremely sensitive function of the rest mass of the neutrino if the Fermi theory is confirmed; (3) a theoretical discrepancy[1] exists between the half-life[2] and the upper energy limit, as recently measured[3]; (4) the mass difference (${}_1\mathrm{H}^3 - {}_2\mathrm{He}^3$) can be accurately determined.

We have developed a new technique for rapid and accurate detection and energy measurement of β-rays, conversion electrons, γ-rays and X-rays (including *K*-capture radiation) from weak sources. The method, applicable to radiations of energy of 0·5–150 keV., uses a proportional counter, containing an argon – methane mixture at a pressure of one atmosphere or more, connected to a linear amplifier of high gain. The output pulses are applied to the deflecting plates of a cathode ray tube and recorded by a moving-film camera. The size of the pulses is a true relative measure of the energy of the ionizing radiation involved, provided that the range of the ionizing particle within the counter is small compared with its dimensions. The histograms of such pulses show that the resolving power of the apparatus is very good.

Radiation of known energy is used to calibrate the apparatus; for example, the fluorescence radiation of copper has been found to be very suitable. The counting system has been checked over the range 6–50 keV. with radiation from radioactive sources and with X-rays, and very good agreement with known values was obtained. The large Auger effect in argon[4] ensures that practically the whole energy of a photon is converted into the kinetic energy of the photo-electrons which it releases from the gas.

The amplifier gives a measurable pulse about three times the peak noise voltage for a charge of 1,500 electrons at the first grid. Thus, with a gain in the gas of as little as 100—ensuring strict proportionality—a measurable pulse is secured from the formation of 15 ion pairs; the system, therefore, can readily measure electron energies down to 500 eV.

Fig. 1 gives a typical calibration spectrum of the fluorescence X-radiation of copper, showing the *Kα* and *Kβ* groups clearly resolved. The counter contained sufficient tritium gas to give about 5,000 counts per minute, and the X-radiation is superimposed on part of the ${}_1\mathrm{H}^3$ β-spectrum; the distribution shows that a pulse size of 47·5 units (arbitrary scale) corresponds to the *Kα* groups of copper, taken[4] as 8·01 keV. Fig. 2 shows the tritium spectrum for the range 1–18 keV. taken under the same conditions. The background, about 15 counts per energy interval, has been subtracted and the energy scale set up according to the above calibration; about 40,000 pulses are analysed. The upper limit is found to be 16·9 ± 0·3 keV., which is considerably higher than a recent estimate[3] of 11 ± 2 keV.

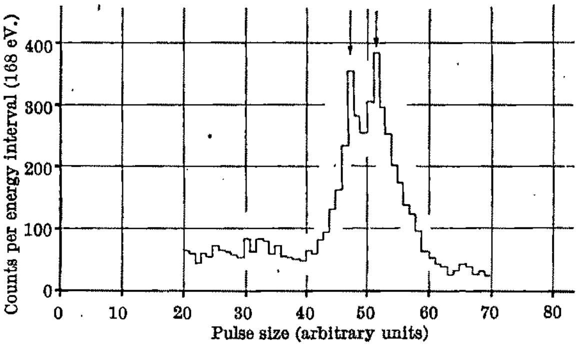

Fig. 1

The calculated Fermi distribution for ${}_1\mathrm{H}^3$ of end-point $\sim$ 17 keV. shows a maximum at about 2 keV.: a maximum appears on our experimental curve near 2·5 keV., but we find that it is definitely rather wider than the maximum of the theoretical curve. We have made various experimental tests which confirm that the shape at low energies is not due to absorption of hydrogen by the wall with consequent loss of range of the emergent electron. The radioactive gas could be pumped off readily and completely, and the shape of the spectrum was found to be independent of the ratio of surface to volume for the counter. Taken with two cylindrical counters of effective lengths 12 cm. and 4·5 cm. and diameters 6·7 cm. and 2 cm. respectively, the results were identical within experimental error. The histograms given here were obtained with the larger tube. The range of the most energetic electrons of ${}_1\mathrm{H}^3$ is negligible compared with the dimensions of this counter. It seems certain that in this work the departure from agreement with Fermi at low energies cannot be ascribed, as in a number of previous spectrographic investigations with other sources, to the ordinary limitations, in particular the thickness and support of the source and the absorption at the window of the detector. This disagreement may be rather important in view of the relative simplicity of the Fermi theory for the light nucleus ${}_1\mathrm{H}^3$.

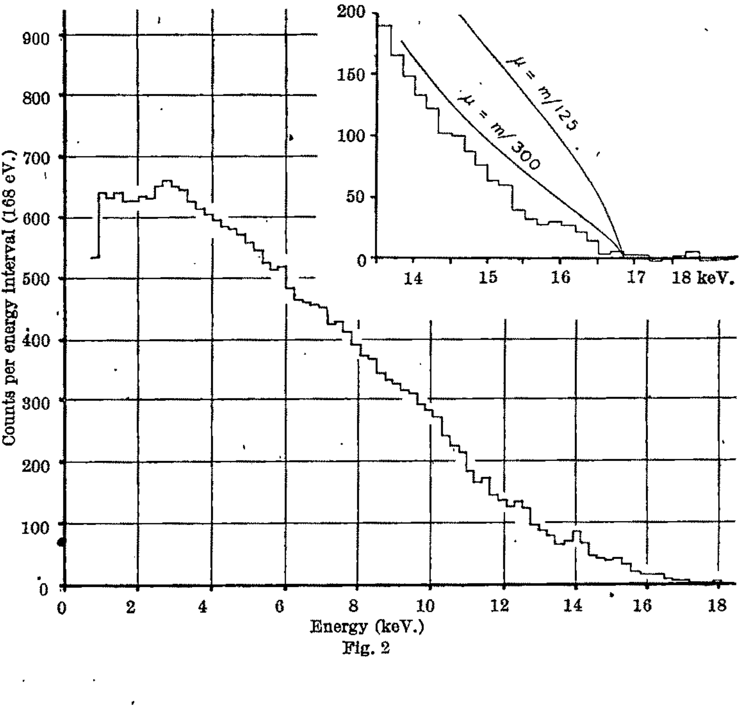

Fig. 2

We have considered the possibility of the spectrum being complex, but its shape seems to rule out such an explanation. The detector is such that γ-rays following emission of β-particles of a hypothetical softer group would have given rise to a readily observable discontinuity on our histograms, since the efficiency of detecting such γ-rays would be ~ 25 per cent. The life-time of the excited state of $_2He^3$ would have to be appreciably greater than the life-time of $_1H^3$ to escape detection.

In view of the above considerations, it is possible to justify the application of neutrino theory to the upper end of the spectrum in the usual manner. However, we have shown in the inset figure two curves calculated for neutrino masses $\mu = m/125$ and $m/300$, and comparison of these with experiment seems to indicate that μ is less than $m/300$.

Since there is no evidence of γ-radiation following the β-emission, we can write the mass equation (atomic) as

$$_1H^3 - {}_2He^3 = 0{\cdot}000018.$$

It is a pleasure to thank Prof. P. I. Dee for his valuable advice throughout the work. We are grateful to Mr. B. Touschek for elucidating various theoretical points.

S. C. CURRAN
J. ANGUS
A. L. COCKCROFT
Department of Natural Philosophy,
University of Glasgow. May 21.

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Velocity of Photons

I AM seeking an answer—or a reference to an answer—to an apparent paradox arising out of the theory that light is transmitted in the form of photons, which may be illustrated by the following concrete example.

Atoms of sodium on Sirius, vibrating so as to give out a definite spectral line, send out photons each of which contains the amount of energy ($h\nu$) corresponding to such vibration. These photons, therefore, are identical in all respects, since their energy content is dictated solely by local conditions and clearly cannot be influenced by what may be their ultimate targets, if any. Two such photons are directed towards the solar system, and one arrives at the earth which is approaching Sirius at 30 miles per second, and the other on Mars which happens to be receding from Sirius with the same velocity. What physical factor causes these photons to give different optical effects since (*a*) their internal energies are identical, (*b*) their speeds are also identical, since they arrive at their targets with the velocity (absolute and relative) of light, which is independent of the motions of source and observer ?

I have searched in vain for any explanation of the Doppler effect which recognizes (*a*) that light moves in the form of photons, and (*b*) that the velocity of the photons is independent of that of their source.

Personally, I can see no answer to this query unless the theory as to the travel of light in the form of photons is profoundly modified.

H. FLETCHER MOULTON
King's Bench Walk, Temple, E.C.4.

Latitude Effect and Meson Decay

IT has been pointed out recently[1] that the height of the atmospheric layer (100 mb.) in which most mesons are supposed to be produced decreases from the equator towards the poles. The decay of the mesons causes a corresponding increase in cosmic ray intensity.

A first calculation of this effect based on a decay constant[2,3] $L = 5$ km. seemed to indicate that the greater part of, if not all, the latitude effect might be explained thus. A more precise estimation of the 'atmospheric latitude of effect' as distinguished from the geomagnetic can be obtained as follows. The altitude of the 100-mb. level varies not only with geographic latitude but also with the seasons. It is assumed that the seasonal effect of cosmic rays as observed in latitudes where the geomagnetic effect is small, if not nil, is entirely due to these variations. This is called the 'atmospheric seasonal effect'. Further, the 'atmospheric latitude effect' is defined as the variations in cosmic ray intensity caused by the differences at different geographic latitudes in the yearly averages of the heights at which mesons are produced; all measurements having been reduced before to standard atmospheric pressure. The ratio of the two effects can be obtained by comparing the seasonal variation of the meson-producing layer with its average latitudinal variation between the equator and the latitude under consideration. The influence of a differing energy spectrum is neglected.

Measurements with shielded ionization chambers at sea-level[4,5] and tables and graphs of the altitude of the 100-mb. level[6,7] supply all the data required. These are tabulated in columns 1, 2, 3, 4.

1		2	3	4	5	6	7	8
Sydney	34° S.	0·20	2·0	1·3[4]	1·3	1·5	3·0	13
				1·1[5]	1·7			
Vancouver	50° N.	0·35	1·2	3·1[4]	3·1			
				1·2[5]	1·8	2·5	3·0	14

Column 2: Difference summer–winter of the height of the 100-mb. level in km. (dH).
3: Difference equator–40° lat. of same level divided by value of column 2.
4: Observed difference summer–winter as percentage of cosmic ray intensity.
5: Adjusted column 4.
6: Average of column 5 (dI/I).
7: Atmospheric latitude effect equator–40° lat. as percentage of total cosmic ray intensity, obtained by multiplying columns 6 and 3.
8: Decay constant L in km. obtained by dividing column 2 by column 6.

The values for some of the seasonal variations of cosmic rays have to be adjusted for the difference in the period over which they and the stratosphere data were averaged (column 5). The decay constant L was calculated from the relation $dI/I = - dH/L$, in which I is the cosmic ray intensity and H the height. Taking into consideration the wide differences possible in the measurements of the heights at times as well as localities far removed from the cosmic ray measurements, it is satisfactory to find that the results obtained for the decay constant lie within the range[8,9] of 9–19 km. of the most reliable determinations. In conclusion, it can be stated that the atmospheric latitude effect is about three per cent of the total intensity, that is, one third of the total latitude effect between the equator and the knee at sea-level. This reduction of the geomagnetic latitude effect, if confirmed, will require a revision of the energy spectrum of the primary cosmic rays.

The east–west effect, the nearly constant geomagnetic latitude of the knee, demonstrate also that a great part of the latitude effect is of magnetic origin.

When an attempt was made to obtain accurate corrected values for the geomagnetic effect alone, it was found that the necessary experimental data did not exist. The previously used temperature correction[4,5] presupposes at least a very high correlation between sea-level temperature and the altitude of the 100-mb. level, which is not proved. On the other hand, this correlation could mask a geomagnetic effect extending beyond the knee, the correlation between sea-level temperature and latitude being of the order of 0·9 and more.

The height of the meson-producing layer will depend not only on latitude and season but also on other local meteorological and geographical factors, distribution of land and sea, mountains and so on. To achieve a reliable and accurate correction, it is clearly necessary to obtain simultaneous cosmic ray and high-atmosphere data at the same locality. A new world-wide survey made under these conditions might reveal that some of the unexplained features of Compton's can be explained as a 'local atmospheric effect' and do not represent a variation in primary intensity.

Results obtained during the 1948 cruise of the *Wyatt Earp*, the ship of the Australian Antarctic Expedition, will be published shortly in the *Australian Journal of Scientific Research*. The measurements extend to within 200 miles of the magnetic south pole.

H. D. RATHGEBER

Physics Department,
University, Melbourne.
June 8.

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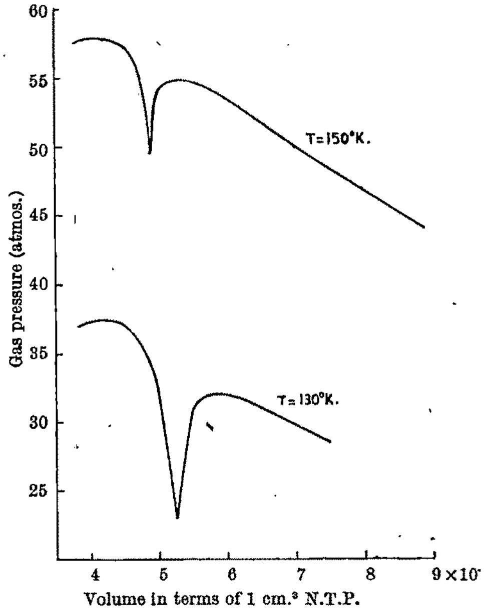
An Approximate Equation of State

IN a previous communication which appeared in *Nature*[1], Prof. Max Born and Dr. H. S. Green gave an account of a general kinetic theory of condensed matter (see also refs. 2–5). A new equation of state was derived which covers both phases, liquid and gas. Some numerical results (to be published in detail elsewhere) have now been obtained.

The theory shows that the difference between the liquid and the gas corresponds to the existence or non-existence of real roots of a certain transcendental equation. This was in the original form an integral equation, but has now been reduced, by using a suitable expansion, to an algebraic equation with a unique analytic continuation, so that the definition of the complex roots is unambiguous.

The theory of condensation developed by Mayer[6] and others[7,8] is confirmed by the present theory to the extent that a divergence of the cluster series is found, which is intimately associated with the process of condensation. Concerning the exact point at which this divergence occurs, detailed calculations do not confirm Mayer's contention that it happens at the density of the saturated vapour. The isotherm is continued into the metastable region above this density, rising to a maximum and falling to a subsequent minimum as the density is increased, much in the way foreshadowed by van der Waals more than fifty years ago. The point of divergence is fou to be at the minimum of this curve, which separa the metastable states of the liquid from those of t gas.

A numerical computation has been carried out argon using the Lennard-Jones[9] potential; t isotherms have been calculated, one for the empiri critical temperature ($T = 150°$ K.) and one for lower one ($T = 130°$ K.). The accompanying gra shows the result.



Concerning the absolute values, one can comp the experimental critical point with the situation the maximum in the gas region of the first cur The results are given in the table, for 1 cm.³ of at N.T.P.

	Experimental	Calculated
Pressure	50 atmospheres	54 atmospheres
Volume	0·0034 cm.³	0·0052 cm.³

A conspicuous feature of the curves is the f that for small volumes they do not ascend stee but have a maximum and fall again. This may due to the crudeness of the approximation actu employed (namely, only the first three roots of transcendental equation were taken into accou But it seems to be quite possible that it is an indi tion of another range of unstable states separat the liquid from the solid. This has to be investigat

Exact numerical prediction would need a gr amount of computation. It seems more import to use the same method for calculating the ra distribution function, which can be compared direc with X-ray experiments. This will be done i paper in due course.

ANTONIO E. RODRIGUE

Department of Mathematical Physics,
University of Edinburgh.

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ELECTRON OPTICAL OBSERVATIONS ON CHROMOSOME STRUCTURE IN RESTING CELLS

By FERNANDO CALVET*, BENJAMIN M. SIEGEL†, and DR. KURT G. STERN
Polytechnic Institute, Brooklyn, N.Y.

RESENT knowledge of chromosome structure is based chiefly on observations made on fixed prerations of large *mitotic* chromosomes or of the -called giant chromosomes in the salivary gland of rtain diptera with microscopes utilizing visible or tra-violet light[1]. A preliminary account has cently been published of electron microscope udies on large plant chromosomes[2]. Little or thing is known concerning the structure of chromomes in *resting* cells beyond the fact that they are esent in the form of exceedingly slender threads hromonemata) or of the so-called chromatin netork[3].

Following preliminary observations, made in our boratory in collaboration with Miss Judith hryver[4], we have studied in some detail the romatin structure present in the resting nucleus of lf thymus lymphocytes. An RCA ectron microscope of the universal pe, equipped with a self-biased ectron gun and an objective pole ece corrected for asymmetry[5], was ed in this work.

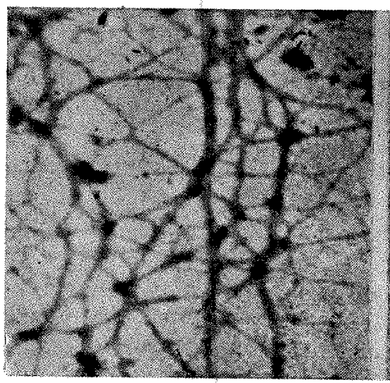

Fig. 1

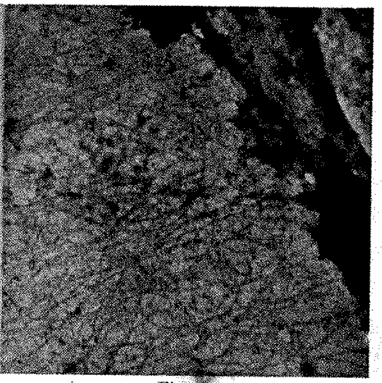

Fig. 2

Fig. 1. Chromatin network of thymus lymphocyte, prepared by rupture in high vacuum. Overall magnification, × 20,000

Fig. 2. Ultra-fibrils, obtained by lanthanum acetate treatment of chromatin network of thymus lymphocyte. Overall magnification, × 20,000

Pure suspensions of thymus lymphytes were obtained by mincing esh or frozen tissue under 0·9 per nt sodium chloride solution, straing the resulting milky suspension rough gauze, sedimenting the cells a centrifuge at low speed, and suspending them in physiological lt solution. The intact lymphytes have a diameter of approxiately 7 μ, while the nuclei measure 6 μ. Owing to their relatively ge size, the cells as well as the clei are opaque when examined rectly in the electron microscope. romium-shadowed replicas[6] prered from slowly dried, intact ymus lymphocytes show a *pitted* surface. Its pearance may, to some extent, reflect the undering structure of these cells, or it may represent artefact produced by shrinkage upon drying in high vacuum.

When the lymphocytes are ruptured by quick ying in a special, high-vacuum chamber, or when ey are damaged mechanically by placing a susnsion of the cells in physiological salt solution in a aring blendor, a mass of cellular contents escapes rough the ruptured cell membrane. After the toplasmic components of this mass, which usually mains connected with the 'ghost' of the cell, have en dissolved by washing with physiological saline, e chromatin nature of the residue adhering to the llodium film on the copper screen can be demonated with the aid of nuclear stains, for example, etocarmin or Feulgen stain, and the optical croscope. The examination of the same material, but without fixing or staining it, in the electron microscope reveals a loose mesh of cross-linked fibres of indeterminate length and of varying width, ranging from about 200 A. to 700 A. (Fig. 1). With the exception of dense spots which are situated at cross-over points of the fibres, little, if any, fine structure may be discerned in them. It is believed that the material shown in Fig. 1 represents the *chromatin network* as it exists in the nucleus of resting cells, in agreement with the classical view[3] according to which the 'thread type' nuclei of the cells of glandular tissues consist essentially of a reticulum of chromatin threads distributed in a fluid nucleoplasm. While the nucleoprotein nature of these fibres appears established through their origin, solubility, staining as well as other chemical properties, and their high density towards electron beams, their relationship to or identity with the *chromonemata* or 'resting chromosomes' remains to be determined. The examination in the electron microscope, at low power, of the particles isolated from thymus tissue by repeated use of the Waring blendor at low and high speed according to Mirsky and Ris[7], and designated as 'resting chromosomes' by these workers, indicates that they represent random fragments of the chromatin network resulting from mechanical shearing action rather than preformed units of well-defined structure.

Lanthanum salts are known to possess a high affinity for nucleic acid and have previously been used for analytical purposes and ultra-violet microscopy of chromosomes (cf. T. Caspersson[1]). When thymus lymphocytes are treated with lanthanum acetate after the cells have been ruptured mechanically or by exposure to a high vacuum, the fibres composing the chromatin network are further resolved into bundles of fine *ultra-fibrils* of fairly uniform thickness of 80–100 A. (Fig. 2). In addition, the

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Research Fellow, Spanish Cultural Relation Board.

Weizmann Institute, Rehovoth, Palestine.

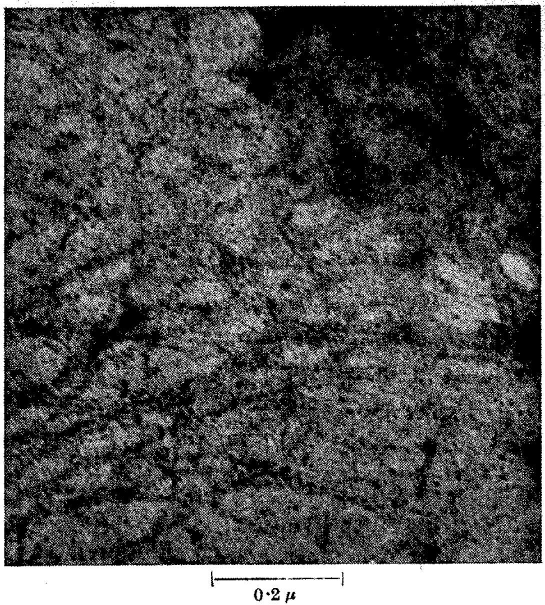

Fig. 3. Photographically enlarged area from Fig. 2, showing fine structure of lanthanum-stained ultra-fibrils. Overall magnification, × 80,000

lanthanum reagent acts as an 'electron stain' on the nucleoprotein ultra-fibrils and permits the detection of details which cannot be seen in unstained preparations. (Structural details of muscle and collagen fibrils have been brought out by electron-staining with phosphotungstic acid by F. O. Schmitt *et al.*) Carefully focused electron micrographs of lanthanum-treated fibrils show that they possess definite fine structure of a high order of regularity. This is evident from Fig. 3, which represents a photographically enlarged area of Fig. 2.

The inspection of a number of electron micrographs of this type suggests that the banded appearance of the lanthanum-stained ultra-fibrils is produced by the *coiling* of a fine thread to form long helices. The apparent width of the individual 'bands' or 'disks' is about 30–40 A., spaced at approximately equal intervals from each other. It is of interest to note that X-ray diffraction measurements on a synthetic albumin thymonucleinate complex[8] and ultracentrifuge and diffusion experiments on thymonucleohistone particles in 0·8 *M* sodium chloride solution[9] have yielded estimates for the width of such molecules of 23 A. and 40 A. respectively. Thus it would appear possible that the structures reproduced in Figs. 2 and 3 represent spirals formed by individual desoxyribonucleoprotein molecules in combination with lanthanum ions. A fine structure of this type has recently been postulated on theoretical grounds by one of us[10].

This work was supported by a grant from the Brooklyn Cancer Committee, the assistance of which is gratefully acknowledged.

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EVOLUTION OF THE DENTITION OF THE ORANG-UTAN

DURING his searches for the remains of th forerunner of man, beginning in 1887 an covering a span of more than twelve years, the lat Prof. Eugène Dubois collected prehistoric and foss teeth of the orang-utan in the islands of Sumatr and Java. Dubois has always been very guarded i his comments on the prehistoric teeth; but th fossil have received much attention because the were ascribed to *Pithecanthropus erectus*. The result of a recent study made by me on this material* ar summarized here.

Dubois' explorations started in prehistoric cave in the Padang Highlands, Central Sumatra. Th cave fauna appeared to be characterized by th relative abundance of the orang-utan (now confine to the northern parts of the island, and to Borneo and contained no extinct species. In general, th cave teeth differ from their recent homologues b their greater average size. In several cases I fin that the differentiation which the species has unde gone since the deposition of their teeth in the cave has proceeded to a stage equal to that of goo subspecies.

More than three thousand isolated subfossil teet of the orang-utan were collected by Dubois in centra Sumatra, representing some three to five hundre individuals. The study and statistical analysis this collection has revealed certain interesting trenc in the evolution of the dentition. They stamp th prehistoric orang-utan, which may be known *Pongo pygmæus palæosumatrensis*, as a larger an more simian form than the recent orang. On th average, the teeth of the prehistoric orang-utan a 16 per cent larger than the recent. The later incisors, both in the upper and in the lower jav were relatively less reduced in size. The canines we larger and less hypsodont than the recent, and th sexual difference in size was even more pronounce in the prehistoric than it is in the present-day oran utan. The anterior lower premolar was larg relative to the posterior. The excess in size of th second molar over the first and the third, a typical simian feature that is met with in early stages the evolution of the hominid dentition, was mo pronounced in the prehistoric orang-utan than it now.

The two upper molars from the middle Pleistocen at Trinil in Java ascribed to *Pithecanthropus erect* by Dubois have been stated to belong to an oran utan by Miller, Weidenreich and Von Koenigswal The careful study of the original specimens leaves shadow of doubt as to their belonging to the oran utan. They can be determined as representing sin. and M^4 dext. respectively, most probably derive from one and the same individual. The fossil Javane teeth are not larger than their recent homologues.

Pleistocene teeth of the orang-utan have be described from southern China by Pei, Von Koenig wald and Weidenreich. In contradistinction to t Pleistocene teeth from Java, however, the fos Chinese teeth are decidedly larger than the recen and they even differ from those of *Pongo pygmæ palæosumatrensis* in their distinctly larger size. lower canine from the Hoshangtung cave in Yunna

* "Prehistoric Teeth of Man and of the Orang-utan from Cent Sumatra, with Notes on the Fossil Orang-utan from Java and Southe China." By Dr. D. A. Hooijer. *Zool. Med. Museum, Leyden*, 175–301, pls. I-IX, 2 diagrams.

China, described by Weidenreich, is made the type of a new subspecies, *Pongo pygmæus weidenreichi*, on account of its being still bigger and less hypsodont than its homologue in *Pongo pygmæus palæosumatrensis*. It has thus become evident that the orang-utans which roamed the Pleistocene forests in southern China and in Java respectively were racially different, the continental form being larger than the Javanese. The fossil canine from Yunnan is structurally ancestral to that of the subfossil Sumatran orang-utan; but the relationship between the fossil Chinese and the subfossil Sumatran race cannot be regarded as firmly established on the base of isolated teeth. At any rate, the Pleistocene forerunner of *Pongo pygmæus palæosumatrensis* must have been larger than that of Java, the island in which the orang-utan is now extinct. The Javanese orang-utan was already of the small size of the present-day Sumatran and Bornean orang-utan in the Pleistocene, and it might very well have decreased in size still further up to the present, a condition that is paralleled by other species in which the record is more complete.

The dental characteristics of the recent orang-utan, which have been used in so many comparative studies on the dental anatomy of man and the apes, have now been shown to be the result of an evolutionary change dating from the emergence of the species early in the Pleistocene. The prehistoric Sumatran and the fossil Chinese orang-utan are still further removed in dental structure from man in the points which distinguish the recent orang-utan dentition from that of modern man. D. A. HOOIJER

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

THE forty-sixth annual report of the Carnegie Trust for the Universities of Scotland, Dunfermline, covers the academic year 1946–47 and again includes as appendix the new scheme for the award of fellowships and scholarships which came into effect on October 1, 1947. Grants made under the eighth quinquennial distribution for the period October 1, 1947, to September 30, 1952, and detailed in an appendix, include £33,650 to the University of St. Andrews, £13,350 to University College, Dundee, £70,000 towards the erection of the final portion of the Chemistry Institute at the University of Glasgow, £47,000 towards the cost of the new Chemistry Department at the University of Aberdeen, £23,000 for library expenditure and £25,000 for capital expenditure on the university schemes on the Bush and Dryden estates at Edinburgh, the grand total being £234,000 to the universities and £36,000 to extra-mural colleges. Special attention is directed to the observations in the report on assistance to students. The Executive Committee, examining the new situation created by Circular 106 of the Scottish Education Department, considered that until the amount of the bursary awarded by the education authorities had been ascertained for each individual applicant to the Trust, it would be premature to make any extensive alterations in the system adopted for the award of Carnegie Trust grants. Nevertheless, the Executive Committee expected that a turning point in the administration of the Carnegie Trust, so far as half its annual income is concerned, may have been reached, and that very considerable sums at present absorbed in assistance with class fees will be liberated for new projects. The amount disbursed for this purpose during 1946–47 was £51,072 to 3,068 beneficiaries, as against £55,109 to 3,250 beneficiaries in 1945–46.

In the report on the work of investigators during the year, special reference is made to the work of the following: J. L. Miller, on various aspects of high-voltage engineering; Eric Reid, on the diabetogenic principle of the anterior pituitary body; A. M. Mathieson, on the use of X-rays for the study of the structure of complex sulphur compounds and of anthracene; J. C. Robb's measurement of the rate of addition of atomic hydrogen to an unsaturated hydrocarbon; and N. Grassie, on the thermal degradation of high polymers of the polyvinyl type. N. Grassie has devised a molecular still of very high performance and has thrown much light on the mechanism of depolymerization; R. I. May has made rapid progress in the study of polymerization in the gas phase; and A. McLaren in investigations of the role of radicals in polymerization. Mention is also made of the 'cruciform' macromolecule compounds, obtained by C. W. Youngson, of D. Ellis and G. T. Dickson's results in the study of the molecular structure of colchicine, and of S. C. Reid and R. C. Stuart's work on the chemistry of mandelic acid derivatives. In his work on the Silurian rocks of the Pentland hills, Dr. A. Lamont has made a major contribution to geology. Dr. D. B. McIntyre has completed his work on the north-west part of the Loch Doon Plutonic complex and is now studying granitization phenomena in the Alps. Dr. N. Holgate has investigated the igneous rocks of the Glen Bervie complex, and Mrs. E. M. Knox's research has revealed the presence of several new types of microspores in the coals of the Limestone coal group of both the Fifeshire coalfield and the Central coalfield of Scotland.

The report of the Superintendent of the Laboratory of the Royal College of Physicians refers to Lieut.-Colonel W. F. Harvey's microscopic investigation of his collections of sections of human tumours, Dr. J. C. Lees and T. W. Lees' tests in mice of the tumour growth-inhibiting power of ten representative drugs, Dr. J. C. Lees and W. W. Park's collection of data regarding 120 cases of carcinoma of types usually affecting older patients but occurring at 30 years or less, and Dr. E. K. Dawson's histological investigations. Work under Dr. W. O. Kermack has been directed chiefly to the synthesis of compounds of possible interest as chemotherapeutic agents; Miss B. Cairns has worked on the synthesis of halogenated 1-azanthracenes, such as 9-bromo-2:4-dimethyl-1-azanthracene, and Dr. McKail on benzthiazoles containing an amino-group in the benzene ring. Mr. Bryce Douglas extended his research on *p*-phenanthrolines and related compounds to the synthesis of derivatives containing a basic side-chain in the 4-position and a chlorine atom in the 9-position. Dr. R. A. Miller is working on the determination of the conductivity and chloride content of human mother's milk throughout the lactation period both under normal and abnormal conditions, and Col. Glen-Liston and Dr. F. Chisholm's work on leucorrhœa has been completed, as has Dr. R. S. Barclay's work on the course of mortality and fertility in Scotland during the past eighty years.

The appendixes include a list of publications by fellows, scholars and recipients of grants received since September 30, 1946.

FIFTH COMMONWEALTH ENTOMOLOGICAL CONFERENCE

BECAUSE of the War, thirteen years have elapsed since the last Commonwealth Entomological Conference was held in London, and there is no doubt that the recent fifth Conference, which ended on July 29, has been the best attended and one of the most successful of the series. There were forty-two delegates, representing the United Kingdom, Canada, Australia, New Zealand, India, Southern Rhodesia and various Colonial territories, and the open meetings were attended also by large numbers of entomologists from Great Britain and overseas.

The first day was devoted to a discussion on insecticides and their application. This is the first time that this topic has appeared on the agenda of a Commonwealth Entomological Conference, and it was the only one to be given a full day.

The discussion on recent developments in insecticides was opened by Dr. R. A. E. Galley, scientific secretary to the Insecticides Development and Research Committee. He summarized the present knowledge on synthetic insecticides, many of which are still in the early experimental stage. Particular interest lies in the development of systemic insecticides which are absorbed by plants and thereafter toxic to insects which feed on them.

Dr. V. B. Wigglesworth, director of the Unit of Insect Physiology of the Agricultural Research Council, in a discussion on the mode of action of the new insecticides, said that D.D.T. if injected internally was almost equally toxic to insects and vertebrates. The reason that the former are so readily affected if they come in contact with D.D.T.-treated surfaces, while the latter are unharmed, is because of the readiness and rapidity with which absorption takes place through the insect cuticle. An account of Canadian experience with the new insecticides was given by Mr. W. A. Ross, of the Canadian Department of Agriculture, who stated that, of them, D.D.T. was the one most extensively used. Because of the great increase in the importance of orchard mites following the use of D.D.T., a search for efficient acaricides is one of the principal problems of fruit insect research in Canada. Several promising ones have already received preliminary investigation.

A discussion on the application of insecticides from the air was opened by Dr. D. L. Gunn, of the Anti-Locust Research Centre. After mentioning, the question of costs, Dr. Gunn spoke of the importance of ensuring a sufficiently homogeneous coverage of the target area. He pointed out that while a great deal of publicity has been given to aircraft spraying, and while in certain circumstances it would undoubtedly prove of value, little is yet known as to whether it can establish itself in competition with other methods.

Dr. W. R. Thompson, of the Commonwealth Bureau of Biological Control, who was to have opened the discussion on the biological control of insects, was unable to be present, and this session was opened by Mr. A. B. Baird, of the Canadian Department of Agriculture. Mr. Baird gave an account of the work of the Bureau of Biological Control since the last Conference, and spoke also of projects, mostly involving forest insect pests, with which he had been associated. Dr. W. Cottier, of New Zealand, followed with an account of the successful biological control of the small cabbage-white butterfly (*Pieris rapæ* L.) in New Zealand, and Dr. R. H. Le Pelley described the steps leading up to the control, by means of introduced parasites, of the coffee mealy bug in Kenya. This insect has at different times passed under different names, and this led to the search for parasites, made in the early stages of the investigation, being misdirected. When it was eventually realized that the injurious mealy bug was an undescribed species, native to the adjoining territory of Uganda, the parasite search became properly directed and was successful.

Some account of the general principles of the biological control of weeds by means of insects was given by Dr. D. Miller, of the Cawthron Institute, New Zealand. He also outlined particulars of some of the weed control projects which have been undertaken in New Zealand. These have been concerned with gorse, *Acæna* sp., and ragwort.

Mr. A. H. Strickland of the West African Research Institute, Tafo, Gold Coast, presented an able summary of special techniques relating to the estimation of insect populations in the field. He is of the opinion that little purpose is served by carrying out insect census work unless a preliminary detailed study has been made of the biology and habits of the species of insects concerned.

The discussion on recent developments in the control of stored products insects was opened by Mr. F. N. Ratcliffe, of the Division of Entomology of the Australian Council for Scientific and Industrial Research. He confined his remarks to wheat insects, and mentioned that the exploitation of D.D.T. and benzene hexachloride against grain insects is at present limited by the prevalent fear of their toxicity to human beings. In conclusion he stressed the importance of scientific men who work in this field having a knowledge of the manipulating conditions of the grain industry.

The subject of tsetse fly research and control was opened by Dr. T. A. M. Nash, and Dr. K. R. S. Morris took a prominent part in the discussion. Dr. Nash indicated the main lines in which research has been conducted; he remarked that each of the seven most important species of *Glossina* has different vegetational and climatic requirements, host preferences, and characteristic behaviour. While many methods of control have seemed promising, they have usually failed to produce complete elimination of the fly, with the result that as soon as control measures are relaxed, the fly density starts to rise.

In a discussion of the need for plant quarantine on a continental basis with special reference to Africa, delegates from various African territories gave particulars of the plant quarantine practice in their areas. The danger that might arise from uncontrolled air transport was emphasized.

Dr. B. P. Uvarov, who opened the discussion on locusts and grasshoppers, said that the outstanding result of the past twenty years of locust investigation is the firm establishment of the principle of outbreak areas, where the initial transformation of the solitary phase into the gregarious phase occurs and the first swarms of a plague-cycle are formed. While of recent years great strides have been made in discovering and applying effective palliatives, these must not be regarded as the end-point of the investigation; a radical solution of the problem must be sought in outbreak prevention, which needs more fundamental research.

Following the discussion on locusts and grasshoppers, the remaining part of the last afternoon was spent considering the recommendations of a Termite Sub-Committee which had been set up at an early stage of the Conference. These recommendations stressed the urgent need for research work on termites, particularly in the Colonies.

During the course of the Conference, delegates isited Whipsnade, Rothamsted Experimental Station, the Pest Infestation Laboratory of the Department of scientific and Industrial Research at Slough and the new entomological Field Station of the Imperial College of Science and Technology at Silwood Park. These visits, combined with certain social occasions, erved to give delegates that chance of informal iscussion which is perhaps the most valuable part of conference of this nature.

FOSSIL FLORA OF KERGUELEN ISLAND

THE biological interest of Kerguelen Island (latitude 49° S., longitude 69° E.) has been well known to botanists since 1847, when the young Joseph Hooker, as junior surgeon in Ross's famous voyage to the Antarctic in the *Erebus and Terror*, ontributed a description[1] of the botany of this island ained as the result of the expedition's first winter in he southern hemisphere (May–July, 1840). The xtreme poverty of the flora was its most noticeable eature, only eighteen species of flowering plants having been found by Hooker, and of these only eight overed any considerable expanse of ground. These ncluded the remarkable endemic crucifer, *Pringlea ntiscorbutica* (the Kerguelen Island cabbage), and a eculiar umbellifer related to the 'balsam bog' of the Falkland Islands. In comparable latitudes in the orthern hemisphere much richer floras were known o occur, the vegetation of Spitsbergen, for example, ontaining records in 1847 of forty-five species of owering plants on a comparable area. This, coupled ith the isolated position of the island in the middle the Antarctic Ocean, almost equidistant from outh Africa and from Australia, the presence of the ndemics and the vegetational affinity with the even ore distant Falkland Islands (off Cape Horn), are all oblems of lively plant-geographical interest to us as Hooker. Problems of equal interest are those raised the very marked changes of climate which have ccurred in these now desolate latitudes in fairly cent geological time. Hooker himself was profoundly impressed by seeing not only coal but also ssilized tree trunks of considerable size (one is pecifically mentioned by Ross as 7 ft. in circumference), although the existing vegetation cannot ast even a shrub, still less a tree, and this circumance was certainly one of the more powerful reasons hich predisposed him to the immediate acceptance the idea of evolution when it came.

The fossil woods brought back by the Ross expedin were not further investigated until 1921, when dwards[2] of the British Museum identified them as niferous." Shortly after this in 1934 Seward and nway[3] identified araucarian twigs and cone scales some macroscopic plant remains brought back by la Rue in 1931. This material also contained the nains of a moss and some indeterminate fragments dicotyledonous leaves and ferns.

An additional contribution is now available in the hth part of vol. 2 (pp. 129–142) of the Reports of the British, Australian and New Zealand Antarctic Research Expedition of 1929–31, published at Adelaide, 1947, under the title of "Plant Microfossils from the Lignites of the Kerguelen Archipelago by Isabel C. Cookson" (price 4*s*. 6*d*.). This is one of the few applications of the pollen analysis technique to fossil floras of the southern hemisphere, and though carried out on very limited material the results add greatly to previous knowledge while holding out considerable hope of more to come.

As was to be expected from Seward and Conway and from Edwards, araucarian pollen predominates. This is, however, not the only gymnosperm present. Five distinguishable species, undoubtedly belonging to the Podocarpaceæ though of less certain generic identity within that family, are listed under the form genera of *Disaccites* (*Podocarpidites*), *Polysaccites* (*Microcachryidites*) and *Disaccites* (*Phyllocladidites*). Angiospermous pollen is also present though more sparingly, five species only being so far recorded, three of which appear to be dicotyledons and two monocotyledons. In contrast there are ten varieties of Pteridophyte spores, probably of ferns, but not identifiable generically. There are likewise two species of ascomycetous fruit body.

While the available information does not yet permit of a generalized palæoecological statement to be made of this most interesting region it seems clear that gymnosperms and ferns predominate in the lignites so far examined, the age of which is on that account thought to be Tertiary. It is greatly to be hoped that this work will be further extended by a systematic study of additional collections and through the whole thickness of the deposits.

[1] Ross, J. C., "A Voyage of Discovery and Research in the Southern and Antarctic Regions during the Years 1839–43" (London, 1847).

[2] Edwards, W. N., *Ann. Bot.*, 35, 609 (1921).

[3] Seward, A. C., and Conway, V., *Ann. Bot.*, 48, 715 (1934).

BIOLOGY AND CONTROL OF THE PEA MOTH

THE pea moth, *Laspeyresia nigricana*, Steph., is a widely distributed pest of garden and field peas in Great Britain and central and southern Europe, while in North America it has spread to all main pea-growing areas. In England the most severe losses occur in the pea-producing counties of Lincoln, Essex and Kent. D. W. Wright and Q. A. Geering, of the Horticultural Research Station and School of Agriculture, Cambridge, have published a useful paper on the biology and control of the pea moth (*Bull. Entom. Res.*, **39**, pt. 1, 57 ; 1948).

It appears that the moths show no special preference for ovipositing on or near the flowers or pods. The larva feeds on the young seeds in the pod and bores a hole through the pod-wall for the purpose of reaching its food. The hole heals over, however, in a few days, leaving a small blister. When fully grown the larva spins a thin, web-like cocoon immediately below the soil surface, wherein pupation takes place. The majority of the moths emerge before the end of July in the following year. Normally there seems to be only a single generation of this insect in Britain.

The trials that were carried out indicate that different varieties of peas differ widely in their susceptibility to attack. Furthermore, the infestation on the varieties is influenced by the amount of foliage cover that is available, the heaviest attacks being where the cover is most dense. Certain varieties of peas are well known to escape much of the severity of pea moth attack if sown early. Also, it appears that crops can be grown almost free from infestation if sown in the latter half of June or in July, since they will mature after the flight period of the moth.

It is recommended that the residue of crops picked green should be removed immediately and fed to stock, made into manure or ensilaged. This prevents the caterpillars from maturing in the seeds and pupating in the soil. Experiments using D.D.T. as an emulsion, or as a suspension, showed that considerable reduction in attack could be obtained with the concentration at 0·5 per cent by weight of D.D.T. It was found that the spray should be applied before egg-hatching has begun which, for sowings made in late April and in May, would be about 7–10 days after the first flowers appear on the crop.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (with high mathematical qualifications) in the Department of Mathematics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (August 28).

Histological Technician—Prof. A. Durward, Department of Anatomy, Medical School, The University, Leeds 2 (August 30).

Professors or Assistant Professors of Physics, Zoology, Botany, Mathematics, Geography, at the Higher Teachers' Training College, Baghdad; Professor or Assistant Professor of Mathematics, Assistant Professor of Physics, Professor of Biology, Lecturer or Assistant Professor of Psychology, Professor of Chemistry, at the Queen Alivah College; Dean, and a Professor of Electrical Engineering, at the College of Engineering; Assistant Professor of Economic Statistics, at the College of Commerce—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7 (August 31).

Assistant in Botany—The Secretary, The University, Aberdeen (August 31).

H.M. Inspectors of Factories—The Secretary, Ministry of Labour and National Service (O.E.11), 80 Pall Mall, London, S.W.1 (August 31).

Principal, a Professor of Civil Engineering, a Professor of Mechanical Engineering, and a Professor of Electrical Engineering, at the Government College of Engineering, Dacca—The High Commissioner for Pakistan, 14 Fitzhardinge Street, London, W.1 (August 31).

Senior Professional Officer (Ceramic and Refractory Research), University of the Witwatersrand, Johannesburg—The Director, Government Metallurgical Laboratory, c/o Mr. Victor Reid, South Africa House, Trafalgar Square, London, W.C.2 (August 31).

Chemist-in-Charge at the Royal Ordnance Factory, Pembrey, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.606/48A (August 31).

Chemists in certain Explosive Factories in the Directorate of Ordnance Factories under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.605/48A (August 31).

Laboratory Assistant (Grade I) in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 4).

Lecturer in Agriculture, a Lecturer in Dairying, an Assistant Lecturer in Botany, a Lecturer in Horticulture, and a Horticultural Adviser and Lecturer (junior post)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (September 4).

Lecturer (Grade II or Grade III) in Electrical Engineering—The Secretary and Registrar, The University, Bristol (September 4).

Lecturer in Inorganic Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (September 11).

Senior Organic Chemist in the biochemistry section for work on the organic constituents of fruit-bearing plants—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (September 11).

Head of the Instrument Division at the National Institute for Medical Research, Hampstead—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1 (September 11).

Assistant Lecturer, preferably with some experience in Radar research—The Registrar, University College, Hull (September 13).

Assistant Lecturers (2) in the Department of Civil Engineering—The Professor of Civil Engineering, Queen's University, Belfast (September 15).

Mullard Readership in Electronics at the Imperial College Science and Technology—The Academic Registrar, University London, Senate House, London, W.C.1 (September 15).

Professor of Power Stations in the Mechanical Engineerin Department of the Faculty of Engineering, Farouk I Universit Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfiel Gardens, London, W.1 (September 15).

Senior Lecturer in Electrical Engineering at the Universit of Melbourne—The Secretary, Universities Bureau of the Britis Empire, 8 Park Street, London, W.1 (September 15).

Professor of Botany at Fouad I University, Cairo—The Directo Egyptian Education Bureau, 4 Chesterfield Gardens, London, W. (September 15).

Inspectors (Salmon and Freshwater Fisheries) in the Ministr of Agriculture and Fisheries—The Secretary, Civil Service Com mission, 6 Burlington Gardens, London, W.1, quoting No. 225 (September 16).

Senior Experimental Officer in an experimental researc establishment of the Ministry of Supply, near Salisbury—The Secretar Civil Service Commission, Scientific Branch, 27 Grosvenor Squar London, W.1, quoting No. 2256 (September 17).

Research Fellowship in the Turner Dental School—Th Registrar, The University, Manchester 13 (September 18).

Simon Visiting Professor, and Simon Research Fellowship for Advanced Study or Research in the Social Sciences—The Registra The University, Manchester 13 (September 29).

Agricultural Economists (3, one at each College)—The Secretar West of Scotland Agricultural College, 6 Blythswood Square, Glasgow C.2; The Secretary, Edinburgh and East of Scotland College Agriculture, 13 George Square, Edinburgh 8; The Secretary, Nort of Scotland College of Agriculture, 41½ Union Street, Aberdee (September 30).

Lecturer (ungraded) in Veterinary Parasitology—The Regis trar, Schools of Tropical Medicine and Veterinary Science, Th University, Liverpool (September 30).

Assistant Examiners in the Patent Office under the Board Trade—The Secretary, Civil Service Commission, 6 Burlington Ga dens, London, W.1, quoting No. 45A (September 30).

Chair of Mechanical Engineering, a Senior Lecturer Zoology, a Lecturer in Zoology, and a Technician in the De partment of Zoology, at Auckland University College, New Zealan—The Secretary, Universities Bureau of the British Empire, 8 Pa Street, London, W.1 (October 1).

Readership in Civil Engineering at King's College—Th Academic Registrar, University of London, Senate House, Londo W.C.1 (October 1).

Chair of Organic Chemistry at the Imperial College of Scienc and Technology—The Academic Registrar, University of Londo Senate House, London, W.C.1 (October 4).

Curator of the Auckland Zoological Park—The Office of th High Commissioner for New Zealand, 415 Strand, London, W.C. (Auckland, October 29).

Lecturer in Tropical Hygiene—The Dean, Liverpool Scho of Tropical Medicine, Pembroke Place, Liverpool 3, endorsed 'Lectur ship in Tropical Hygiene' (October 31).

Fellowships and Scholarships for the advancement of Extractio Metallurgy—The Secretary, Nuffield Foundation, 12–13 Mecklenburg Square, London, W.C.1 (November 1).

Demonstrator in Zoology—The Secretary-Registrar, Wy College, Wye, Kent.

Plant Physiologist to study the physiology of cocoa, with speci reference to water, nutrient and light requirements, and Plan Breeders to undertake the selection and breeding of cocoa types a varieties and progeny trials, at the West African Cocoa Resear Institute, Gold Coast—The Director of Recruitment, Colonial Offic Sanctuary Buildings, Great Smith Street, London, S.W.1.

Scientific Officer to deal with administrative aspects of resear —The National Coal Board, Establishments (General) Branch Hoba House, Grosvenor Place, London, S.W.1, quoting TT/68.

Graduate (or equivalent) as Assistant in Enquiry Laborator dealing with works problems submitted by member firms—T Printing, Packaging and Allied Trades Research Association, Rand Road, Leatherhead, Surrey.

Honours Graduate for work on engineering applications of flu mechanics—The British Hydromechanics Research Association, Petty France, London, S.W.1.

Laboratory Assistant (Grade II) for hygiene and bacteriolo department—The Secretary, King's College of Household and Soc Science, Campden Hill Road, London, W.8.

Scientists with research and practical experience in (*a*) Co Mining (Ref. TT/70), and (*b*) Coal Chemistry, analytical wo metallurgy or coal tar (Ref. TT/71)—The National Coal Boar Establishments (General) Branch, Hobart House, Grosvenor Pla London, S.W.1, quoting appropriate Ref. No.

Lecturer in Mathematics at the University of Otago, Dunedin The High Commissioner for New Zealand, 415 Strand, London, W.C

Chemist by the East African Industrial Management Boa Nairobi, Kenya—The Crown Agents for the Colonies, 4 Millba London, S.W.1, quoting M.N.21789/3E.

Laboratory Technician (male) in the Department of Chemic Pathology—The Secretary, Medical School, Guy's Hospital, Lond Bridge, London, S.E.1.

Managing Chemist to take charge of the Metallurgical Develo ment laboratories in the Department of Atomic Energy at Spri fields Factory, Salwick, Preston, a Chemist-in-Charge (must ha extensive metallurgical knowledge with experience in modern metho of metallurgical investigation), and Chemists to supervise expe mental work related to the metallurgical development involved the production of Atomic Energy—The Staff Section, Ministry Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Lecturer in Civil Engineering, and a Lecturer in Mechanic Engineering—The Clerk to the Governing Body, Battersea Po technic, Battersea, London, S.W.11.

Assistant Director (Metallurgical Development) in the Depa ment of Atomic Energy, Risley—The Staff Section, Ministry Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

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MEDICAL EDUCATION

MEDICAL education continues to be the subject of very lively discussion. In 1944 the Goodenough Committee issued its much-quoted report on the "Organisation of Medical Schools"[1]. A year ago an authoritative sequel appeared in the form of the General Medical Council's "Recommendations as to the Medical Curriculum"[2]. Newer and detailed proposals have now been published under the title "The Training of a Doctor" under the authorship of a Curriculum Committee that was set up in 1945 by the British Medical Association[3]. In the background, reaching far back over the years, are many other reports on the same subject. Before considering where the British Medical Association's proposals stand in relation to those of the Goodenough Committee and the General Medical Council, it is useful to consider for a moment why the medical curriculum is always under fire. For so it would seem to be if one compares medical with other university departments ; there has certainly been no corresponding wealth of reports about the teaching of chemistry, physics or electrical engineering.

The underlying reason would seem to emerge from the fact that the medical sciences, which are part of the general field of biology, have not evolved very far in the hierarchy of science. The physical sciences are well to the fore, and in their present state of development conform far more closely to the pattern that is expected of a well-knit and properly based structure of scientific knowledge. This in turn allows a clear academic separation between the fundamental sciences of physics and chemistry and such applied subjects as mechanical and chemical engineering. Corresponding divisions of interest are quite impracticable on the biological side. As a result, to take an example, the student of zoology or of agriculture may find himself equally concerned either with fundamental or applied science. The same dual, and at times confused, purpose besets the medical departments of a university. Thus, the overwhelming task of a medical school is to train practising doctors. Its next task, but a task not second in importance, is the training of medical scientists and the advancement of medical knowledge. It is this division of purpose which is clearly the background for all educational difficulties in medicine.

Because the two objectives of a medical school are pursued in the same harness, the curriculum for 'applied medicine', if it can so be called, is always immediately affected by changes in fundamental medical knowledge. Unfortunately, however, the curriculum has never been automatically readjusted so that proper weight is given to new advances in relation to old-established knowledge. What has generally happened is that new subjects, as they grew in importance, have been added to the existing syllabus, the structure of which has thus been altered not by changes in its general configuration, but mainly by the process of discrete accretion. Not surprisingly, the medical course has in consequence increased over the past thirty years or so from four to six years. If the same process were to continue, and the strong claims of new interests were admitted, there is no saying how many years would have to be allowed for the training of a doctor in twenty years time.

Here lies the main driving force behind the constant stream of discussions about the reform of the medical curriculum. There is a second to which the British Medical Association Curriculum Committee directs attention—namely, that advances in medical knowledge over the past fifty years have not resulted in a "proportionate improvement" in the standard of medical practice. It is almost a truism that the practice of medicine is more up to date in relation to new biological knowledge than are most industrial and engineering undertakings in relation to advances in the physical sciences. But this is obviously no reason for complacency, and the British Medical Association is right in insisting that, without improvements in the system of education, little can be expected in the quality of our medical graduates. Allowing for the fact that the bulk of the sixty thousand medical men in Britain are in one or other kind of practice, and therefore circumscribed in the expenditure of their energies, it is a startling fact that over the past fifty years or so, most major and fundamental advances in medical science have come from the few hundreds who have kept to the research laboratory. This is all too painfully obvious when one scans the list of Nobel laureates in medicine, or lists of medically qualified men who have been elected to the Royal Society—or to corresponding bodies in other countries. One cannot suppose that more than a fraction of the best minds among medical graduates have dedicated themselves to the laboratory. It is tragic, therefore, to contemplate how circumstances and education have limited the potentialities for advancing medical knowledge which actual practice provides.

In the remedies it suggests, the British Medical Association is at one with the Goodenough Committee and the General Medical Council about such things as the need to eliminate unnecessary detail and specialities from the curriculum; about the desirability of 'integrating' its various parts; and about the fact that the time is ripe to introduce into the curriculum such subjects as psychology and social medicine. It takes an independent line about many matters of more detailed policy. For example, it opposes the Goodenough recommendation that chemistry, physics and general biology for intending medical students could be taught in schools; it holds that anatomy and physiology could be confined to four instead of the five terms recommended in previous reports—although in this recommendation, since its proposed terms are longer, all that is suggested is the curtailment of vacations; it disagrees with the Goodenough Committee that, in general, one can combine good teaching and research abilities in the same individual, and suggests that where the head of a department is a research man, someone else should be made responsible for the teaching.

These and other like matters are, however, questions of detail. The real point is whether the British Medical Association's proposals regarding the direction and integration of the curriculum will achiev the "aim of the medical curriculum". The repor takes the line that "the undergraduate medical cours should be primarily concerned with the training i those basic principles of medicine which are a necessary foundation for all forms of medical practice" This in turn implies that the student should b trained over the whole field of medicine. "Ther should be no clash in outlook", the report reads "between the practitioner and the research worker" since both use the same intellectual methods. An the British Medical Association Committee hold that a proper medical education would have th effect that the medical practitioner would continu to be a student throughout his postgraduat career.

Specialization in education is repeatedly attacked and the report pleads for what is described as th "synoptic view". It argues for a "liberal and general' school education for intending medical students, an opposes early "vocational" concentration on science "general culture", it states, should take the place o "premature narrow specialization in the basi sciences". In its insistence on the need for 'integration', it points out that the many subjects which com into the medical curriculum break the continuity o the student's career. For example, physics, chemistry and biology should be taught in the first year of th medical course "as different aspects of general science" From this would emerge an understanding of th general principles of scientific method, which woul be further laid bare in the syllabuses for anatomy an physiology. Continuity would be better assured b such measures as distributing the teaching of pathology and psychiatry throughout the clinical years, an integration would be helped by ceasing to break u the final examinations into the separate discipline of surgery, medicine, gynæcology, and so on. Th emphasis throughout the report is on re-ordering th curriculum to the end that the patient be seen as whole. General medicine, the Curriculum Committe claims, is the 'linchpin' of the clinical subjects, an should be taught as the basic clinical subject from which the specialities have branched. "It mus remain an integral study of human disease in all it facets, both physical and mental."

A number of these proposals are undoubtedly very sound. But on the other hand, the value of th report is not strengthened by obscure concepts, an in particular by what seems to be an undue allegianc to words such as 'unity', 'whole', 'fundamental principles' and 'general culture'. A synoptic view is clearl useful; but its over-emphasis seems to detract from rather than to enhance its importance. Man, we ar told, must be regarded as a whole, and not as the sun of his component systems; "the sense of the unity o medicine is the special purpose of the teaching o general medicine". Instead of emphasizing excessiv morphological detail, "the general truths of anatomy' should be inculcated. Students, we are also told "must not be allowed to think that laboratory investigations are a substitute for personal observation They should be trained to understand that the purpose of X-rays, pathological reports, and the like, i refute or confirm the practitioner's own findings, and that they must be regarded as servants, not as masters."

It is difficult to avoid feeling that these are mostly platitudes. It is undoubtedly true that a man with a general education is often more interesting and intellectually alert than one without. But as a class, are doctors any less 'cultured' than, say, an equivalent number of men who did not concentrate on science in school and the university ? It is obvious also that a doctor should regard his patient as a whole, and "not as a collection of systems and organs corresponding to the specialities of medicine". But when a patient comes to a doctor, is he really regarded as such ? It is perfectly true, too, that a man should not become the victim of the techniques of observation which he uses. But equally, is it correct to imply that pathological studies or X-ray methods are not just another form of personal observation ?

Above all, it is dangerous to obscure the fact, which is what the Report does, that advances in medical knowledge have come about almost entirely out of increasing specialization, and through the fragmentation of the 'oneness' of medicine. The 'general physician' may be a disappearing species, but it has disappeared over a period in which the health of the people has been progressively improving.

How a deliberate avoidance of educational specialization, beginning at school and continuing through to the end of the 'intern' year spent after medical qualification, can materially improve the quality of medical practice is, therefore, difficult to see. More, not less, specialized scientific training would seem to be wanted if full advantage is to be taken in practice of advances in fundamental medical science. One wonders, therefore, whether the British Medical Association is not attempting the impossible, in so far as the verbal character it imposes on medical education is out of keeping with the trend of developments in medical practice. More and more the general practitioner is taking on the function of a sorting-machine which directs those sick whom it cannot help into specialized avenues for particular treatments. This fact the British Medical Association report clearly recognizes ; but nevertheless it consistently seems to write down the importance of the specialities. The trend cannot be condemned because specialization can be carried too far. That danger will be there whatever form medical education takes. Nor can the trend be stopped, for the simple reason that advances in knowledge, not only in medicine but also in every other field of science or applied science, inevitably mean greater and greater specialization.

If medical education is to undergo the fundamental overhaul which the British Medical Association Committee rightly describes as necessary, it is surely essential to safeguard the education of the specialist, and the specialist approach, as well as that of the general practitioner. The problem is whether the two aims can be satisfied by the same curriculum. The period of medical training is already very long in relation to the years of a doctor's service, and if several more years have to be added to a general medical curriculum for gaining experience in a speciality, the burden of education becomes almost too great. Sooner or later the question will have to be faced whether the approach to reform should not be the opposite of that advocated in most recent reports, including that of the British Medical Association Committee. What may be wanted is the division of the curriculum into specialized 'sectors' that cut right through the clinical and pre-clinical subjects. In such a vertical organisation, the cardiovascular 'sector' or 'department', or the neurological 'department', or the infectious diseases 'department', would embrace their relevant anatomical, physiological, pathological and clinical aspects. The medical student, after an initial year or so in which he became familiar with the language of the subject, and, in general terms, the layout of the body and the nature of its mechanisms, as well as the broad character of the most frequently used techniques of medical education and practice, could move from sector to sector, becoming educated in all aspects of each in the integrated way demanded by the British Medical Association Committee. Teachers would be sufficiently experienced to indicate the interrelations of different sectors, and so to impress the 'wholeness' of medicine in its most useful sense. The time spent in different sectors, and the emphasis of instruction in each, would be varied according to the needs of general practice. But no more time would be spent in all than would be deemed necessary to train a man for the declared purposes of general practice. After his first qualification, the would-be specialist would then concentrate in the sector or sectors of his interest, in an atmosphere where basic science and applied knowledge form an interrelated pattern, and in which either one or the other could become the central interest. A synoptic view over the whole field of medicine seems impossible to attain. A synoptic view within a sector of, say, the problems of digestion and nutrition—all the way from their anatomical to their biochemical aspects—or of the locomotor system, is far more within the bounds of educational possibility. In short, horizontal may have to give way to vertical integration if the medical curriculum is to be materially improved. At the moment the preclinical subjects of anatomy, physiology, and biochemistry supply the normal picture of the whole field that is later split up into the variety of specialities that make up clinical medicine. No amount of horizontal integration or of reference back during the clinical years to the preclinical subjects is likely to achieve as useful an interrelated pattern of education as would a vertical division of interests.

It is in these major matters that the British Medical Association report is least convincing. On the other hand, it contains many useful suggestions that could be immediately applied in medical schools, to the betterment of present educational methods. Very useful, too, is its suggestion that there be formed an "Association of Teachers in Medical Schools" to discuss alternative possibilities for the curriculum—for the British Medical Association Committee has wisely recognized that all proposals are in the nature of plans for experimental action, and that plans must necessarily change with the changing content of medicine itself.

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[1] Report of the Interdepartmental Committee on Medical Schools. (H.M. Stationery Office, 1944.) (Reviewed in *Nature*, **154**, 322; 1944.)

[2] Recommendations as to the Medical Curriculum. General Medical Council, April 1947. (Reviewed in *Nature*, **160**, 481; 1947.)

[3] The Training of a Doctor. Report of the Medical Curriculum Committee of the British Medical Association. (London, Butterworth and Co., Ltd., 1948.) 7s. 6d. net.

FERN PHYLOGENY

Genera Filicum

The Genera of Ferns. By Dr. Edwin Bingham Copeland. (Annales Cryptogamici et Phytopathologici, Vol. 5.) Pp. xvi + 247 + 10 plates. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1947.) 6 dollars.

A Revised Classification of Leptosporangiate Ferns

By E. E. Holttum, *J. Linn. Soc. London*, **53**, pp. 123–158 (1947).

BY a curious coincidence two independently compiled reclassifications of the ferns have appeared in print almost simultaneously but from different parts of the world. Both are of very considerable botanical interest, since the phylogeny of ferns is a topic of wider evolutionary significance than the taxonomic context alone might suggest. The phyletic views of the late Prof. F. O. Bower, based largely on anatomical and developmental data, are well known to all morphologists and have for long been the basis of teaching in many universities. The phyletic views of the pure systematist in pteridology have, however, been only imperfectly available. Christensen's phyletic scheme published in 1938 was regarded by its author as only tentative, though unfortunately he did not live to develop it more fully. This scheme has, however, been kept vividly in mind by both the authors under review and both can, in a sense, be read as commentaries on Christensen as on Bower.

The circumstances of composition of the two works are very different. Holttum's explanation of his own is that it was a sequel to the compilation of a Fern Flora of the Malay Peninsula which had been carried out at Singapore between 1942 and 1944, that is, during the Japanese occupation. The step from this to a reclassification of the leptosporangiate ferns seems, therefore, to have been in a sense unpremeditated and the outcome of close acquaintance with the very rich fern vegetation of that country. By being confined to a limited section of the ferns the ground covered is that contained in vol. 3 of Bower's classic work, all of which was, until quite recently, included in the spacious but unnatural family, the Polypodiaceæ.

In Holttum's view the Polypodiaceæ *sens. lat.* should be replaced by five families, namely, Polypodiaceæ *sens. strict.* (including *Polypodium* and *Dipteris*), Grammitidaceæ, Thelypteridaceæ, Dennstædtiaceæ and Adiantaceæ.

To a British botanist the chief interest of these innovations is likely to lie in the third and fourth families. By placing the male fern (*Dryopteris Filix-mas*) as a derivative of *Dennstædtia*, Holttum departs from, and perhaps undermines, one of the central tenets of Bower's phylogeny by which the Dryopteroids are thought to derive from an ancestor with superficial but not marginal sori. Further, by separating the marsh fern (*Thelypteris* not merely into a different genus from the male fer but also into a different family, the Thelypteridacea Holttum endorses and extends a long-considered vie of Christensen's that the genus *Dryopteris sens. la* is polyphyletic. With this latter view, it may b said in passing, some recent cytological work of th reviewer is in complete agreement. An independen statement of somewhat similar views had previousl been published by Ching[1], though this could not hav been known to Holttum at the time.

Copeland's book is a work of greater scope, since i sums up the views of a life-time primarily devoted t the study of ferns and is intended as an authoritativ work of reference, an intention which is on the whol excellently fulfilled. It includes the whole of th ferns and is preceded by a few pages of highly instruc tive historical introduction in which the taxonomi views and practice of the author are briefly discussed Of the 305 genera recognized and described, only si have not been personally accessible to him, whil 33 have been created by him and 69 others revived Some familiar genera have, on the other hand, bee suppressed, and a British botanist will perhaps b surprised to note the submergence of, for example *Scolopendrium* in *Asplenium*. The treatment of th Polypodiaceæ (which is split into twelve families differs in many ways from that of Holttum—a divergence which is easily understandable in the light o Copeland's introduction; but both authors endorse th views of Christensen in his treatment of *Dryopteri* and in other ways. Of the new or revived genera large proportion occur in the Hymenophyllaceæ, th 600-odd species of which are distributed into thirty three genera instead of the two unwieldy groups o *Trichomanes* and *Hymenophyllum*. Pedantic as thi may at first appear it is clearly an essential preliminar to the attainment of clarity on phyletic trends withi this large and interesting group.

The weakest part of the book is the treatment o anatomy. This is clearly not the centre of the author' interest, though he is compelled to make some use o it in his treatment of the Polypodiaceæ. It is perhaps scarcely his fault that comparisons with Bower will be more consciously made by some of his readers than they may have been by himself; but the extreme compression of the allusions to anatomy makes thei inclusion of doubtful value in certain cases. The very well known and complex stem structure of the bracken (*Pteridium*), for example, is merely referred to as a solenostele without further qualification—a degree of simplification which amounts almost to distortion.

On the positive side, a point of unusual interest to a northern reader is the stress which is laid on the southern hemisphere as the putative place of origin for a large proportion of existing fern genera. This view had been strongly impressed on the author by his earlier studies of the Hymenophyllaceæ and other groups, which still have a predominantly southern distribution, and also by his long residence in the Philippines and familiarity with their flora. According to Copeland nine-tenths of all tropical fern genera are of southern origin, and that the Antarctic continent itself may have been the centre of this evolutionary development is an idea which is less familiar to northern botanists than its importance deserves. For this reason alone the book deserves close and critical study by students of vegetation as well as by students of ferns. It should also perhaps be mentioned that the potential value to pollen analysts of the numerous descriptions of fern spores has already been pointed out by Erdtman in a Swedish review; the absence of illustrations may, however, perhaps prove a disadvantage here.

Though it is always possible, in a compilation of this kind, to make suggestions of detailed improvements, these should not, in this case, be regarded as seriously detracting from the sterling value of this book, which as a taxonomic study will remain an indispensable source of reference for many years. Not only the author, but also the publishers are to be congratulated on the production of a compact, convenient, and scholarly piece of work.

I. MANTON

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[1] Ching, C., "Natural Classification of the family Polypodiaceæ", *Sunyatsenia*, 5, pp. 201–267 (1940).

PATHOLOGY OF TUMOURS

Pathology of Tumours

By Prof. R. A. Willis. Pp. xxiii + 992 + 52. (London: Butterworth and Co. (Publishers), Ltd., 1948.) 63*s.* net.

IN all branches of biology where the experimental method, and the co-operation of the chemist and the physicist, are extending our knowledge of living things, it is still essential for the results of morphological inquiry not only to be preserved but also to be reviewed, summarized and restated in the light of contemporary opinions. The descriptive morphologist acquires his knowledge and judgment by long experience, which no interloper, however gifted with modern techniques, can hope to achieve in a short space of time as a subsidiary interest. This is particularly the case with microscopical work, where sound interpretation of the visual image usually requires long experience and training.

Nevertheless, the chemist and physicist who are partners in a modern biological research team will seek at least some acquaintance with the morphological side of the problems they are investigating, and here is a book on tumours which not only pathologists but also all workers in cancer research will find extremely valuable. The author has not provided just another detailed work of reference, confined to the systematic description of the structure of tumours. He begins with an admirable summary, extending over twelve chapters, of the main characteristics of tumour formation, their mode of origin, statistical study of incidence, experimental production in animals, metastases, and the theories of the nature of neoplasia. The second part of the book describes with commendable precision the characteristic features of tumours in specific regions of the human body and includes many case-histories, together with information on comparable tumours in animals.

It is now generally accepted that the successful production of an advanced text-book should be the work of collaborators each responsible for some particular section. So many text-books by a single author are apt to become reproductions in condensed form of the existing literature, enlightened only in those sections where the author has detailed experience. Dr. Willis makes it quite clear that, though he wishes to give a general outline, much of the book is a personal record of his own observations and conclusions. The five hundred illustrations are all from material he has studied personally. Inevitably there are controversies concerning the interpretation of some types of tumour. Where conflict arises with other pathologists, it is refreshing to find the author stating his convictions, avoiding 'non-committal vagueness' and at the same time admitting that his own opinions may have to be modified in the light of further research. There is a vigour and a challenging frankness in his criticism of the work and opinions of others which is perhaps characteristic of the Australian temperament. Where controversies have been tediously prolonged, the more heretical contributors are singled out as "pathologically incorrigible, absurd or deservedly moribund"—expressions which English authors of scientific books and papers unfortunately go out of their way to avoid. The author's opinions, though forcibly stated, are given, however, with reasons that can only be helpful in allowing the reader to distinguish reasonable hypothesis from dogmatic assumption.

As a work of reference the book is well constructed with clear headings to the numerous sub-sections of each chapter. In the references the more important papers are distinguished by a full title with the author's name in block capitals, while the less important papers are indicated in smaller type without title. Dr. Willis wrote this book while holding the Sir William H. Collins chair of comparative pathology in the Royal College of Surgeons of England. He is now director of the Department of Pathology of the Royal Cancer Hospital, London.

E. S. HORNING

FORCES BETWEEN COLLOIDAL PARTICLES

Theory of the Stability of Lyophobic Colloids

The Interaction of Sol Particles having an Electric Double Layer. By E. J. W. Verwey and J. Th. G. Overbeek, with the collaboration of K. van Nes. Pp. xi + 205. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1948.) 22*s.* 6*d.* net.

MANY of the classical investigations of colloidal chemistry were concerned with the stability of colloidal solutions of insoluble substances, such as gold, arsenic sulphide, silver halides, etc. The well-known phenomenon of coagulation of these sols by comparatively small concentrations of electrolytes suggested that their stability was connected with their electric charges. A considerable amount of research has been made in the past to discover the magnitude and origin of the electric charge on the particles and the nature of the electrical double layer which exists around them in salt solutions. Although qualitative and semi-quantitative explanations have been given of the phenomenon of coagulation and of the rule of Hardy and Schulze, according to which the ionic concentration required for precipitation diminishes rapidly with the charge of the effective ion, yet a complete and satisfactory theory was still lacking.

The present volume contains the results of theoretical investigations on the problem which were carried out by the authors in the Netherlands during the war years. Some short and incomplete accounts of this work have appeared in various journals, but many of the details are published here for the first time. The book, therefore, has the character of a research monograph. It undoubtedly takes the problem to a more definitive stage and will be studied with care by all who are interested in electrical double layers and with the colloidal state. The publishers are to be commended for making the work available to the English-speaking world in such a complete form.

Briefly, the authors' object was to examine in detail the potential curves for the interaction of particles which are obtained by combining the repulsion which arises from the interaction of their double layers with the London – van der Waals' attraction. Following preliminary work by J. H. de Boer and H. C. Hamaker, it is found that a fairly complete explanation of the coagulation process is obtained from the consideration of the combination of these two types of interaction, using reasonable values of the London attractive constant.

For many readers the most interesting part of the book will be the discussion of long-range attractive forces between particles, which are large compared with atomic dimensions. It is found by summation between all the atoms that the van der Waals' attraction diminishes comparatively slowly over distances comparable with the particle size. As this would give rise to appreciable forces between large particles, a relativity correction is suggested to the London expression, which has the effect of reducing to zero the van der Waals' forces at distances of more than about 10^{-6} cm.

One consequence of the slow decline of the van der Waals' attraction within this range is the fact that at the greater distances the attractive forces may again exceed the repulsive, giving a shallow minimum in the potential energy curves at distances of the order of 10^{-6} cm. It is suggested that this may produce thixotropy with non-spherical particles and may be responsible for the curious phenomenon observed by Bernal and Fankuchen with tobacco mosaic virus, namely, the concentrated aqueous phase in which the rod-shaped protein molecules are arranged in alignment at distances varying from zero to 300 A. or more.

J. A. V. BUTLER

CORROSION OF METALS

An Introduction to Metallic Corrosion

By Dr. Ulick R. Evans. Pp. xxxvi + 211. (London: Edward Arnold and Co., 1948.) 12*s.* 6*d.* net.

THE author's object in writing this book was, in his own words, "to provide an account of Corrosion short enough to be read from start to finish within a reasonable time". Let it be said at once that he has succeeded in his purpose and succeeded admirably. This "Introduction to Metallic Corrosion" provides a general, authoritative and up-to-date survey of the subject, which the serious student should be able to master in the course of a few weeks.

The format and general lay-out of the book resemble that of Dr. Evans' "Metallic Corrosion, Passivity and Protection", but the text is much shorter, amounting roughly to one quarter of that of the major work. This compression has been achieved by the elimination of a considerable amount of less important detail and the rearrangement of the subject-matter in eight chapters as compared with fourteen. The chapter headings provide an apt summary of the contents and illustrate the simple logical classification adopted by the author: they are: film growth; electrochemical corrosion; corrosion by acids and alkalis; influence of environment; effect of stress, strain and structure; prevention of corrosion by soluble inhibitors; prevention of corrosion by protective coverings; and statistical and mathematical treatment. The same methodical arrangement is followed in the sub-headings. For example, those for Chapter 6, "Prevention of Corrosion by Soluble Inhibitors", are: principles of inhibition; cathodic inhibitors; anodic inhibitors; inhibitive water treatment in industry; pickling processes to remove scale and rust; inhibitive pretreatment.

All this renders the book easy to read and to follow. It will also be evident from these headings that, while Dr. Evans dwells with unequalled authority on the whole range of corrosion theory, he is at pains to deal with the practical aspects of the problem and to render the utmost assistance to those who have to grapple with corrosion in the rough and tumble of industry.

One attractive and likable feature of the book is that references to the literature are reduced to a minimum; even so, 165 are needed. These are segregated at the end instead of being given as footnotes. Too much attention can never be paid in any scientific text-book to details such as this, which, however unimportant in themselves, in the aggregate make all the difference between a readable and a tedious book. As an eminent psychologist has written, "It requires considerable effort even to follow one's inclinations with consistency", and any aids such as this to lighten the burden of study are not to be despised.

The book is prefaced by an excellent historical introduction. In this, Dr. Evans covers attractively, in the short compass of some five thousand words, the development of knowledge of the subject from the dawn of history to the present day. Some of the theories, held even by research workers who are still alive, make rather queer reading now; but the general impression gained from Dr. Evans' survey is that of constant progress resulting from the integration and interplay of the ideas of a large number of earnest seekers after truth. Not all of them have been cast in an academic mould, for as Dr. Evans remarks: "Industrial necessity has led to the investigation of many points which the pure scientist would probably have overlooked".

He gives an example to illustrate this. An even better one might be that intuitive reasoning alone could scarcely disclose that the initial cause of the corrosion of steel railway sleepers is damage to the protective tar coating caused by the hob-nailed boots of the men walking up and down the line!

The only feature of the book about which a little diffidence might be expressed is the final chapter on statistical and mathematical treatment. It might have been better to omit this. Statistics is a highly specialized subject, to which Dr. Evans has made important contributions, and it is no aspersion on the mental calibre of many who read this book to suggest that they will find this chapter difficult. Dr. Evans has evidently considered this point and was, no doubt, influenced in his decision by the fact that the subject-matter had not previously been published as a connected whole.

In brief, this is an attractive, well-written and well-produced book which will fulfil the purpose for which it is intended, and will undoubtedly appeal to a much wider circle of readers than the more comprehensive "Metallic Corrosion, Passivity and Protection". It is fully worthy of the author's high reputation.

J. C. HUDSON

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL

THE Atomic Energy Research Establishment was founded by a decision of the Government in ovember, 1945, and Prof. J. D. (now Sir John) ockcroft was appointed director in January, 1946. n order to provide a nucleus of accommodation and prepared site, the permanent R.A.F. aerodrome of arwell was allocated to the Establishment and uilding work began there in April, 1946. Harwell as chosen because of its convenient geographical cation, combining reasonable access to London ith nearness to a large university (Oxford), which as considered to be important so that staff should ve good opportunities for discussion with university olleagues.

A nucleus of experienced staff was available in 46, some of whom had worked in the United States tomic Energy Project at Los Alamos and Berkeley, hile others had helped to build the Atomic Energy lant at Chalk River in Canada. These were joined y experimental electronics staff working at the elecommunications Research Establishment in Malern, and by a few senior members of universities. his nucleus has been added to by the recruitment of nior staff, and there are at present Divisions of heoretical Physics, Nuclear Physics, General Physs, Chemistry, Chemical Engineering, Metallurgy, nd Health, each of the size of a large university search school.

The Establishment has very close links with the niversities and industry. Many senior members of e project after the War returned to take charge f university departments; these scientific workers e now consultants to Harwell and some of them rve on the Technical Committee which advises the epartment of Atomic Energy. In addition, many the technological problems of the Establishment e solved by collaboration with industry and with boratories of Government departments and research ssociations.

The purpose of the Establishment is to carry out ndamental research and development in atomic ergy. It is responsible also for providing scientific nd technical information to the Controller of Production, Atomic Energy (Lord Portal) and his gineering organisation at Risley, which is preparing e design for the plutonium production plant which being built near Sellafield in Cumberland.

Pile Programme

The first requirement for an atomic energy proamme of this nature was to build piles, and the st pile, GLEEP (graphite low energy experimental le), was completed in August, 1947. It is a slow utron graphite moderated reactor developing 00 kW. of nuclear energy. The simplest possible sign was chosen so that early experience could be ined in pile operation, and, in fact, the time taken om beginning constructional work to the start-up the pile was only just over a year.

It has a concrete shield, five feet thick, and the aphite blocks and natural uranium rods are built within the shield roughly in the form of a cylinder ing on its side. The power-level at which the pile operating is measured by means of boron trioride chambers sunk into the pile, and the current the chambers suitably amplified is displayed in e control room on a dial calibrated directly in kilowatts. This information is also used to maintain the power of the pile at a constant level by controlling the position of neutron-absorbing cadmium 'control rods', hanging vertically in the pile. A second set of 'shut-off rods' is available to shut down the pile.

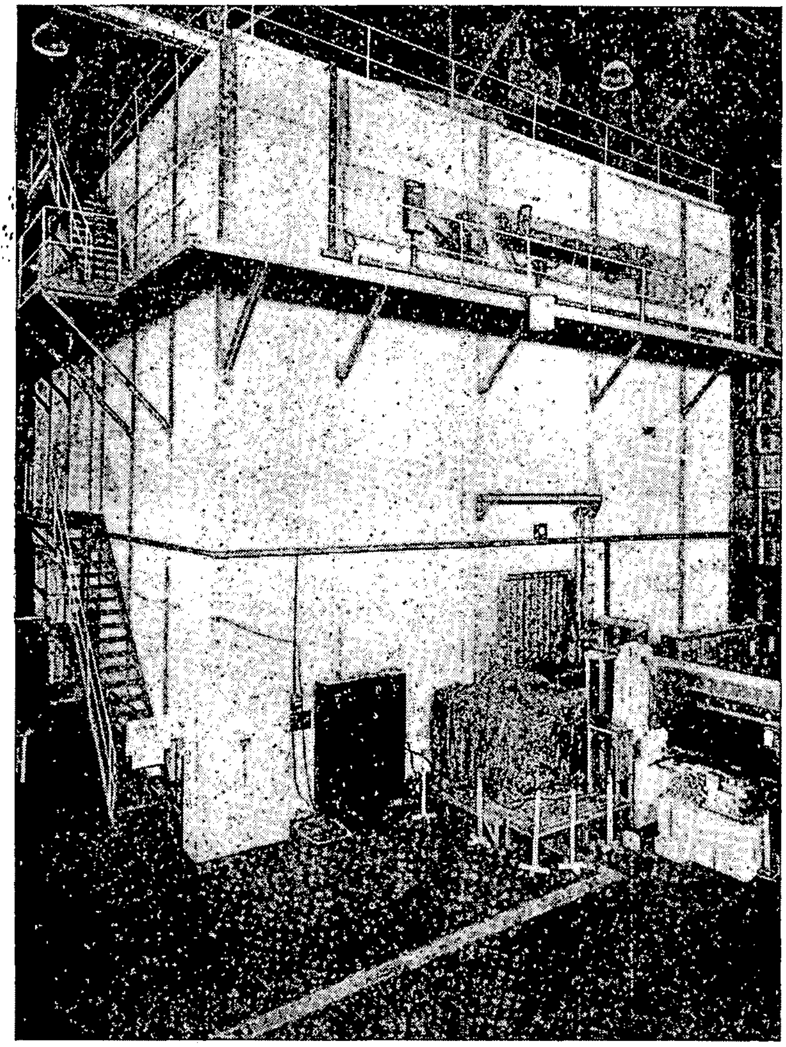
GLEEP is being used for measurement of the properties of atomic nuclei, for testing the nuclear properties of materials used in the construction of piles and for the production of radioactive isotopes.

The second pile, BEPO (British experimental pile), started up at 3 p.m. on July 3, 1948. Although not much larger physically than GLEEP, it is a much more complicated engineering structure and is designed to develop 6,000 kW. of nuclear energy. The heat is removed by an airstream which is drawn through the channels in which the uranium rods lie, and exhausted through a 200-ft. chimney stack. This pile will be used for studying the effects of irradiation on the structural and physical properties of materials which will be used in future piles, and the much higher neutron flux available makes possible a correspondingly wider range of experiments than in GLEEP. BEPO will also be the main source of radioactive isotopes for Great Britain, and it is expected that this work will be transferred from GLEEP to BEPO towards the end of this year, thus freeing GLEEP for full-time experimental work.

In preparation for building these two piles, it has been necessary to develop the production of pure graphite both in Canada and in Great Britain, and also to produce pure uranium metal and fabricate from it the aluminium-encased uranium rods which are used in the piles. This work has involved a large development programme, all of which has been undertaken outside the Establishment, both by industry and other Government establishments.

After the operation of piles, the next stage in a pile programme is the extraction of plutonium from the irradiated uranium metal, and information on the extraction process will be required for the Sellafield plant. The chemical problems involved in the separation of plutonium from the unused uranium and the highly radioactive fission products are among the most difficult in the atomic energy programme, and for this and other radiochemical work a new laboratory is being built at Harwell. This new radiochemical laboratory is a large two-story building, consisting of a central administrative block, connected by air locks and changing rooms to two wings. The wings contain a number of self-contained laboratory suites, each fitted with lead-lined chambers where all radioactive work will be done. A very large air flow is required through the chambers, equivalent at maximum rate to 120 air changes per minute in the laboratories, and this has led to the provision of an exceptionally large ventilation system, the air ducts for which, together with other services, occupy the whole upper floor of the building. Until this building is complete, temporary laboratories for the work have been provided in one of the original buildings.

Buildings are also being erected for chemical engineers, who will follow up the work of the research chemists with semi-scale plant. The chemical engineering programme includes the study of methods of extraction of uranium from the many kinds of low-grade ores in which it occurs.



General view of GLEEP

Industrial Applications of Nuclear Power

The Atomic Energy Research Establishment is working on the problem of the application of nuclear power to industrial purposes. A very small beginning will be to extract from the cooling air stream some of the heat developed by BEPO and to use it for space heating. A heat exchanger for this purpose is being installed.

The design of natural uranium piles in which power could be generated as a by-product at a moderate efficiency is being investigated in detail. This investigation is not complete; but it would appear that the construction of such piles is likely to be technically feasible. They would not, however, be worth while economically since such piles only burn up a very small proportion of the uranium. They would only be worth while as a first step to gain experience.

If nuclear power is to become important in the world, four major problems have to be solved. First, the so-called breeding problem must be solved—uranium 235, the only naturally occurring, or 'primary', nuclear fuel must be made to breed 'secondary' fuel from more abundant materials: either plutonium from uranium 238 or U233 from thorium. Second, materials must be found which
will stand high temperatu
and be suitable for use in p
construction. Third, the che
ical extraction problem mu
be solved—the fissile mater
produced must be separat
economically from the unus
uranium or thorium and t
intensely radioactive fission p
ducts. Fourth, a method
disposal must be found f
the large amount of unwant
radioactive material which wou
be produced by power statio
operating on nuclear fuel.

These problems are difficu
and their solution is going
take time. For this reason,
serious person working in t
field believes that nuclear ener
will make any contribution
world power during the ne
decade. At present, work
entirely in the theoretical a
laboratory stages; but it
probable that a number of pi
plants will be built to allow
these problems to be invest
ated. Until this is done
accurate assessment of the pos
bilities for the future can
made.

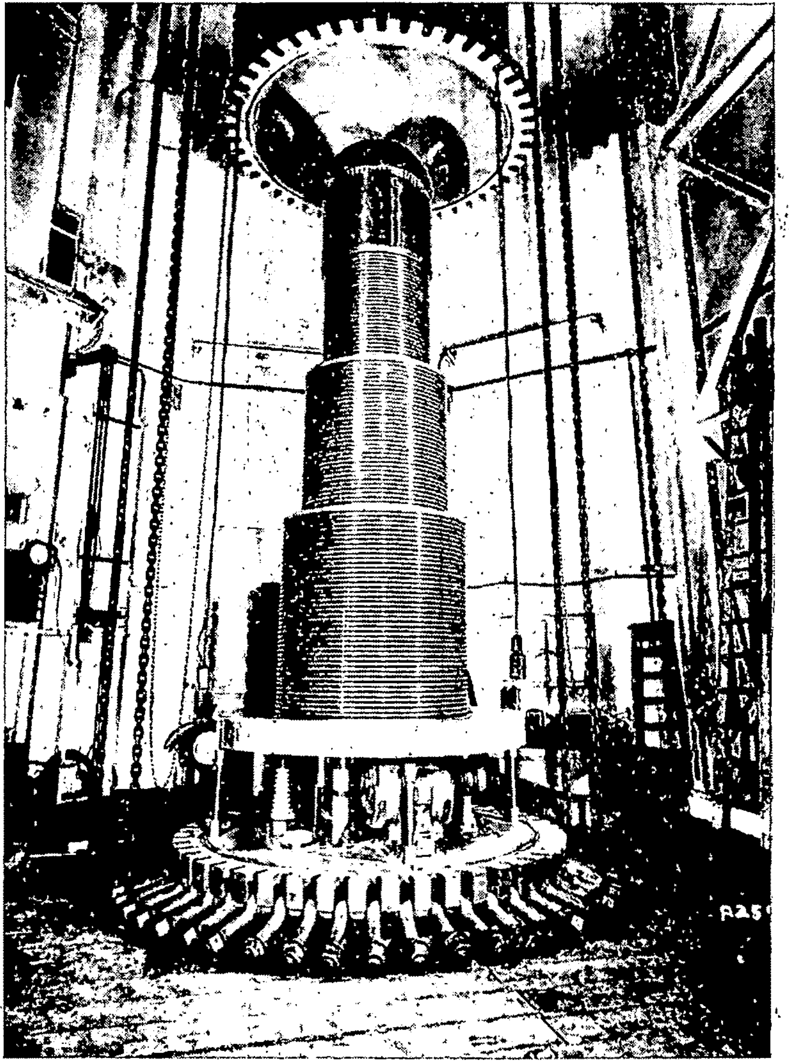
Nuclear Physics

For fundamental research
nuclear physics the Establis
ment is being equipped,
addition to the two piles, wi
several particle-accelerating m
chines.

A frequency-modulated cyc
tron with 110-in. diameter p
pieces is under construction whi
will produce particles with
maximum energy of about 200 MeV.: it will
completed about the end of this year. This machi
will enable the nuclei of most atoms to be brok
up, and will be used to produce new types of nuc
which cannot be produced in the piles.

For the production of monokinetic beams of low
energy particles, a 5-million volt Van de Gra
generator has been built. The design is similar
that of a machine recently completed by Prof. V
de Graaff at the Massachusetts Institute of Tec
nology, and close contact has been maintain
between the Atomic Energy Research Establishme
and the Massachusetts Institute of Technology tea
The design voltage has been obtained without t
accelerating tube in position, and tests are in progr
with accelerating tubes. A 2-MV. machine for wo
in radiation chemistry has been built and is bei
tested by the manufacturer.

In addition to machines for work at Harwell, t
Establishment is assisting universities and t
Medical Research Council by carrying out, on beh
of the Department of Scientific and Industr
Research, development of high-energy particle acc
erators for use in universities and medical depa
ments. A group working at the Telecommunicatio
Research Establishment in Malvern is directing t



Van de Graaff high-voltage generator

velopment of synchrotrons, in-
ding two 30-MeV. machines
r the Medical Research Council,
140-MeV. machine for the
iversity of Oxford and a
0-MeV. machine for the Univ-
sity of Glasgow. It is also
veloping the design of linear
celerators and recently com-
eted a 4-MeV. machine which
now in great demand for
perimental work in nuclear
ysics and radiation chemistry.
Apart from accelerating ma-
ines, a beta spectrometer has
en completed with provision
automatic recording, and
all groups are working on the
sign of neutron spectrometers
d other problems.

The Isotope Programme

It has already been announced
at GLEEP has been used for
e production of radioactive
topes since September 1947.
e rate of production of samples
s increased steadily and is
w about 150 per month.
together more than eight hun-
ed deliveries have been made,
ostly to English universities
d hospitals and to workers
the Establishment, but in-
ding a few to European
untries, and one air delivery
South Africa.
It is expected that BEPO
ll take over the production
radio-isotopes towards the
d of 1948. It will then be
e main source of radio-isotopes
r Great Britain, and will make
possible to extend the supply
countries in the British
mmonwealth and Europe. The higher neutron flux
ailable will allow the preparation of a much wider
nge of materials, and of higher activity samples.
It is intended that the chemical processing and
livery of samples, except those with very short
lf-lives, will be undertaken by the Radio-Chemical
ntre at Amersham, and arrangements have been
ade for the Chemical Research Laboratory to
epare complicated organic molecules containing
dio-carbon, when these are required.
In addition to radio-isotopes, the Establishment
ll produce separated stable isotopes of many ele-
ents. Research groups are working on the separation
stable isotopes by several methods, including
ermal diffusion, fractional distillation and chemical
change. A thermal diffusion plant for the prepara-
on of enriched oxygen 18 is being built, which
ould give by autumn 1948 a yield of 1/7 gm. of
ygen 18 per week, at a concentration of 20 per
nt. A 34-ft. fractional distillation column, working
th liquid carbon monoxide, will be complete in a
w months time, and should give a yield of 0·3 gm./
y of carbon 13 by the end of the year. A small-
ale electro-magnetic separator has been built for
her elements, and a much larger instrument, capable of separating any elements, is being erected. Several mass spectrometers are available for assaying samples, and some development work on the design of these instruments is being undertaken.

Electronics

An atomic energy project requires a great variety of electronic instruments, for example, for pile control, radiochemistry, experiments in nuclear physics and health monitoring. A considerable section of the staff is engaged in designing and developing these instruments. In general, the design is carried to a stage where it can be taken over for production by industry, and the Establishment takes the initiative in finding the requirements of university and medical users, so that their needs also can be met in both the design and production stages.

Health

In view of the possible hazards from radiation and radioactive dusts, very stringent precautions are taken at the Establishment, and the health of all workers is the responsibility of a Medical Division. Everybody is given a thorough medical examination on joining the Establishment, and this is repeated periodically. Workers exposed to radiation have their blood examined from time to time to see whether any change occurs in the number of cells, due to exposure to radiation. Safety measures taken have been such, however, that no over-exposure has occurred and there has been no single case of any harmful effects due to radiation.

Arrangements for the monitoring of scientific workers and their laboratories for radioactivity are the responsibility of a Health Physics Group. Staff exposed to radiation carry a photographic film to record the total dosage taken each week, and those working in very active areas carry pocket condenser chambers from which they can see at any time the amount of radiation to which they have been exposed since the chamber was charged. In addition, fixed instruments are placed in the pile buildings, active chemistry laboratories and grounds to provide a continuous record of radiation. Portable instruments are used to make measurements during any operation such as withdrawing materials from a pile. As a result of all these precautions the actual exposure of staff to radiation is well below the levels which have been recommended by the Medical Research Council. The Health Physics Group is also responsible for monitoring the effluent water from the Establishment and seeing that it complies with the rigid specifications laid down by the Medical Research Council.

SOME NEW RHEOLOGICAL PHENOMENA AND THEIR SIGNIFICANCE FOR THE CONSTITUTION OF MATERIALS

By S. M. FREEMAN
AND
K. WEISSENBERG*
British Cotton Industry Research Association

THE materials studied in rheology are of varied constitution, with intricate patterns of constituent components of visible, colloidal, molecular, atomic and sub-atomic sizes. The patterns range from a *coarse-grained* type in which a discontinuous structure is apparent, to a *fine-grained* one which appears homogeneous and continuous to the eye and even to the microscope; the former type is represented by biological tissues, textile materials, natural and synthetic sponges, foams, powders, timber, cement, etc., and the latter by gases, amorphous liquids and solids, single crystals, etc. In the engineering constructions of Nature and man, widespread use is made of coarse- and fine-grained materials, and this invites an investigation into their mechanical properties as exhibited in changes of volume and form, and into the relation between these properties and the constitution of the materials.

In the present article we shall discuss experiments in which we use both types of material, the coarse-grained ones being particularly valuable here because they can be made to give combinations of mechanical properties suited to the purpose in hand and not easily available in the fine-grained types. Moreover, one can easily vary the constitution of coarse-grained material by physical means an observe macroscopically how the mechanical pro erties depend on the constitution. As an exampl consider coarse-grained sponges of rubber or rubbe like substances. The sponges can be made to displa large elastic recoveries of strains for changes of bot volume and form, a combination not found in fin grained materials. Moreover, the sponges can made in various structural designs, including extremes of an *open* structure with intercommun cating holes, and a *closed* one with isolated hole and also covering a wide range of mixed structur in which the holes may be filled with air or visco or visco-elastic liquids. Another example is provid by the coarse-grained assemblies of fibres, rangi from single hairs to textile fabrics, and yet anoth by powders, etc. We select from the materia of all types samples of a size sufficiently large allow a determination of the mechanical properti in terms of a *continuum theory*, the coarse- and fin grained structures alike being averaged out in continua over regions of macroscopic, microscop or submicroscopic dimensions. For the coars grained materials we can then observe simulta eously the mechanical properties as defined by t continuum theory, and the constitution as reveale by the structural pattern of the components macroscopic size, and thus have a means correlating one with the other. For the fine-graine materials we can observe the mechanical properti as before, and elucidate by analogy the correlati with the hidden constitution on a microscopic a submicroscopic scale.

For ease of reference we shall introduce a nome clature suited to distinguish between different kin of response to mechanical actions. We have exa ined all the materials first in their natural state, wh they are at rest and free from externally appli forces, and we use the term 'isotropic' to indica that the material in its natural state displays f spherical symmetry in response to actions along t various directions in space; the term 'compressib is used to indicate appreciable changes in volu within the range of actions considered; and t term 'shear elastic' to denote in that range appreciable amount of shear strain recovery under sudden release of all external forces. By contra we use the term 'anisotropic' for a deviation fr spherical symmetry, and the terms 'incompressib and 'shear inelastic' when the changes of volume a of shear strain recovery respectively are inapprecia small.

Continuum Theory of the Elasticity of Volu and Form

In the discussion of a continuum theory of t elasticity of volume and form, we shall restrict o selves to materials which are isotropic in their natu state, since the theory appears for these materials its simplest form.

We consider here a differentially small portion an elastic material. Under an applied load of exter forces, the portion will pass from its natural state some static state of equilibrium, shortly referred as the 'loaded state', and will appear there as a cu with edges of unit length. In transit from the natu state the cube will have acquired in the loaded sta a certain *strain*, according to the changes in volu and form, and a certain *stress*, according to t external forces which appear here as traction forces per unit area acting across the faces of the cube. We can then resolve the strain and the stress into components tangential and normal to three adjacent faces of the cube, arrange these components into two square matrices, and define quantities, termed scalar invariants, which remain unaltered under all changes of orientation of the edges and faces of the cube to which the matrices refer. For a given matrix one can express any arbitrarily considered scalar invariant as a function of three, and only three, mutually independent ones, which are distinguished as the first, second and third in accordance with their degrees in the matrix components, and defined respectively as the sum of the terms in the principal diagonal, the sum of the minors of these terms, and the determinant of the matrix. It is then the task of a continuum theory of elasticity to introduce the laws which relate the matrices of stress and strain to one another.

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* Present address: British Rayon Research Association, Bridgewater House, Whitworth Street, Manchester 1.

The classical continuum theory considers only infinitesimally small strains, and assumes for these the validity of Hooke's law. When we apply this law to isotropic materials, we find that the changes of volume must be independent of the tangential components of stress, and the changes of form must be independent of the normal components. Moreover, the law postulates here that the changes of volume are linearly proportional to the mean *isotropic pressure*, calculated as the arithmetical mean of the normal components of stress, and the changes of form linearly proportional to the *deviatory stress*, calculated by subtracting the mean isotropic pressure from the total stress present; the proportionality factors are known as elasticity moduli of volume and of form respectively.

The general continuum theory[3] by contrast considers strains of any amount, small or large, and makes no assumption as to the validity of Hooke's law. We find then for isotropic materials that the changes of volume and of form become interdependent in the sense that the tangential components of stress make some contribution to the changes of volume, and the normal components of stress make a contribution to the changes of form. Lord Kelvin[2] foreshadowed such a possibility in the following words: "It is possible that a shearing stress may produce, in a truly isotropic solid, condensation or dilatation in proportion to the square of its value". We find a general law, according to which the changes in volume can always be expressed as a function of the three scalar invariants of the matrix which represents the stress. It will be noted that the first invariant of stress is linear, contains only the normal components of stress, and is equal to an isotropic pressure multiplied by the factor three, while the second and third invariants are of degrees higher than one and contain normal and tangential components. For a first-order approximation, such as may be allowed for infinitesimally small strain, we neglect terms of higher degrees in the stress components and so find in accordance with Hooke's law that the changes in volume will depend only on the isotropic pressure. When, however, the strains are of appreciable amount, we must take terms of all degrees into account, and we then find non-Hookean terms in the changes of volume which make these changes disproportional to the isotropic pressure, and dependent on both the shear and normal components of stress. In particular, it is to be expected that under large amounts of strain changes of volume may occur even though the first invariant of stress, and the isotropic pressure, are equal to zero, and further, that even paradoxical effects may be expected in which, for example, the volume is decreased while the isotropic pressure acting across the face of a differential cube is a pull. Such a paradox is resolved when one regards the three different invariants as a result of three different ways of forming mean values by averaging over the full solid angle of directions in space. The first invariant corresponds to a mean of the first powers, that is, to a simple arithmetical mean, while the second and third invariants correspond to means of second and third degrees respectively. In the Hookean postulate it is assumed that, for changes of volume, only the arithmetical mean of the traction forces is of importance, while in the general theory means of higher degrees are also admitted.

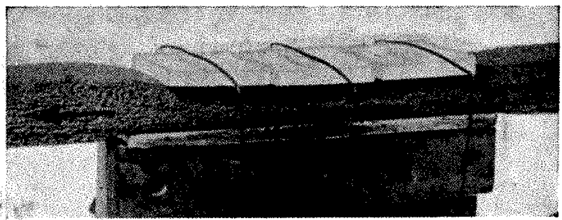
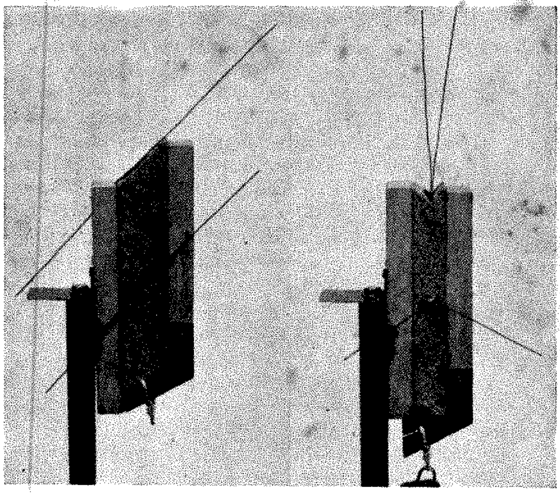


Fig 1



(a) (b)

Fig. 2

To demonstrate experimentally the whole range of effects which are expected in accordance with the general laws we need isotropic materials capable of large elastic recoveries of strain, both in volume and in form. Such materials are available only in a coarse-grained type, and are here provided by the air-filled sponges of rubber with open and closed structures. These sponges show in a striking manner the non-Hookean terms in the changes of volume.

Fig. 1 refers to a sample of sponge rubber which is pulled lengthwise by a 7-lb. weight (indicated by arrows) and simultaneously compressed in height by three blocks of 'Perspex', each loaded by a pair of $\frac{1}{2}$-lb. weights. Attention should be focused on that part of the rubber sponge which lies beneath the middle block, since the blocks on either side are used only as guards intended to secure a nearer approach to homogeneity in the middle. A measurement of the dimensions of the sample reveals that the volume

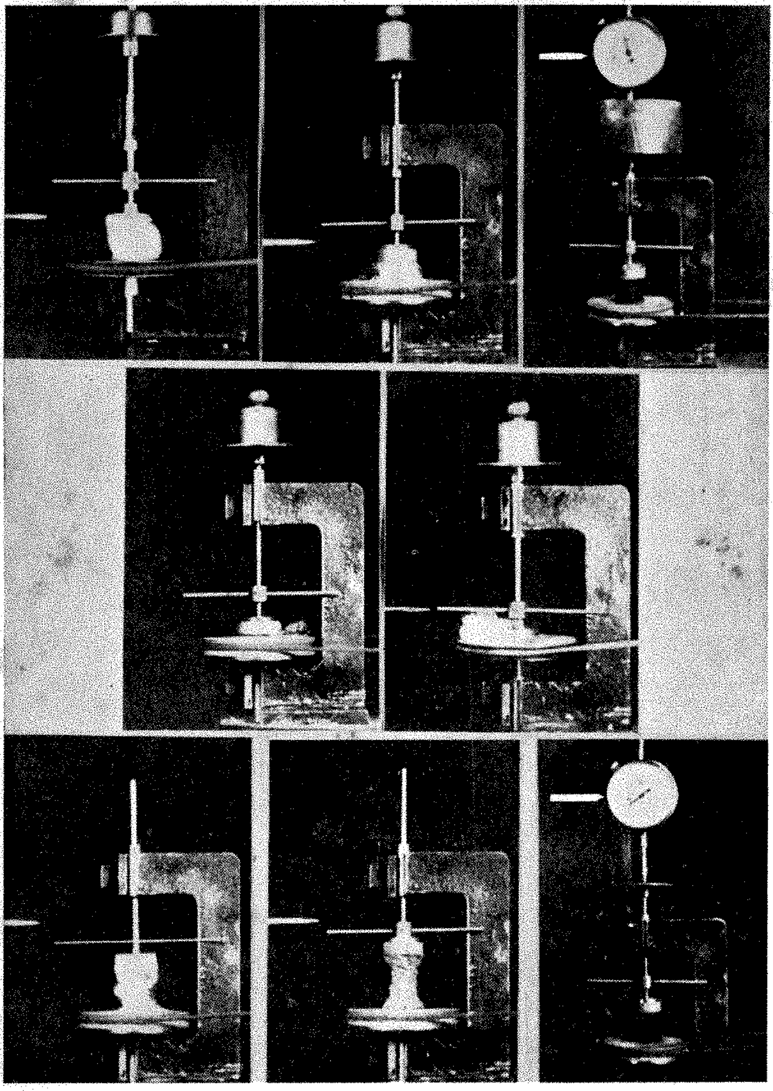


Fig. 3

of the middle part is reduced by about 40 per cent compared with the unstrained state, as the conspicuous decrease in height completely overshadows the changes in the dimensions in length and width. At the same time, the mean isotropic pressure is distinctly in the sense of a pull, since per unit area the lengthwise pulling force is about twenty times as great as the vertical compressive force.

Fig. 2 (*a*) and (*b*) refers to an open sponge rubber cemented between two blocks of wood, the unstrained state being shown on the left (*a*), while on the right (*b*) is the strained state reached when a weight is hung on a bracket fixed to one of the wood blocks. It can be seen that in the strained state the sponge has contracted in all three dimensions, the ends and sides being sucked in, as revealed by the motions of the attached wires, and the thickness being reduced as shown by the decrease in the distance between the wood blocks. In this experiment volume reductions exceeding 40 per cent have been noted, while an examination of the stresses (which is difficult on account of the fact that the stress is heterogeneously distributed in the sponge) shows a mean isotropic pressure in the sense of a pull.

Similar results have been obtained in experiments on samples of sponge rubber of the closed type, and this means that the volume effects shown in Figs. 1 and 2 are by no means restricted to materials with structures in which the changes of volume can occur through an expulsion of the air from the holes in the structure.

Constitution of Matter

In flow experiments on coarse-grained materials, one may observe on a macroscopic scale both the structure and the particular kind of mechanical behaviour displayed, and then correlate one with the other. Such a correlation is difficult to establish for fine-grained materials, since the structure cannot be observed macroscopically. If, however, similarities in behaviour are found between two materials, one visibly discontinuous and the other apparently continuous, the structure which is seen in one provides a possible model (at least) for that which is unseen in the other. (Such an idea appears frequently in scientific literature. H. Mark and F. Eirich used suspensions of elongated particles in liquids to simulate colloidal solution of long-chain molecules, and Sir Lawrence Bragg used groups of soap bubbles to throw light on the sub-visible details of the crystalline structure of metals.) In this way a bridge can be built between the structural and the continuum theories, and an approach made towards finding for the fine-grained materials a correlation between structure and the rheological behaviour.

Preliminary experiments were made to reveal the correspondence in rheological behaviour for the various types of materials here considered.

We first tested the shear elasticity by applying a shearing action and observing the recovery of shear strain under a sudden release of all external forces, so distinguishing between shear-inelastic and shear-elastic materials. We thus collected into the shear-inelastic class some types of fine- and some of coarse-grained materials, the former including optically clear brittle solids, Newtonian liquids, and gases, and the latter dry powders such as chalk, glass, etc. Similarly, we were able to group into the shear-elastic class certain fine-grained types, including colloidal solutions of gelatine, cellulose, rubber, saponified oils, etc., and certain coarse-grained types including the rubber sponges (open and closed) and a large variety of assemblies of fibrous constituents, with the fibres occurring as single hairs or yarns, curled up or stretched out, arranged in a random or orderly manner, varying in length from a millimetre to several metres and composed of wool, cotton, rayon, silk, metal, asbestos, etc.

We then tested the compressibility of the materials and drew a dividing line between the materials termed incompressible and those termed compressible. To a first approximation the dividing line can be drawn so that we find on the side of the incompressible materials fine- and coarse-grained types which are wholly in the condensed states, that is, solid, liquid or intermediate, while on the side of the compressible materials we find the types which are wholly or partly in gaseous states. The division is particularly interesting for the shear-elastic class, in which we find that the types of fine-grained materials considered, namely, the colloidal solutions, are wholly condensed and thus incompressible, whereas the coarse-grained types of rubber sponges and fibrous assemblies contain gases (air) and are accordingly compressible.

On the basis of the classification given above, we can predict in a qualitative way the behaviour under various conditions of the materials within one class and division. We shall illustrate these predictions by describing for the coarse- and the fine-grained materials of the same class experiments under conditions chosen first so that all the materials behave alike because of their class resemblance in shear elasticity[1,3], and secondly, so that they behave differently on account of the additional complications caused by the differences in compressibility.

In the experiments illustrated in Fig. 3, an upright cylindrical specimen of the material considered was subjected to torsion between two parallel disks, the lower one fixed in height but capable of rotation, and the upper one free to move up and down but prevented from rotating. This was achieved by mounting the lower disk on top of a pulley, and securing the upper disk to a stem which slides in a sleeve and carries a crossbar which is checked by the supporting frame. The cylindrical wall of the specimen was left open to the atmosphere. Experiments were performed with various materials including liquids, fibrous assemblies and rubber sponges, but only the shear-elastic materials are shown since the others produce effects of a merely trivial kind. To apply the torsion it is necessary that the material should stick to the disk. For the liquid no special measures are required, but for the fibres it is necessary to face the disks with glass paper, and the sponges must be secured by cementing (thanks are due to Messrs. Dunlop Rubber Co., Expanded Rubber Co., and B.B. Chemical Co., who supplied us with a wide range of sponges, expanded rubbers and adhesives). The photographs show the results of the application of torsion. The pointer on the left-hand side of a picture indicates the original height of the top disk by pointing to the original position either of the crossbar, or of the hand of the dial-gauge.

The first row shows three pictures referring respectively to a fine-grained material, namely, a colloidal solution, and to two coarse-grained materials, namely, a fibrous assembly and a sponge with a closed structure. The materials are subjected to torsion while at the same time they are compressed by a weight. Under these conditions the materials develop stresses which drive them inwards to such an extent as to push the top disk upwards against the action of the weight. The amount by which the top disk rises differs in the three cases, being greatest for the colloidal solution, less for the fibrous assembly and so small for the sponge as to require a dial gauge to reveal it. For the colloidal solution, the torsional motion has to be maintained at constant velocity during the exposure, as otherwise the liquid would lose its stress and run out of the gap. (It is particularly striking that the stresses hold this material in place despite the opposing influence of gravitational and centrifugal forces.) On the other hand, the sponge is a solid which is subjected to a static torsion. The fibrous assembly can be treated as a solid or a liquid, and the torsion applied statically or dynamically.

The second row of pictures shows a visco-elastic liquid and a fibrous assembly. The arrangements are similar to those used for the previous experiments, except that now the speeds and other conditions of the experiment are so chosen that a disturbance occurs in the form of an eddy which rolls the material up and then ejects it from the gap. The photographs were taken at the instant of ejection. No exact theory has yet been developed to account fully for this phenomenon, which occurs exceptionally in liquids but commonly in the fibrous assemblies; it was first observed by K. Weissenberg and R. J. Russell on some specially prepared visco-elastic liquids.

All the photographs so far discussed show the similarity between the coarse- and fine-grained materials. By contrast, the third row shows the additional complication produced in the coarse-grained materials because of their compressibility. The specimens are a fibrous assembly, an open sponge and a closed sponge, in all cases cemented to the disk and treated as solids. A statical torsion has been applied; but in this case without weighing down the top plate. All the materials are again drawn inwards, but the upper disk is pulled down, that is, in the opposite sense to that shown before. It is evident that the materials have been reduced in volume by the waisting and reduction in height.

From the experimental observations cited, it may be concluded that a wide range of structures of cellular or fibrous type provide possible models for the hidden molecular structure of the apparently continuous colloidal solutions in the shear-elastic class. Such models would be insufficiently resistant to changes in volume, and it would be necessary to provide for the missing resistance by appropriate assumptions.

Thanks are due to the director of the Shirley Institute for giving us the opportunity to carry out this work and permission to publish it. We are indebted to Mr. C. Bradley and Miss J. Gallagher for the photographs accompanying this article.

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[1] Freeman, S. M., and Weissenberg, K., *Nature*, **161**, 324 (1948).

[2] Thomson, Sir W., "Math. and Phys. Papers", III, XCII, Part 1, 34.

[3] Weissenberg, K., *Nature*, **159**, 310 (1947).

BRITISH ASSOCIATION

BRIGHTON MEETING

THE programme for the 110th Annual Meeting of the British Association for the Advancement of Science has now been published. The meeting will be held in Brighton during September 8–15, under the presidency of Sir Henry Tizard, who will deliver an address on "The Passing World" in which he will review some of the outstanding features of the progress of science and technology in Great Britain from the close of a period of stagnation towards the end of the nineteenth century.

The meeting will be held, as usual, in thirteen concurrent sections with a number of joint sessions, and the programme also includes evening discourses and a session of the Division for Social and International Relations of Science, at which Dr. Julian Huxley and others from Unesco will discuss "Science Across the Frontiers".

The sectional programmes contain a wide variety of topics, ranging from cosmic magnetism to the effects of the cinema on young people. The objects of the annual meetings of the Association being to provide opportunities for men of science to meet each other and discuss their work in the setting of science as a whole, to allow men of science and laymen to meet each other, and to increase the public understanding of science, the programme includes both specialist and general topics (nearly three hundred speakers).

Among the former are sessions on recent advances in the crystalline state, opened by Sir Lawrence Bragg, geology and air photography, functional morphology (including an address by Prof. H. Graham Cannon), the denudation of the weald, applicable mathematics, the case for and against the metric system, transmission of effects from the endings of nerve fibres (opened by Sir Henry Dale), recent advances in colour vision (including an address by Prof. H. Hartridge), to mention only a few.

The more general topics include industrial applications of electronic devices (with exhibition), new metals in industry, new building materials, problems of Colonial development, movements of population, fuel economy with special reference to the heat pump, human blood groups, problems of old age. Various aspects of food and nutrition will be discussed at several sessions arranged by the Sections of Zoology, Economics, Physiology, Agriculture and Chemistry, and the programme also includes discussions and talks on science in industry as arranged by no fewer than seven sections.

Arrangements have been made for sixty excursions and a number of social engagements, and the members will be entertained at a civic reception in the buildings on the Royal Pavilion Estate.

Further details of the meeting may be obtained from the Secretary of the British Association, Burlington House, London, W.1 (Regent 2019). There is no closing date for registration, and hotel accommodation is still available in Brighton.

THE SWEDISH DEEP-SEA EXPEDITION

By Prof. HANS PETTERSSON
Göteborg

AN account has already been given of the first part of the cruise of the *Albatross* (see *Nature*, October 25, 1947, p. 559). On August 27, 1947, the *Albatross* started from Balboa on its cruise across the Pacific Ocean, and five months later terminated it in the idyllic harbour of Ternate, visited by the *Challenger* Expedition seventy-three years earlier. The course led first to the Galapagos Islands, where the upwelling cold water and the deposits beneath it were studied; then along a west-north-west direction until the eighteenth parallel was reached, from there turning south for Nukuhiva and for Tahiti. Between Tapeete and Honolulu the course of the *Challenger* was followed, although to the opposite direction, several of its stations being repeated under way. From Honolulu the course lay to the south-south-west and, after crossing the equator for a fourth time, we steered west-north-west, finally reaching the great deeps south-east of Mindanao.

Our four first crossings of the counter-equatorial current were used for a close study of its hydrography by frequent deep series, intercalated by bathythermograph shots through the uppermost 140 metres. Interesting results are shown by our diagrams, as the signs of upwelling and descending water in the regions of divergence and convergence respectively in the surface. A distinct oxygen minimum extended from a few hundred metres downwards for 800 m. or more. Clouds of suspended particles studied by the Tyndall method were met with also at great depths.

The ruggedness of the sea bottom revealed by our echograms often proved an obstacle to coring operations, as were also the not infrequent encounters with hard bottom (lava beds) at great depths, sometimes leading to partial or total loss of the steel coring tubes. Nevertheless, fifty-seven cores, varying in length from a few metres to fifteen metres, were raised from depths between 2,000 and nearly 8,000 m., their total length approaching 500 metres. Many of them, especially those taken near the equator, showed a pronounced stratification indicating changes of surface conditions affecting the distribution of plankton organisms. A special feature on our echograms near the regions of divergence at the surface were diffusely reflecting layers in a depth of 100–250 metres, presumably fish shoals or masses of other pelagic organisms. Attempts to sample these reflecting layers failed for lack of suitable gear.

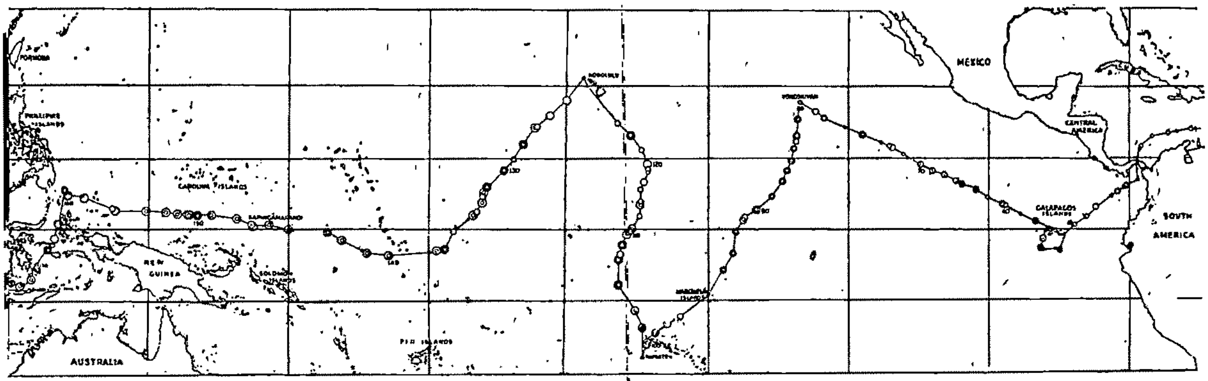
Landings made at different ocean islands afforded opportunities for making botanical collections and photographic studies of animals and plants.

Measurements of the thickness of sediment by means of recording echoes from exploding depth charges were made frequently along our course. Except near Panama, where higher values were found, no reflecting layers could be discovered below the 1,000-ft. level, in striking contrast with the much deeper echoes found in the Mediterranean and in the open Atlantic Ocean.

After proceeding through the Sunda Archipelago to Soerabaya, raising sediment cores displaying volcanic ash layers and taking hydrographic soundings under way, the expedition started on its cruise into the Indian Ocean on February 18, 1948, from Bali. Strong winds, approaching hurricane force in the squalls, made work impossible during the first week; but afterwards weather conditions were ideal. Such was not the case, however, with the state of the sea bottom, the ruggedness of which made both core sampling and measurements of sediment thickness precarious. The number of cores raised from the eastern Indian Ocean was therefore unexpectedly small—a total length of only 60 metres—and the loss of instruments was relatively heavy.

An interesting feature on our echograms was a perfectly flat bottom at a depth of about 4,300 metres, which extended for several hundred nautical miles from near the equator towards the coast of Ceylon, where the depth over long stretches did not vary by more than a few fathoms. Here the core sampler was broken in two, proving that the bottom was hard, with very thin cover of sediment (an extensive lava bed ?).

Following from Colombo a course towards the south-south-east, we again passed over the southern hemisphere, afterwards setting course for the Seychelles. The cores raised from the western Indian



Track of the *Albatross* across the Pacific. The circles indicate the stations occupied

Ocean were more numerous than in its eastern parts; and especially after leaving the Seychelles on a northerly course over the Somali Deep they displayed very pronounced stratification. In the Gulf of Aden as well as in the southern part of the Red Sea in its northern part, the rocky nature of the bottom made core-sampling precarious—the lowest parts of the cores frequently gave off a smell of sulphureted hydrogen, indicating a deficient oxygenization of the bottom waters.

As earlier in the Pacific, our numerous soundings of the thickness of sediment made in the Indian Ocean gave very moderate depths for the reflecting layer, rarely exceeding 200 metres and frequently less than 100 metres.

The hydrographic soundings included two sections across the equatorial current system, where again indications of fish-shoals (or other densely packed pelagic organisms) were found on the echograms. The *Albatross* was considerably delayed coming up the Red Sea by a strong northwester, and arrived at Suez on May 8, having thus devoted two and a half months to the Indian Ocean and to the Red Sea.

OBITUARIES

Sir Clifford Paterson, O.B.E., F.R.S.

SIR CLIFFORD COPLAND PATERSON, director of the Research Laboratories of the General Electric Co., Ltd., Wembley, died at the Watford Peace Memorial Hospital on July 26, shortly after returning from Australia, where he had been acting as contact between British and Australian scientific bodies.

Born on October 17, 1879, Paterson was educated at Mill Hill School and Finsbury Technical College under Silvanus Thompson. After serving a four-year apprenticeship in an engineering works in London he obtained further practical experience in Glasgow and at the Oerlikon Works in Switzerland, going afterwards to Faraday House under Dr. Alexander Russell. From 1903 until 1919 he was principal assistant to Sir Richard Glazebrook at the National Physical Laboratory, and was responsible for the electro-technical and photometric departments. Under his guidance these departments made outstanding contributions in precision methods of measuring electrical power and the establishment of the international standard of light. The Paterson–Walsh electric height finder for indicating automatically the heights of aircraft was developed during the First World War.

Paterson joined the General Electric Co., Ltd., in 1919 to establish the research laboratories of that Company, of which he was made a director in 1941. The progress of so highly technical an industry as electrical engineering depends essentially on scientific research, and the research laboratories which grew up around the achievements and personality of Paterson are representative of the finest of their kind. Starting with a staff of twenty-nine, the General Electric Research Laboratories now employ 1,750 people. Working under the inspiration and guidance of Paterson a distinguished team have made valuable contributions to developments ranging from heavy engineering to electronics. In lighting and vision, fields in which Paterson's greatest personal contributions to science were made, they have been outstanding, as well as in many other branches of applied physics.

The successful prosecution of the War demanded the speedy solution of new problems requiring the application of scientific principles. Radar was a notable example—employed first for the detection of enemy aircraft, then for naval purposes for detection and intricate gun ranging. In this and in many other directions, the facilities and the personnel of the General Electric research organisation under Paterson's direction were a great national asset.

Paterson was a man of great personal charm. His high principles and great integrity in his business, professional and personal relations were so well recognized by all with whom he came into contact that there is no need to stress them. His wide interests and the confidence imposed in him and the esteem with which he was regarded are reflected in the numerous high offices which he held in his profession, and the honours and awards conferred upon him. He was a past president of the Institution of Electrical Engineers, the Institute of Physics, the Electrical Research Association, the Illuminating Engineering Society, the International Commission on Illumination, the Institution of Illumination Engineers in Charge, and the Junior Institution of Engineers. He had been vice-president of the Royal Institution and chairman of council of the British Standards Institution. He was on the Advisory Council of the Department of Scientific and Industrial Research and a member of the Executive Committee of the National Physical Laboratory. He received the degree of D.Sc. (*honoris causa*) of the University of Birmingham in 1937, he was elected to the fellowship of the Royal Society in 1942, awarded the Faraday Medal of the Institution of Electrical Engineers in 1945, and the Ewing Medal by the

Council of the Institution of Civil Engineers in 1947. He was knighted in 1946. The last of his many honours, the Gold Medal of the Illuminating Engineering Society of America, was presented shortly before his death.

He was immensely proud of the City of London's tribute to him when during the last two years of the War he was Master of the Worshipful Company of Tallow Chandlers.

Paterson was a notable and delightful lecturer, and was at his best when his subject lent itself to experiment and demonstration. Among his outstanding lectures and papers may be mentioned the Faraday Lecture of the Institution of Electrical Engineers, "The Free Electron"; the Guthrie Lecture, "The Appraisement of Lighting"; the J. J. Thomson Jubilee Lecture, "The Electron Liberated"; and the British Association York Meeting, "The Use of Photocells".

Opportunities for relaxation and recreation to a man of Paterson's capacity for devotion to the service of his Company and the profession of which he was so distinguished a member were few; but his hobbies of gardening and yachting were a never-failing source of interest and delight to him. His garden, which Lady Paterson and he planned themselves, and the original formation of which was largely the result of their own labours, was much admired by all who were privileged to see it. The majority of his holidays were spent in his yacht on the River Deben at Waldringfield.

By Paterson's death the engineering profession suffers an inestimable loss. The records of his work remain, and are available. Through the great organisation which he built up his influence will be perpetuated; but we shall miss his sound and mature counsel, which grew out of his accumulated experiences and widespread contacts and activities.

Lady Paterson, two sons and a daughter survive him.

A. P. M. FLEMING

Mr. J. R. Cowie

On August 5, Mr. John R. Cowie died aged sixty-six leaving a widow, two sons and one daughter. Chairman of the Council of the Electrical Research Association since the spring of this year, he had been a member of the Council since 1924. This long association with industrial research was particularly concerned with circuit-breaking phenomena and switchgear, which was the first and remains the largest item of research and development in the Association's programme.

Mr. Cowie was especially qualified for leadership both by experience and character. A native of Scotland, he was educated in Edinburgh (Watson's and the Heriot-Watt College) and Glasgow. Apprenticed to William Thomson and Co., he also worked with the British Electric Plant Co., and William Beardmore and Co., before joining the Glasgow Corporation, where he was associated with the late Mr. Lackie and Sir Archibald Page and concerned, *inter alia*, with the Dalmarnock power station and the raising of steam pressures. He joined A. Reyrolle and Co. twenty-seven years ago and was southern area manager at the time of his death. During this period he was associated with most of the great electrical developments in London and in the South and West of England and Wales. He served on the Council of the Institution of Electrical Engineers during 1919–22, and in 1937 was president of the Association of Mining, Electrical and Mechanical Engineers. His influence in the electrical industry was great. Few leading engineers had the same depth of experience and association with great and new projects both on the supply and the manufacturing sides. No one was more trusted, or, indeed, more trustworthy. In negotiation and in matters of discretion his wise counsel and his strong principles were ever in request. His clearness of thought, sincerity and frankness of expression were nevertheless allied to great kindliness. He was a loyal friend and his help was freely given to those who approached him. His subordinates thought as highly of him as his colleagues. He was esteemed not only by engineers but also by those he met in his many sports and hobbies—rugby, hockey, golf, fishing, horticulture and dog-breeding. His convictions inspired respect and his character affection.

S. WHITEHEAD

We regret to announce the following deaths:

Dr. P. R. Lowe, O.B.E., formerly keeper in charge of ornithology, British Museum (Natural History), on August 18, aged seventy-eight.

Prof. A. F. C. Pollard, emeritus professor of physics in the Imperial College of Science and Technology, University of London, on August 15, aged seventy.

Prof. S. W. J. Smith, F.R.S., emeritus professor of physics in the University of Birmingham, on August 20, aged seventy-seven years.

NEWS and VIEWS

Sociology in the London School of Economics: Prof. D. V. Glass

The University of London has just established a new chair of sociology, tenable at the London School of Economics, and has elected Dr. D. V. Glass as the first occupant. This, the third chair in sociology in the School, is designed to promote teaching and research in the sociology of contemporary society and in current methods of collecting and analysing data obtainable by field studies and social surveys. It is therefore a post which offers great opportunities, and Dr. Glass' experience is particularly relevant. He is well known as a demographer of international repute, his most substantial work in this field being "Population Policies and Movements in Europe". He has for many years been research secretary of the Population Investigation Committee and was put in charge of the Family Census by the Royal Commission on Population. His interests have always been more in the social aspects of population than in pure statistical demography. He served his apprenticeship in social research under Prof. Lancelot Hogben, undertaking studies of educational opportunity in Great Britain, and he also published a little book on "The Town" in 1935. All this suggests that he is likely to turn his attention to such questions as family and household structure, local and occupational groups, and social mobility and stratification. These are all eminently subjects for the study of which the chair has been instituted.

The British Institute of Archæology, Ankara: Mr. Seton Lloyd

Mr. Seton Lloyd, who (as announced in *Nature* of August 14, p. 250) has been elected to the directorship of the recently founded British Institute of Archæology in Ankara, started his career as architectural assistant to Sir Edwin Lutyens, and gained his early archæological experience in Egypt during the late 'twenties. During 1930–37 he worked under Dr. Henri Frankfort, as field supervisor to the Iraq Expedition of the Chicago Oriental Institute, and there gained an exceptionally detailed knowledge of mound-excavation on a wide variety of Mesopotamian sites. During this period he had the satisfaction of recovering many now famous art treasures from the rich Sumerian temples of Tell Asmar and Tell Ajrab. Next came two seasons with the Neilson Expedition under Prof. J. Garstang at Mersin in Turkey, where a stratified excavation of extreme complexity gave full scope to his particular talent. Since 1939, as technical adviser to the Directorate of Antiquities in the Government of Iraq, he has been indirectly responsible for a succession of astonishingly successful excavations, which have not only preserved the continuity of archæological discovery, but also raised his Department from a mere administrative service to a unique position as a research institution. Indeed, it would be difficult to over-estimate the debt which Mesopotamian archæology already owes to Mr. Lloyd's technique and the new generation of Iraqi excavators to his guidance. His name is now coupled with those of Mallowan and Woolley as one of the most gifted and successful excavators of our age. On him devolves the task of training those of the coming generation, and it could not be in better hands. His publications show him to be a good all-round archæologist and good artist, with a scholarly as well as a scientific outlook. The new Institute thus makes an auspicious start.

Botany in Nigeria: Prof. F. W. Sansome

The new University College in Nigeria is fortunate to have secured Dr. F. W. Sansome as its first professor of botany. Dr. Sansome received his undergraduate training in Edinburgh as an agriculturist. Upon this foundation he added, at first in Glasgow and later at the John Innes Horticultural Institution, a thorough training in botany and genetics. At this time Dr. Sansome carried out important work on tetraploidy in tomatoes, and published (with Dr. Philp) "Recent Advances in Plant Genetics", which rapidly ran through two editions. He then became senior lecturer in the Botany Department in the University of Manchester, and assistant director of the Experimental Grounds, with responsibilities in horticultural botany and genetics. He devoted his energy, with great success, to the building up of facilities for horticultural research, and the Jodrell Bank Station owes its efficiency to Dr. Sansome's work. Dr. Sansome's infectious enthusiasm has endeared him to horticulturists and students in the north of England, and his wisdom and wit and generosity are greatly appreciated by his colleagues. The good wishes of professional botanists and a large general public will accompany him on his new venture. It is a pleasure to know that his wife, who is distinguished for her research on cytology, is to be a research fellow in Ibadan, and will continue her work there.

Veterinary Science in Bristol: Prof. F. Blakemore

In 1943 the Committee on Veterinary Education, of which Dr. T. Loveday was chairman, recommended that a new school of veterinary science should be established in the University of Bristol. With the concurrence of the Ministry of Agriculture and Fisheries and of the University Grants Committee, the University has undertaken to carry out this recommendation. Plans are far advanced for the additional buildings required, and the small estate of Langford is available as a field station. It is proposed to admit students to the first year of study in the autumn of 1949. The University has recently appointed, as its first professor of veterinary medicine, Mr. F. Blakemore, who is at present superintending veterinary investigation officer for England and Wales. Mr. Blakemore received his veterinary education at the Universities of Liverpool and Manchester. After some experience in practice he served as veterinary officer for the county of Glamorgan, and as veterinary investigation officer for the Eastern Provinces. In 1946 he was appointed to the post he now relinquishes. He has been responsible for the teaching of general hygiene in the University of Cambridge. Mr. Blakemore has carried out extensive work on fowl paralysis and on various diseases of lambs, calves and pigs. He was the first to identify fluorine poisoning of stock in Great Britain and has traced its relation to industry. Recently he has been engaged in the study of mineral deficiency diseases in cattle.

Marin Mersenne (1588–1648)

On September 1 occurs the tercentenary of the death of the French ecclesiast, mathematician and philosopher, Marin Mersenne, whose correspondence with his contemporaries, published in 1933–37, sheds much light on the history of physical science. Born on September 8, 1588, at La Souitiède, Sarthe, he was educated at the Jesuit College at La Flèche, where for a short time he had Descartes—eight years his junior—as a school-fellow. From La Flèche, Mersenne went to Paris to study at the Sorbonne, and about 1616 entered the religious order of Minim Friars, an offshoot of the Franciscans. From 1616 until 1619 he was professor at the College of Nevers and thence onwards was superior of the Convent of his Order in Paris. He travelled into Germany, Holland and Italy, translated Galileo's "Mechanics", and held small gatherings of mathematicians and the like in his room in the Convent, thus anticipating the inauguration of the Royal Academy of Sciences.

Auguste Henri Forel

Neurologist, psychiatrist, entomologist, eugenist, temperance and penal reform advocate, Auguste Henri Forel was born a century ago, on September 1, 1848, at Morges, Canton Vaud, in Switzerland. His childhood studies of ants culminated in the publication, at the age of twenty-six, of "Les Fourmis de la Suisse", of which Darwin confessed that seldom in his life had he been more interested by any book. Studying medicine at Zurich, Forel specialized in psychiatry and was appointed professor of psychiatry in the University and director of the Insane Hospital. The more important works of this indefatigable and versatile man include "Der Hypnotismus und die Suggestive Psychotherapie" (1889), "Hygiene der Nerven und des Geistes" (1903) and "Die Sexuelle

Frage" (1905). The last was translated into sixteen languages, and the year of his death witnessed the publication of a sixteenth edition. It was described by Havelock Ellis as "without doubt the most comprehensive, and taking into account its many-sidedness, perhaps the ablest work which has yet appeared on the sex question". When he was fifty, Forel gave up teaching and devoted himself to the pursuit of his bewildering variety of interests. In 1912 he had a stroke, which resulted in permanent paralysis of his right hand. To the literature of auto-pathography he contributed an interesting account of his dysphasia in the *Journal für Psychologie und Neurologie*, of which he was founder and editor. His autobiography "Out of My Life and Work" (English translation, 1937) is a frank and fascinating self-portrait of one of the most picturesque scientific figures of modern times. He died in 1931.

The *Philosophical Magazine*: 150th Anniversary

THE *Philosophical Magazine* was first published in 1798, and the board of directors and the editorial board have every reason to be proud of the journal's record during its long life of a hundred and fifty years. The title-page to the first volume indicates a breadth of interest "comprehending the various branches of science, the liberal and fine arts, agriculture, manufactures and commerce". Succeeding volumes of the *Magazine* have achieved for it an international reputation as a scientific journal in the realm of physical and mathematical science. David Brewster, John Tyndall, William Thomson, Oliver Lodge, J. J. Thomson are names to be found in the list of editors who succeeded Alexander Tilloch and Richard Taylor, and it is not surprising that such men of science have been responsible for the publication of important papers by research workers in various fields, including those of relativity and atomic physics. The traditionally high standard of the *Philosophical Magazine* has been well maintained, and we wish the periodical every success on the journey towards the two hundredth anniversary of its foundation.

To mark the hundred and fiftieth anniversary of the founding of the *Philosophical Magazine*, a special commemoration number has been edited by Dr. Alan Ferguson under the general title "Natural Philosophy through the Eighteenth Century and Allied Topics" (Pp. viii+164. London: Taylor and Francis. 15*s*.). This is a most useful survey, and includes articles on astronomy through the eighteenth century by Sir H. Spencer Jones, physics by Prof. Herbert Dingle, chemistry by Prof. J. R. Partington, and mathematics by Dr. J. F. Scott. An appropriate review by Engineer-Captain Edgar C. Smith provides interesting material on the achievements of civil engineering. Among the allied topics dealt with are: scientific instruments by Mr. Robert S. Whipple, the scientific periodical from 1665 to 1798 by Dr. Douglas McKie, and the teaching of the physical sciences at the end of the eighteenth century by Dr. F. Sherwood Taylor. The whole volume is both interesting and instructive, containing a wealth of information which enhances its value as a book of reference.

The Night Sky in September

NEW moon occurs on Sept. 3d. 11h. 21m. U.T., and full moon on Sept. 18d. 09h. 43m. The following conjunctions with the moon take place: Sept. 4d. 18h., Mercury 3° S.; Sept. 6d. 22h., Mars 0·7° S.; Sept. 10d. 13h., Jupiter 4° N.; Sept. 29d. 13h., Venus 6° S.; Sept. 30d. 05h., Saturn 4° S. In addition to these conjunctions with the moon, the following conjunctions take place: Sept. 9d. 10h., Saturn in conjunction with Regulus, Saturn 0·8° N.; Sept. 20d. 16h., Mercury in conjunction with Spica, Mercury 0·2° S. Mercury sets at 19h. 15m., 18h. 45m. and 17h. 52m. at the beginning, middle and end of the month, respectively, and is too close to the sun for favourable observation. The planet reaches its greatest eastern elongation on Sept. 25. Venus is a morning star, rising at 1h. 15m., 1h. 30m. and 1h. 55m. at the beginning, middle and end of the month, respectively; it has a stellar magnitude of approximately − 3·8 throughout most of September, and can be observed with phase a little more than half moon most of the time. The planet attains its greatest western elongation on Sept. 3. Mars sets at 20h. 10m. and 18h. 50m. at the beginning and end of the month, respectively, and is too close to the sun for favourable observation. Jupiter can be seen for some time after sunset, the times of setting being 22h. 25m. and 20h. 40m. on Sept. 1 and 30, respectively, but the planet lies rather low for good observation in northern latitudes. Saturn rises at 4h. 10m. and 2h. 35m. at the beginning and end of the month, respectively, and can be seen as a morning star, stellar magnitude 0·9. One occultation of stars brighter than magnitude 6 occurs as follows: Sept. 27d. 01h. 43·5m., 47 Gemi. (*R*), where *R* refers to reappearance; the latitude of Greenwich is assumed. Autumnal equinox commences on Sept. 23d. 03h.

Announcements

DR. G. H. S. BUSHNELL has been appointed curator of the Museum of Archæology and Ethnology in the University of Cambridge.

Mr. B. C. Clayton and Mr. V. D. O. Smyth have recently been appointed advisory officers at the Research Station of the Board of Greenkeeping Research, St. Ives Research Station, Bingley, Yorkshire.

UNDER the auspices of the Society of Chemical Industry, a conference on "Dust in Industry" will be held at the University of Leeds during September 28–30. Further information can be obtained from the General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

A CONFERENCE on "Modern Applications of Liquid Fuels" will be held at the University of Birmingham during September 21–23, under the joint auspices of the Institute of Petroleum and the Institute of Fuel. The president will be Mr. J. A. Oriel. Further information can be obtained from Mr. R. W. Reynolds-Davies, General Secretary, 18 Devonshire Street, London, W.1.

A CONVENTION on "High Vacua" will be held at Gleneagles, Perthshire, during October 12–13, under the presidency of Sir Charles Darwin. Further information can be obtained from Mr. L. L. Maitland, British-American Research, Block E.2, Hillingdon North, Glasgow, S.W.

A DISCUSSION on "Meteors" will be held in the Physical Laboratories of the University of Manchester on September 9. It will be opened by Dr. F. L. Whipple of Harvard University; other speakers will include Mr. J. P. M. Prentice, Dr. J. G. Porter, Mr. N. Herlofson and Dr. A. C. B. Lovell. Further information can be obtained from Dr. Lovell at the above Laboratories.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Behaviour of a Particle of Very Small Mass in a Magnetic Field

It would seem at first sight that a particle of very small mass, such as accompanies β-disintegration or electron-capture, and significant magnetic moment μ, would be very difficult to observe. According to Bethe[1], it should have a fairly high ionizing power and a correspondingly small penetration into matter. Moreover, if it already possesses a charge *e*, the uncertainty principle should play a part in all cases where experimental evidence on μ would be sought[2]. However, for an ultra-relativistic particle (that is, a particle with a high ratio of kinetic mass to rest mass) special considerations come into play which may modify the generally accepted conclusions.

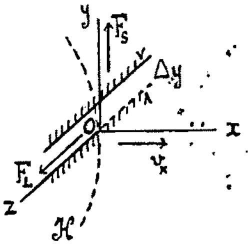
A Dirac particle can be considered as a spherule which is both magnetized and carries an electric charge. As Frenkel[3] has pointed out, if the particle has a magnetic moment $\vec{\mu}$, an electric moment $\vec{\pi}$, of the same order of absolute value, must necessarily appear. Moreover, when the speed approaches *c*, the three vectors $\vec{\mu}$, $\vec{\pi}$ and $\vec{c}$ tend to become orthogonal[4]. The magnitude of the moment $\vec{\mu}$ should vary with the speed if it could have any direction whatever. However, in the case where the moment $\vec{\mu}$ is orthogonal to the direction of the displacement, the former has the properties of invariance, as described by Louis de Broglie[5], who pointed out that the densities of moments $\vec{\mu}$ and $\vec{\pi}$ form the six components of an antisymmetrical tensor of the second order: the main moments that are obtained by integration from these densities have invariant values. Thus, in the relativistic case, moment $\vec{\mu}$ would always tend to follow the orthogonal direction and to be invariant in this.

Let us write the uncertainty relation in a new form that is better adapted to high speeds:

$$\Delta x \,.\, \Delta\eta \geqslant \frac{h}{m_0 c}, \text{ where } \Delta x \,.\, \Delta v \geqslant \frac{h}{m_0 \eta^3} \qquad (1)$$

$$(\text{for } \Delta p = m_0 c \,.\, \Delta\eta = m_0 \eta^3 \, \Delta v).$$

In the diagram, particles (e,μ), with a speed v_x in the direction Ox, cross a long slit in the Z direction which has the width Δy.



The Lorentz force at the origin O is $F_L = ev_x\, H(O)$. The width Δy of the slit introduces in this force an uncertainty

$$\Delta F_L = e\left[v_x\left(\frac{\partial H}{\partial y}\right)\Delta y + H(O)\Delta v_x\right],$$

which we must compare to the force F_S due to spin. The ratio of these forces, with $\mu = eh/4\pi m_0$, will be

$$\frac{\Delta F_L}{F_S} = \frac{4\pi m_0}{h}\left[v_x \Delta y + \frac{H}{\partial H/\partial y}\,\Delta v_x\right], \qquad (2)$$

putting, from (1),

$$\Delta y \geqslant \frac{h}{m_0 \eta^3 \Delta v_y} \text{ and } \Delta v_x \geqslant \frac{h}{m_0 \eta^3 \Delta x}. \qquad (3)$$

(2) then becomes

$$\frac{\Delta F_L}{F_S} \geqslant \frac{4\pi m_0}{h}\left[\frac{h}{m_0\eta^3}\cdot\frac{v_x}{\Delta v_y} + \frac{h}{m_0\eta^3}\,\frac{H}{\partial H/\partial y}\,\frac{1}{\Delta x}\right], \text{ or}$$

$$\frac{\Delta F_L}{F_S} \geqslant \frac{4\pi}{\eta^3}\left[\frac{v_x}{\Delta v_y} + \frac{H}{\partial H/\partial y}\,\frac{1}{\Delta x}\right].$$

The term in brackets being obviously greater than 1, we finally get

$$\Delta F_L/F_S \geqslant 4\pi/\eta^3, \qquad (4)$$

and the magnetic moment μ will be observable if

$$\eta^3 \geqslant 4\pi, \qquad (5)$$

a condition that is obviously fulfilled for every relativistic particle.

The magnetic moment of a charged light particle might thus be found.

Even if we deny invariance to the magnetic moment and allow that its absolute value might decrease as the kinetic mass of the particle increases, the various expressions which have been given[6] for the conditions of observability remain, with a power of η diminished by one unit, and the conclusions are unchanged.

The foregoing considerations are of a very general character. The question will be examined afresh with the Dirac method. On the other hand, I shall shortly show that a relativistic particle may give a weaker ionization when traversing matter than was previously thought. This arises both because of the orthogonal relation of the electric moment $\vec{\pi}$ to $\vec{\mu}$ and $\vec{c}$, and because of the contracting of the magnetic and electric lines of force in a plane normal to the direction of its displacement.

J. THIBAUD

Institute of Atomic Physics,
University of Lyons,
1 rue Raulin, Lyons.
May 8.

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Feret's Statistical Diameter as a Measure of Particle Size

Various measures of the size of irregularly shaped particles as seen in profile under the microscope have been used, chosen according to their theoretical significance or practical ease of measurement. These include, using Heywood's notation[1,2]: (i) the diameter of the circle of equal area, *d*; (ii) the diameter of the circle of equal perimeter, *D*; (iii) the length of line bisecting the profile area (Martin's statistical diameter[3]), *M*; and (iv) the perpendicular distance between parallel tangents touching opposite sides of the profile (Feret's statistical diameter[4]), *F*. *M* and *F* are determined for randomly oriented particles, thus giving an average value over all possible orientations. *d* is usually regarded as the ideal measure of particles seen in profile, but is somewhat difficult to determine experimentally with precision. It is, however, common practice when sizing very small particles to estimate *d* visually by comparing them with standard reference circles on a Patterson and Cawood or similar type of eyepiece graticule[5,6]. *M* and *F* are convenient to measure in practice with aid of an eyepiece scale or filar micrometer, and have been extensively used by various workers. *D*, or rather the ratio *D*/*d*, termed by Heywood[1] the 'contour ratio', and its reciprocal called the 'degree of circularity' by Wadell[7], have been used in discussing the shape and hydrodynamical properties of particles. For these purposes *D* has usually been determined by direct perimeter measurement of the projected images of particles. It does not appear to have been adopted intentionally in any work known to me as a direct single measure of particle size.

In fact, it can be shown that *D* and *F* are equivalent measures provided that the particle profile is non-re-entrant, a condition which is usually satisfied. This simple identity seems to have been overlooked hitherto in particle-size work. Elementary calculation will demonstrate the relationship for simple geometrical outlines, for example, triangle or rectangle, orientated in all possible directions. The proof in the more general case follows readily by considering each element of the perimeter separately. The three-dimensional equivalent of this result is already well known, namely, that the mean projected area of a three-dimensional particle averaged over all orientations is equal to one quarter of the total surface area of the particle, again with the condition of non-re-entrancy. This latter relationship has been much used in the determination of the specific surface of suspended particles by light obscuration methods[8]. Both results follow from two mathematical theorems given by Cauchy in 1841[9]. The second of these theorems is discussed by Vouk[10].

In a recent paper, Heywood[2] has discussed the various methods of measuring microscopical particles. Judging other measures by comparison with the mean projected diameter, *d*, as standard, he concludes: "The Feret definition of statistical diameter is not recommended on account of the large positive error introduced for elongated particles". Interpretation of the Feret diameter as $1/\pi$ of the perimeter shows that no general correspondence with *d* can obtain for particles of differing shape; but it gives this statistical diameter an important new significance, particularly in connexion with the specification of particle shape and correlated properties.

W. H. WALTON

National Coal Board, Scientific Department,
4 Albert Hall Mansions,
London, S.W.7.
April 26.

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Projected Area of Convex Bodies

In connexion with photometric determination of specific surface of finely divided material, it is essential to know the relation between the projected area of particles, which is actually measured, and the corresponding surface area. The solution of this problem was first given by A. Cauchy in his "Memoire sur la rectification des courbes et la quadrature des surfaces courbes" (Paris, 1832)[1]. A short account of his results in the form of theorems was later published in the *Comptes rendus*[2], but no formal proof was given. It is the latter paper which is usually referred to in connexion with the above problem.

The relevant theorem states that

$$S = 4\overline{A}, \tag{1}$$

where S is the surface area and $\overline{A}$ the average projected area of the convex body. The average is taken over all possible orientations in space. Although this result has been much used and discussed by many experimental and theoretical workers[3], there still seems to be much confusion and uncertainty as to its general validity. Thus in *Nature* recently[4], Dr. B. A. Scott says that it can be shown that the ratio of surface to projected area for a rectangular parallelepiped in random motion is $18\pi/(8+\pi)$ independent of the relative lengths of the axes. Dr. Scott uses this result to compute the surface area of calcined and hydrated alumina, and obtains a very good agreement between the estimates of the surface area obtained from optical measurement and other methods. Since similar work is going on in our laboratory, Dr. Scott's statement induced us to examine once more the literature on Cauchy's theorem, and we came to the conclusion that an error must have crept into Dr. Scott's calculations.

Since the original Cauchy's papers are not easily accessible and the discussion of the problem presented therein is not always easy to follow, we think it worth while to give a short proof of equation (1) in a slightly different form from that given by Cauchy.

Consider a convex body having a surface area S. Suppose there are no re-entrant surfaces, that is, the surface S cannot be pierced by a straight line on more than two points. We divide S into a large number of infinitesimal surface elements, which can be represented by a vector $\vec{d\sigma}$ having the direction of the outward normal to the surface element and the magnitude numerically equal to its area. The projection dA of such an element on a fixed plane P specified by its normal $\vec{n}$ is given by the absolute value of the scalar product $|\vec{d\sigma} . \vec{n}|$. For the sake of simplicity, we shall suppose that the plane P is perpendicular to one of the axes (for example, the x-axis) of a rectangular co-ordinate system x,y,z. The components of the vectors $\vec{d\sigma}$ and $\vec{n}$ will then be given by: $\vec{d\sigma} = d\sigma\,(\sin\vartheta\cos\varphi\vec{i} + \sin\vartheta\sin\varphi\vec{j} + \cos\vartheta\vec{k}$, and $\vec{n} = \vec{i}$, where $\vec{i}, \vec{j}, \vec{k}$ are unit vectors in directions of the co-ordinate axes, and ϑ and φ are the angles which the vector $\vec{d\sigma}$ forms with positive z and x axes. Since all orientations of the surface element are equally likely, the average value of the projection of $\vec{d\sigma}$ on the plane P is given by:

$$\overline{dA} = \frac{1}{4\pi}\iint\limits_{\omega} |\,\vec{d\sigma}\cdot\vec{n}\,|\,d\omega, \qquad (2)$$

where $d\omega$ is the element of solid angle ($= \sin\vartheta\, d\vartheta\, d\varphi$) and the integration has to be carried out over the total solid angle 4π. Now in optical problems the surface element will contribute to the projection of the body only if its orientation is such that the angle between $\vec{d\sigma}$ and $\vec{n}$ is less than $\pi/2$. Therefore, the right-hand side of equation (2) should be multiplied by a factor 1/2. Thus we have

$$\overline{dA} = \frac{d\sigma}{2\pi}\int_0^{\pi}\int_0^{\pi/2}\sin^2\vartheta\cos\varphi\, d\vartheta\, d\varphi. \qquad (3)$$

The integration of (3) gives

$$\overline{dA} = 1/4\, d\sigma. \qquad (4)$$

Now if there are no re-entrant surfaces, we can consider the elements of the surface of a convex body as giving equal contributions independent of each other to the total average projected area of the body, and we can write

$$\overline{A} = 1/4\iint\limits_{\sigma} d\sigma, \qquad (5)$$

and the proof of the relation (1) is completed.

In the presence of re-entrant surfaces, equation (5) is not valid, since the contributions from different surface elements cannot be taken as independent. Our assumption that a given surface element contributes to the projected area only if the angle between vectors $\vec{d\sigma}$ and $\vec{n}$ is less than $\pi/2$ is no longer true. There will be some orientations of the body in which some of the surface elements will not make any contribution, although their normals form with the normal of the fixed plane P an angle less than $\pi/2$, because of the obscuration effect. Therefore the ratio of the projected to the surface area for such bodies will always be less than 1/4.

For polyhedra it is not necessary to subdivide the surface in infinitesimal elements $d\sigma$. It suffices to calculate the contribution from each of the n faces separately, and to replace the integral in equation (5) by a summation.

The validity of relation (1) can also be shown by computing the projected area of the body as a whole, and integrating over all possible orientations. This method was used by Cauchy in his original paper (1) in the case of an ellipsoid. The calculation is easy for such simple bodies as the cube, the parallelepiped, the prism or the cylinder, but for more complicated polyhedra it becomes very tedious.

V. VOUK

London School of Hygiene,
Keppel Street,
London, W.C.1.
April 26.

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Proton Bombardment of Fluorine

CAPTURE γ-rays have been detected in the proton bombardment of most of the light nuclei from Li^7 to Cl^{37}. The yield from a thick target for a single level in the compound nucleus is proportional to:

$$\Gamma_p\Gamma_\gamma/\Gamma. \qquad (1)$$

The presence of a competing mode of disintegration only reduces this yield as much as it increases the total width Γ. Thus, in the case of F^{19}, the most probable transmutation is the short-range α-emission:

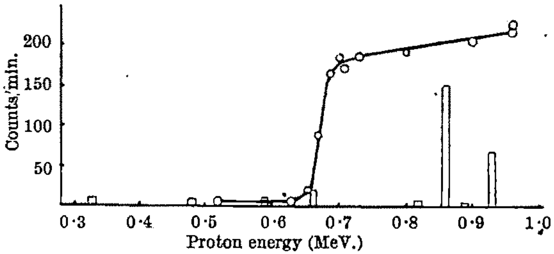
$$F^{19} + H^1 \rightarrow Ne^{20*} \rightarrow O^{16*} + He^4$$
$$O^{16*} \rightarrow O^{16} + h\nu \text{ (6 MeV.)}; \qquad (2)$$

but this should not decrease the probability of γ-emission from the levels of Ne^{20} produced by protons of more than about 600 keV., for in this energy region we expect the proton width Γ_p to exceed the short-range α-particle width Γ_α; and the total width Γ will be determined largely by the former.

The high yield of 6 MeV. γ-rays from (2) does, however, make it difficult to observe the expected capture γ-rays:

$$F^{19} + H^1 \rightarrow Ne^{20*} \rightarrow Ne^{20} + h\nu \qquad (3)$$
$$(Q = 12{\cdot}8 \text{ MeV.}).$$

We used the (γ,n) reaction in Cu^{63} as a threshold (10·9 ± 0·3 MeV.)[1] detector, counting the resulting 10·5-min. activity on thin-wall aluminium β-counters. The accompanying graph gives our results, and also indicates the positions and relative yields of the resonances for process (3)[2]. The shape of the rise between 630 and 700 keV. was compared with the rise in the yield of the 6 MeV. γ-rays, measured simultaneously with a Geiger – Müller γ-counter, and agreement was good. The slow rise between 700 and 960 keV. may be the result of a dirty target, or may indicate the emission of γ-rays from the broad levels[3,4] of Ne^{20}. In either case, it is clear that there is no yield of high-energy γ-rays from the other resonances of reaction (3), comparable with the yield at the 660 keV. resonance.



o, Cu^{62} activity; ⊓, short-range α-particle resonances

The energy available for this transition, 13·4 MeV., does not greatly exceed the threshold of the detector; and Dee, Curran and Strothers[5] found no γ–γ coincidences from fluorine bombarded with protons. It is thus probable that the γ-ray that we detect is the full energy transition to the ground-state.

Having the 590 and 862 keV. resonances available for background runs with the high intensity of 6 MeV. γ-rays alone present, we were able to measure the higher energy γ-rays by the coincidence absorption method, using two Geiger–Müller counters. By this means the angular distribution of the capture γ-ray was found to be isotropic, intensities at 0°, 45° and 90° to the proton beam direction being equal within a probable error of 10 per cent. The yield at the 660 keV. resonance was estimated at 2·2 ± 0·8 per cent of the 6 MeV. γ-rays, giving a radiation width of the order of 2 eV. for this level of Ne^{20}, and less than 0·1 eV. for the others up to 1 MeV. proton energy. This yield is consistent with our measurements with the copper detector if the (γ,n) cross-section of Cu^{63} is about $1 \cdot 5 \times 10^{-27}$ cm.² at this energy[6].

S. DEVONS
H. G. HEREWARD

Cavendish Laboratory, Cambridge.

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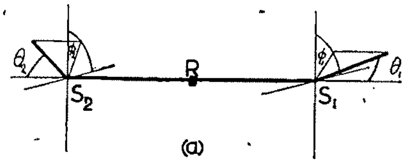
Polarization of Annihilation Radiation

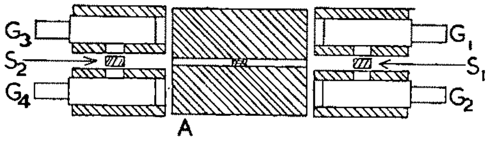
AN attempt has been made to detect the relative polarization of the two photons of energy 0·51 MeV. produced in the annihilation of slow positrons. If pairs of quanta from a source of annihilation radiation at R (Fig. *a*) are scattered at S_1 and S_2, theory[1-3] predicts an angular distribution of quanta after Compton scattering given by the formula

$$N(\theta_1\varphi_1\theta_2\varphi_2)d\Omega_1 d\Omega_2 =$$
$$k\left\{\frac{[(1-\cos\theta_1)^3+2][(1-\cos\theta_2)^3+2]}{[2-\cos\theta_1]^3[2-\cos\theta_2]^3} - \frac{\sin^2\theta_1\sin^2\theta_2\cos 2(\varphi_1-\varphi_2)}{[2-\cos\theta_1]^2[2-\cos\theta_2]^2}\right\}d\Omega_1 d\Omega_2,$$

where θ_1 and θ_2 are the angles through which the quanta are scattered, φ_1 and φ_2 are the azimuthal angles measured in a plane perpendicular to the direction of incidence (S_1RS_2), and $N(\theta_1\varphi_1\theta_2\varphi_2)d\Omega_1 d\Omega_2$ the probability of the two quanta being scattered into elements of solid angle $d\Omega_1$ and $d\Omega_2$ in the directions $(\theta_1\varphi_1)$, $(\theta_2\varphi_2)$.



(a)



(b)

The apparatus for the experimental verification of this formula is sketched in Fig. *b*. Positron-active material, packed into an aluminium tube, is placed at the centre of the lead block A. Oppositely directed quanta pass down the collimating channel to strike the cylindrical scatterers S_1 and S_2. Lead shields define the solid angles into which quanta must be scattered to reach the Geiger counters G_1, G_2, G_3 and G_4. Coincident discharges of either G_1 or G_2 with either G_3 or G_4 are recorded when all four counters lie in the same plane (coplanar position), and when one pair of counters is rotated through 90° about $S_1 S_2$ (perpendicular position), corresponding to mean values of $(\varphi_1-\varphi_2)$ of 0° and 90° respectively. The total numbers of discharges in each pair of counters (of which 70 per cent are due to quanta scattered by S_1 or S_2) are recorded and used to calculate corrections for source decay and chance coincidences.

Sources of Cu^{64} (12·8 hr. half-life) were prepared by deuteron bombardment of copper in the Cambridge cyclotron; each had an initial activity of about 3×10^8 positrons per sec., and gave useful counting rates over a period of 36 hours after irradiation. The results from thirteen such sources are condensed into the accompanying table. The first results were obtained with brass scatterers 1 in. long and 0·6 in. in diameter; later, aluminium scatterers of the same dimensions were used to minimize the effect of double scattering. Two different arrangements of lead shields surrounding the counters were used, the first defining rather larger solid angles for detection of the scattered quanta than the second. Corrections have been made for source decay, chance coincidences, and a background-rate of 3 per hr. due to cosmic rays. The net coincidence-rates at the beginning of each run were of order 0·5 per min. The errors quoted are standard deviations calculated assuming normal statistical fluctuations, and are compatible with the variations in the results from individual sources.

Scatterer material		Brass	Brass	Aluminium
Lead shield arrangement		Wide angle	Narrow angle	Narrow angle
$\frac{\text{Counting-rate (perpendicular pos.)}}{\text{Counting-rate (co-planar pos.)}}$	(theory)	1·55	1·82	1·86
,, ,, ,, ,,	(experimental)	1·39 ± 0·07	1·31 ± 0·17	1·51 ± 0·10

The results establish the existence of a relative polarization. Further experiments are needed, however, to determine whether the discrepancies between theoretical prediction and experimental results are merely instrumental, or due to a breakdown of theory.

The deviations appear too large to be dismissed as due to statistical fluctuations, especially as the independent results using different scatterers are all consistently lower than the theoretical predictions. Any double scattering of quanta within the scatterers would tend to reduce the observed ratio; the increase in the observed ratio with the lower density scatterers may be significant. A rigorous calculation of such an effect is not feasible; rough calculations indicate that it should not be serious. The Geiger counters are being replaced by scintillation counters; an expected twenty-fold increase in detection efficiency will permit the use of smaller scatterers of low-density material, more close defined geometry, and increased counting-rates, and so settle definitely whether or not the theoretical predictions are quantitatively correct.

Note added in proof, August 21. The results of Bleuler and Bradt[4] are noted. Their value for the ratio of perpendicular to coplanar coincidence-rates, while in agreement with theory, has a sufficient margin of error to be compatible with the results quoted here.

R. C. HANNA

Cavendish Laboratory, Cambridge.

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Origin of Cosmic Ray Stars

As yet, the absorption of the star-producing radiation has only been measured in air. Nevertheless, the variation of the intensity of single tracks recorded in photographic plates under various lead absorbers has been measured at high altitude and at sea-level[1,2]. The decrease of single tracks with a given lead absorber is found to be much less than the decrease of stars in an equal weight of the atmosphere. Perkins[2] has shown that the number of single tracks is proportional to the number of stars, and therefore it appears established that the range of the star-producing component of cosmic radiation expressed in gm./cm.^{2} is larger by a factor of approximately 3 in lead than it is in air.

This difference in range could be caused possibly by the difference in (*a*) density, or (*b*) atomic weight, A, of the two materials. Perkins has assumed the former and has concluded that the stars are produced by an unstable particle. It seems worth while to explore the latter possibility, as this leads to a dependence of the range of the primaries on A, not very dissimilar from that found experimentally.

Thus, it is well known that the nuclear radius is approximately proportional to $A^{1/3}$:

$$R = r_0 A^{1/3}, \text{ with } r_0 \sim 10^{-13} \text{ cm.} \qquad (1)$$

The cross-section, σ, will be πR^2, and the number of nuclei per gm./cm.^{2}, n, will be N/A, where N is Avogadro's number. Hence the mean free path for a radiation interacting strongly with the nuclei will be given by:

$$l = 1/n\pi R^2 \text{ gm./cm.}^2, \text{ or } l = A^{1/3}/N\pi r_0^2 \text{ gm./cm.}^2. \qquad (2)$$

Substituting numerical values, one obtains:

$$l_{\text{air}} \doteq 130 \text{ gm./cm.}^2, \; l_{\text{lead}} = 311 \text{ gm./cm.}^2,$$
$$l_{\text{lead}}/l_{\text{air}} = 2{\cdot}5,$$

which do not differ greatly from the observed values.

Thus, as an alternative to the assumption of unstable primaries, one may equally well assume the primaries to be stable particles having a cross-section for star production given by the so-called geometric cross-section, and hence a range given by (2).

From the known constitution of the Ilford nuclear emulsion, one obtains for the range of the primaries in the emulsion on this basis:

$$l_E = 200 \text{ gm./cm.}^2 = 50 \text{ cm.}, \qquad (3)$$

since $\rho_E = 4$. Let S be the number of primaries crossing 1 cm.^{2} per day, and I the number of stars formed per c.c. per day. Then approximately:

$$S/l_E = I. \qquad (4)$$

Now, at Jungfraujoch, $I \sim 10$ stars/c.c./day, and hence:

$$S \sim 500/\text{cm.}^2/\text{day}, \qquad (5)$$

or, in other words, about 12 per cent of the total corpuscular radiation at this altitude.

This is in rough agreement with Schopper's estimate[3] of the intensity of fast neutrons, based on measurements of the number of recoil protons recorded in plates covered with paraffin. Thus, the assumption that the majority of cosmic ray stars are caused by fast neutrons is not in violent disagreement with the existing data.

E. P. GEORGE

Physics Department, Birkbeck College,
London, E.C.4. May 19.

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Random Association of Points on a Lattice

A LATTICE is defined to be a rectangular array of points each of which may be any one of k colours. In a previous communication[1], I have given the first and the second moments for the probability distribution of the total number of joins between points of different colours, when the probability that any point is of colour r is $p_r \left(\sum_1^k p_r = 1 \right)$ and is independent of the colour of all the other points. A join was there defined as a line between two adjacent points parallel to the axes of the lattice. The present note gives the first and the second moments for the distribution of (1) the number of joins between points of the same colour, and (2) the total number of joins between points of different colours for two- and three-dimensional lattices when all possible joins between adjacent points are included. The first distribution corresponds to Todd's distribution of 'doublets'[2].

(1) *Joins between points of the same colour, say, rth colour.*

(*a*) Two-dimensional lattice: $m \times n$ points:

$$\begin{aligned} \mu_1' &= (4b - 3a + 2)\, p_r^2, \\ \mu_2 &= (4b - 3a + 2)\, p_r^2 \\ &\quad + 8(7b - 9a + 11)\, p_r^3 \\ &\quad - 15(4b - 5a + 6)\, p_r^4. \end{aligned}$$

(*b*) Three-dimensional lattice: $l \times m \times n$ points:

$$\begin{aligned} \mu_1' &= (13e - 9d + 6c - 4)\, p_r^2, \\ \mu_2 &= (13e - 9d + 6c - 4)\, p_r^2 \\ &\quad + 2(325e - 378d + 432c - 488)\, p_r^3 \\ &\quad - (663e - 765d + 870c - 980)\, p_r^4. \end{aligned}$$

(2) *Total number of joins between points of different colours.*

(*a*) Two-dimensional lattice: $m \times n$ points:

$$\begin{aligned} \mu_1' &= 2(4b - 3a + 2)\, \Sigma p_r p_s, \\ \mu_2 &= 2(32b - 39a + 46)\, \Sigma p_r p_s \\ &\quad - 8(39b - 48a + 57)\, \Sigma p_r p_s p_t \\ &\quad - 60(4b - 5a + 6)\, \Sigma p_r^2 p_s^2 \\ &\quad + 120(4b - 5a + 6)\, \Sigma p_r p_s p_t p_u. \end{aligned}$$

(*b*) Three-dimensional lattice: $l \times m \times n$ points:

$$\begin{aligned} \mu_1' &= 2(13e - 9d + 6c - 4)\, \Sigma p_r p_s, \\ \mu_2 &= 2(338e - 387d + 438c - 492)\, \Sigma p_r p_s \\ &\quad - 2(1677e - 1926d + 2184c - 2456)\, \Sigma p_r p_s p_t \\ &\quad - 4(663e - 765d + 870c - 980)\, \Sigma p_r^2 p_s^2 \\ &\quad + 8(663e - 765d + 870c - 980)\, \Sigma p_r p_s p_t p_u. \end{aligned}$$

In all these expressions, $a = m + n$, $b = mn$, $c = l+m+n$, $d = lm + mn + nl$, and $e = lmn$. The summations are taken for all values of r, s, t and u such that $1 \leqslant r < s < t < u \leqslant k$.

All the distributions tend to the normal form when l, m and n tend to infinity.

The corresponding results when the lattices consist of a fixed number of points of the various colours, say $n_1, n_2, \ldots n_k$, have also been worked out. These results, being long and complicated, will be given in another communication to be published shortly.

P. V. KRISHNA IYER

Department of the Design and
Analysis of Scientific Experiment,
Oxford. April 9.

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Difference – Differential Equations

THE general linear homogeneous difference-differential equation with constant coefficients is

$$\Lambda(y) \equiv \sum_{\mu}\sum_{\nu} a_{\mu\nu} y^{(\nu)}(t + b_\mu) = 0, \qquad (1)$$

where $0 \leqslant \mu \leqslant m$, $0 \leqslant \nu \leqslant n$, $y^{(\nu)}(t)$ is the ν-th derivative of the unknown function $y(t)$ and $0 = b_0 < b_1 < \ldots < b_m$. Particular examples of this equation have appeared in radiology[1,2], economics[3,4] and the theory of control mechanisms[5,6]. The most useful 'boundary conditions' are also the most convenient from the theoretical point of view; we suppose assigned the values of $y(t)$ in an initial interval $0 \leqslant t < b_m$. In terms of these given values, we define a function

$$\varphi(s) = \sum_{\mu}\sum_{\nu} a_{\mu\nu} \exp(b_\mu s) \times$$

$$\left\{ \int_0^{b_\mu} y^{(\nu)}(u) e^{-su} du + \sum_{\lambda=0}^{\nu-1} s^{\nu-1-\lambda} y^{(\lambda)}(0) \right\}.$$

(In particular cases this usually reduces to something fairly simple.) It is obvious that $y = \exp st$ is a solution of (1) for any s satisfying

$$\tau(s) \equiv \sum_{\mu}\sum_{\nu} a_{\mu\nu} s^\nu \exp(b_\mu s) = 0.$$

The zeros of $\tau(s)$ are infinite in number; but their asymptotic behaviour is readily calculable[7]. Under suitable conditions, the solution of (1) is

$$y(t) = \sum_{s} \frac{\varphi(s) \exp st}{\tau^1(s)}, \qquad (2)$$

where s runs through all the zeros of $\tau(s)$. I here assume that $\tau(s)$ has no double zero; if it has, a slight modification must be made in the corresponding term. The series in (2) is convergent and its sum is $y(t)$ (i) for all t, if $a_{mn} \neq 0$ and $a_{0n} \neq 0$, and (ii) for all $t > b_m$, if $a_{mn} \neq 0$. (2) was first given by Hilb[8], but under conditions which would exclude most of the applications. A detailed proof of its validity under the conditions stated will be published shortly[9].

The most interesting question about $y(t)$ is how it behaves when t is large and, in particular, whether $y(t)$ becomes small, periodic or large. This requires a study of the zeros of $\tau(s)$. In any particular case the behaviour of the large zeros can be determined from Langer's theory[7]. If these zeros all have their real parts negative, so that the corresponding terms in $y(t)$ are damped, attention must be directed to a finite number of non-large zeros. This problem for the particular cases in which

$$\tau(s) \equiv s(s + \alpha)e^s + \beta_1 + \beta_2 s + \beta_3 s^2$$

and

$$\tau(s) \equiv s^2 (s + \alpha_1)e^s + (\beta_1 + \beta_2 s)(\alpha_1 + \alpha_2 s)$$

has been discussed by Hartree and others[5,6]. Another special case, into which the equations occurring in radiology[1] and in economics[3,4] may be trivially transformed, is the equation

$$y'(t + 1) + \alpha y(t) = 0 \qquad (\alpha > 0).$$

For this, $\tau(s) \equiv se^s + \alpha$. If $\alpha < \frac{1}{2}\pi$, all zeros of $\tau(s)$ have their real parts negative and $y(t) \to 0$ as $t \to +\infty$, whatever the initial conditions. If $\alpha > \frac{1}{2}\pi$, at least two zeros of $\tau(s)$ have their real parts positive and $y(t)$ oscillates with increasing amplitude as $t \to +\infty$, except under very special initial conditions. For $\alpha = \frac{1}{2}\pi$, there is a periodic solution $y = A \sin(\frac{1}{2}\pi t + B)$ with arbitrary A and B, and the general solution approaches this as t becomes large. There is a periodic solution for $\alpha = 2k\pi + \frac{1}{2}\pi$, where k is any whole number, but the general solution oscillates infinitely unless $k = 0$.

The non-homogeneous equation

$$\Lambda(y) = v(t), \qquad (3$$

where $v(t)$ is a known function, can also be solved for those $v(t)$ which have a readily calculable Laplace transform. Of course, if any particular solution of (3 can be found, the problem of finding the general solution, or the solution satisfying 'boundary conditions' of our type, is reduced to the same problem for (1), just as in the theory of differential equations.

More substantial and more interesting problems are presented by linear difference – differential equations with variable coefficients[10] and by non-linear equations[11]. The only published application of such a non-linear equation known to me occurs in Lord Cherwell's investigations by probability methods into the distribution of prime numbers[12].

E. M. WRIGHT

Department of Mathematics,
University of Aberdeen.
April 26.

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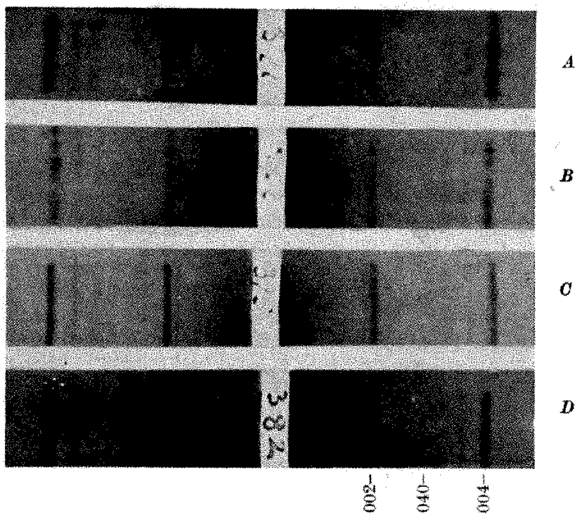
X-Ray Diffraction Effect Shown by some Specimens of Chrysotile

IN a study of the 'tailed' spots occurring on X-ray fibre photographs of chrysotile a camera with a slit approximately 0·7 cm. high was used, so that nearly 1 cm. of the fibre was irradiated. The purpose was to obtain lines instead of spots in the X-ray photograph, and thus facilitate photometry. The lines obtained, however, were beaded, the effect being particularly evident with specimens from Barberton (Figs. *A* and *B*). A specimen from Thetford showed only a slight variation in intensity along the lines (Fig. *C*), and a Russian specimen showed no visible variation. The effect can be imitated to some extent by pinching at regular intervals a specimen not showing it (Fig. *D*).

The beadiness seems to be due to a fairly regular variation of the scattering power along the fibres, possibly due to variation in external conditions during their growth. It is not due to multiple foci in the X-ray tube or irregularities in the slit system, since the beads move up and down with the specimen when its position is changed; they are not shown by all specimens, and are independent of the tube and camera used. It is unlikely that they are caused by non-uniform mechanical deformation of the fibres in detaching them from the lump, since they were shown by a specimen 0·10 cm. × 0·14 cm. in cross-section, which was quite rigid and could not bend to any extent during detachment.



(*A*) Specimen of chrysotile from Barberton, South Africa. (*B*) Another specimen from Barberton. (*C*) Specimen from Thetford, Canada. (*D*) Specimen *C*, pinched at intervals

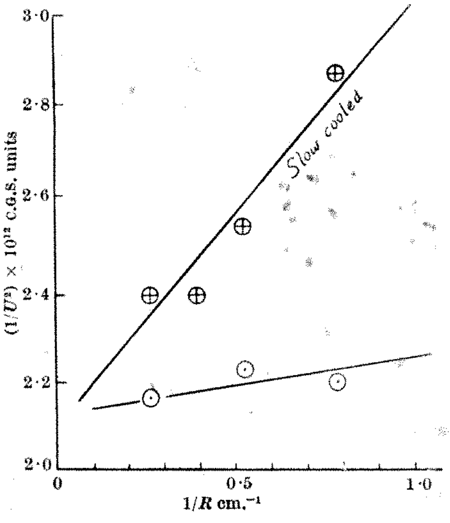
We are grateful to Dr. F. A. Bannister, of the British Museum (Natural History), for verifying the existence of the beadiness with his apparatus, and to Dr. F. J. North, of the National Museum of Wales, for the gift of specimens. Part of the apparatus used was purchased with a grant from the Royal Society

J. G. Jones
A. J. C. Wilson

Viriamu Jones Laboratory,
University College, Cardiff.
April 28.

Low-Order Detonation in Solid High Explosives

The recent communication[1] of Jones and Mitchell reporting the existence of a specific stable 'low' velocity of detonation in the case of crystalline or granulated T.N.T. is of considerable interest in that it emphasizes the importance of grain size in low-density unconfined charges. I have obtained similar results in the case of heavily confined cast T.N.T. charges, in which the grain size can be varied over fairly wide limits by variation in casting technique and alteration in the rate of charge cooling.



Velocities of detonation were measured over 30-cm. intervals by the Dautriche method with calibrated I.C.I. Cordtex as the standard detonant. Heavy copper confinement (3·2 gm./sq. cm. of charge surface) was employed, and measurements were made at a number of different charge diameters. The detonation velocities obtained with two widely different rates of charge cooling are summarized in the accompanying graph. It will be seen that plots of $1/U^2$ against $1/R$, where U is the observed velocity of detonation and R the charge radius, are approximately linear in character; but the slope of the line increases markedly with decreased cooling rate. The two experimental lines thus obtained are, of course, only two representatives of an infinite number possible between certain limits. These 'low' detonation velocities obtained by slow cooling were apparently stable in the sense that no change in velocity could be detected over 24 in. of charge length. The reduction in detonation velocity effected by slow cooling was very considerable, amounting to as much as 850 m./sec. at a charge diameter of 1 in., and cannot, therefore, be explained in terms of density changes, since these were very slight even at the slowest cooling rates.

Hydrodynamical calculations of detonation velocity assume that decomposition occurs at constant volume, under which condition it is dependent only on the heat of detonation and the density of the explosive. It has been known for some time, however, that in the case of solid high explosives, the detonation velocity normally decreases with decreasing charge radius. The best explanation of these detonation values lower than the hydrodynamic detonation velocity is on the basis of the lateral energy loss hypothesis of H. Jones[2]. In the case of solid high explosives, decomposition rarely occurs at constant volume since the process of chemical decomposition requires a very small but nevertheless finite time for completion. There is, therefore, behind the detonation front a region of finite length where equilibrium conditions have not yet been established, and which is usually termed the reaction zone. As a result of the very high pressures developed, some lateral expansion of the detonation products may occur in the region of the reaction zone, that is, before decomposition is complete, so that the maximum temperature and pressure are not developed. This will result in an energy decrease at the detonation front, with an attendant diminution in the velocity with which the detonation wave is propagated through the explosive.

The lateral energy losses will be a function of: (1) the charge radius; (2) the degree of confinement; (3) the 'reaction time' of the explosive, or the time required for the primary decomposition process, since this will determine the length of the reaction zone, and hence the time during which 'effective lateral expansion' can occur.

From the present series of experiments, in which considerable velocity changes have been produced at constant charge diameter and confinement by alteration in the rate of charge cooling, it would appear that the 'reaction time' of cast T.N.T. is a function of the rate of charge cooling. Since it is well established that the crystal size is very dependent on the rate of charge cooling, it seems very probable that the 'reaction time' of cast T.N.T. is a function of crystal size, increasing with increasing crystal size. The bearing of this crystal size – reaction time relationship on the mechanism of the detonative decomposition and the physico-chemical processes occurring in the detonation wave will be discussed fully in a paper to be published shortly.

I acknowledge my thanks to the Chief Scientist, Ministry of Supply, for permission to publish this letter.

T. C. Tranter

Department of Chemistry,
University, Birmingham.
April 17.

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Anomalous Magneto-Resistance Effects in Bismuth

The change of electrical resistance of bismuth in magnetic fields has been extensively studied, and the investigations of Kapitza[1] and subsequent workers on single crystals have led to the conclusion that the increase in resistance is proportional to the square of the field-strength in weak fields, becoming linear in strong fields. In the course of an investigation into the behaviour of thin fibres of bismuth, we have obtained results which indicate that in certain circumstances the resistance may undergo a small decrease at low field-strengths.

Fibres of bismuth in an envelope of soda glass may be prepared by hot-drawing and a wide variation in diameter is readily obtainable. The range in our experiments was about 5–150 μ. For various orientations of the magnetic field the resistance has been measured as a function of the angular displacement of the specimen. With the axis of rotation parallel to the specimen and perpendicular to the field, the resistance 'cycles' have a periodicity of π. A typical example is shown in Fig. 1.

Comparison of such results with those obtained for single crystals[2] leads to the conclusion that, in general, the fibres are single crystals with the main cleavage plane parallel to the axis.

For a given orientation, the resistance may be plotted against field-strength. In the case of certain fibres the curve so obtained is anomalous in that the change of resistance is negative for a certain range of field strength. The effect is illustrated in Fig. 2, which was obtained with a fibre orientation corresponding to the minimum of Fig. 1.

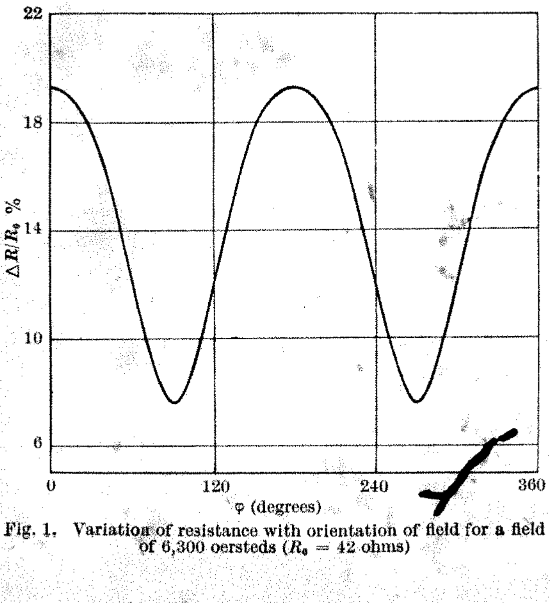

Fig. 1. Variation of resistance with orientation of field for a field of 6,300 oersteds (R_0 = 42 ohms)

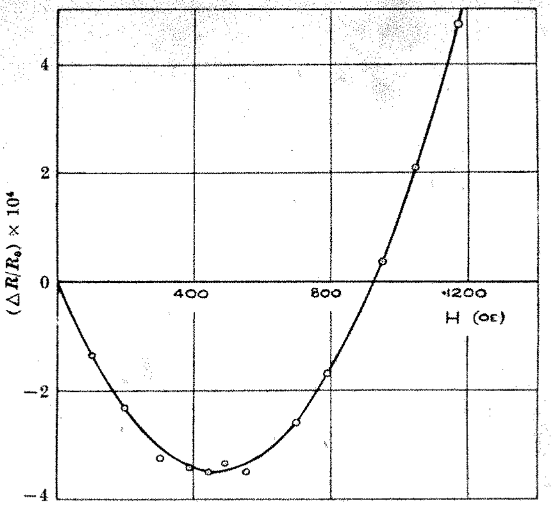

Fig. 2. Dependence of resistance on field-strength, illustrating the negative change

The anomalous change is quite small, and it will be seen that at the minimum of Fig. 2 it is of the order of 4 parts in 10^4. At first sight, a possible interpretation would appear to be in terms of a Hall E.M.F.; but the form of the specimens makes this unlikely and, moreover, the phenomenon does not appear with all fibres.

A negative change in resistance has been predicted on theoretical grounds by Meixner[3] for certain relative orientations of current, field and crystal axis. No previous experimental evidence is known to us, with the possible exception of a paper by Casimir and Gerritsen[4]. The latter, however, attribute their apparent *Umkehreffekt*, obtained with a single crystal, to the presence of a Hall E.M.F. In the case of our specimens, it would seem that while the direction of the current is normally parallel to the main cleavage plane, cases sometimes occur in which this is no longer the case.

A more detailed discussion will be presented elsewhere.

G. K. T. Conn
B. Donovan

Department of Physics,
University,
Sheffield, 10.
April 20.

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Excited States of Silver Bromide and Iodide

It appears that study of the absorption spectra of the silver halide vapours has, with the exception[1] of silver chloride, hitherto been confined to wavelengths above about 2500 A. We have recently photographed the absorption spectra of silver bromide and iodide in the range 2150–3000 A. with a Hilger medium quartz instrument. Within rather critical pressure limits, red-degraded absorption bands are observed in the region 2150–2475 A. for silver bromide and 2150–2350 A. for silver iodide.

For silver bromide, some forty bands have been assigned to a single system involving a transition between the ground-state[2] and an excited state with constants $\nu_e = 43{,}537\cdot4$, $\omega_e = 205\cdot0$, $x_e\omega_e = 0\cdot74$ cm.$^{-1}$. The vibrational constants refer to ^{109}Ag^{81}Br.

In the spectrum of silver iodide in this region, there appear to be two partly overlapping systems, resulting from transitions from the ground-state to two excited states :

C. $\nu_e = 44{,}717\cdot7$, $\omega_e = 158\cdot1$, $x_e\omega_e = 2\cdot3$ (for ^{107}AgI),
D. $\nu_e \sim 46{,}000$, $\omega_e \sim 165$ cm.$^{-1}$.

Thirty bands have been assigned to system $C \leftarrow N$, 17 to $D \leftarrow N$.

The products of dissociation cannot be determined unambiguously; but the most likely products are Ag(^2P) plus halogen (^2P) for all three excited levels.

The relations between the states of the silver halides are summarized below, where k_e is the force-constant in dyne/cm. × 10^{-5}, and ν_e is the system-origin in electron-volts. There seems to be little doubt that the new levels are analogous to the levels C and D of silver chloride.

State		AgCl	AgBr	AgI
D	ν_e	6·05	—	5·7
	k_e	$1\cdot3_2$	—	$0\cdot9_3$
C	ν_e	5·40	5·40	5·54
	k_e	1·318	1·149	0·85
B	ν_e	3·92	3·88	3·87
	k_e	1·226	0·894	0·521[3]
N	ν_e	0	0	0
	k_e	1·832	1·678	1·453

R. F. Barrow
M. F. R. Mulcahy

Physical Chemistry Laboratory,
Oxford.

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The 'Renal Threshold'

According to the definition of Barclay *et al.*[1], the 'renal threshold' can be expressed as a rate of tubular reabsorption per 100 c.c. glomerular filtrate. Thus

$$T = 100\,\frac{Rx}{C}, \qquad (1)$$

where T is 'threshold', Rx is the amount of the 'threshold substance' reabsorbed by the tubules (mgm./min.), and C is clearance of inulin, or mannitol. The same conception of the 'threshold' is also used by Harrison *et al.*[2].

In 1945 I published with Szenes[3] a paper entitled "Aglucosuric Blood Sugar Concentration"[3,4]; this is a calculated blood sugar concentration, above which filtered glucose is not reabsorbed, but passes into the urine. This concentration is thus a dynamic 'threshold'; and the formula can, of course, be used not only in the case of glucose, but also in the case of any other 'threshold substance'.

We deduced the formula of such a threshold substance concentration as follows :

$$Ex = Fx - Rx, \qquad (2)$$

where Ex is excreted substance (mgm./min.), Fx is filtered substance (mgm./min.).

$$\text{But } Ex = \frac{V.Ux}{100};\ Fx = \frac{C.Px}{100};\ Rx = \frac{C.Ax}{100};$$

where V is urine (c.c./min.), Ux is concentration of substance in urine (mgm. per cent), C is clearance of inulin, Px is concentration of substance in blood (mgm. per cent), and Ax is threshold (Szenes and Földi's formula).

$$\text{So } V.Ux = C.Px - C.Ax;\ Ax = Px - \frac{V.Ux}{C};$$

$$\text{but } C = \frac{U.V}{P},$$

where U and P are urinary and plasma inulin concentration (mgm. per cent) respectively.

$$\text{Hence } Ax = Px - \frac{P}{U}\,Ux. \qquad (3)$$

The purpose of the present note is to determine the relation of our formula to Barclay's 'threshold'.

As I have pointed out above, Barclay's formula is :

$$T = 100\,\frac{Rx}{C}.$$

From equation (2) :

$$Rx = Fx - Ex.$$

$$\text{Hence } T = \frac{Fx - Ex}{C}\,.\,100 = \frac{C.Px - V.Ux}{C} = Px - \frac{V.Ux}{C} = Px - \frac{P}{U}\,.\,Ux.$$

Thus Barclay's 'threshold' and our formula are identical. This is noteworthy because we have deduced our formula by means of mathematical considerations, while Barclay chose his definition of the threshold because "plasma values are usually expressed to 100 c.c. and . . . 100 c.c. would appear to be fairly close to the more recent determination of the average rate of filtration in man".

From the equations

$$Rx = \frac{C.Ax}{100} \text{ and } Fx = \frac{C.Px}{100},$$

we have

$$\frac{Rx}{Fx} = \frac{Ax}{Px},$$

whence

$$Ax = Px\,.\,\frac{Rx}{Fx}. \qquad (4)$$

This equation shows that the calculated concentration of the threshold substance in the blood is a function of the actual concentration, the rate of tubular reabsorption and glomerular filtration.

M. Földi

First Medical Clinic,
Budapest.
April 12.

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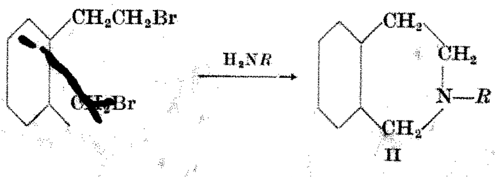
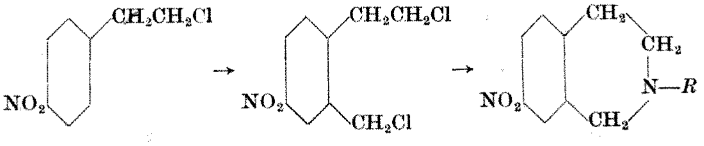
A New Synthesis of 2 : 7-Disubstituted-1 : 2 : 3 : 4-tetrahydro-*iso*-quinolines

It has been shown by Holliman and Mann[1] that *o*-2-bromoethyl-benzyl bromide (I) condenses readily with primary amines to give 2-substituted-1 : 2 : 3 : 4-tetrahydro-*iso*-quinolines (II). Although hitherto



this has apparently been the only known method for the synthesis of 2-aryl-*iso*-quinolines of type (II), it has one serious disadvantage, namely, that for various reasons it does not lend itself to the preparation of *iso*-quinolines of this type having substituent groups in the benzene ring. The presence of such groups may be essential if the tetrahydro-*iso*-quinoline is to possess marked physiological action. To overcome this difficulty we have developed the following synthesis.



III IV V

2-Phenyl-ethyl chloride on nitration affords *p*-nitrophenyl-ethyl chloride[2] (III), which we find undergoes ready chloromethylation to the crystalline 5-nitro-2(2-chloroethyl)-benzyl chloride (IV). We have condensed this compound with several primary amines to obtain in each case the corresponding 7-nitro-2-aryl-1 : 2 : 3 : 4-tetrahydro-*iso*-quinoline (V). These *iso*-quinolines have in turn been converted to their 7-amino, 7-acetamido and other derivatives. The preparation of the dichloride (IV) is much simpler than that of the dibromide (I), and thus affords a ready route to these 7-substituted-*iso*-quinoline derivatives.

2-Phenyl-ethyl bromide can be similarly nitrated and then bromomethylated to form 5-nitro-2(2-bromoethyl)-benzyl bromide, which also readily gives the above cyclization with primary amines.

We are now investigating the synthesis of the phosphorus and arsenic analogues of compounds of type (V).

F. G. Mann
M. H. Beeby

University Chemical Laboratory,
Cambridge.

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Tryptochrome : a Pigment Derived from Tryptophan

When 5 ml. of a very dilute (*c.* 0·05 per cent) solution of tryptophan in 60–80 per cent acetic acid is treated with a drop of 1 per cent aqueous potassium iodate, and warmed to boiling, a violet-pink colour develops, and an intense greenish-orange fluorescence. On dilution with two volumes of water, the pigment gradually separates, and can be extracted with *iso*butyl alcohol or with chloroform, in which solvent it shows a strong absorption band at λ 565–555 mμ, and a weak band at λ 520–515 mμ. Pigment formation requires a large excess of acetic acid, otherwise the mixture turns brown, and an iodotryptophan is precipitated, from which the pigment cannot be generated. The pigment is stable in acid solution, and both tint and fluorescence survive exposure to air and light for months.

The iodate can be replaced by hypochlorite bromate, or free bromine; but the pigment is less pure, and is very easily destroyed by a slight excess of the reagent. Chlorate, peroxide, persulphate, perborate, manganese dioxide, ferricyanide and ferric iron are ineffective for colour production.

The name 'tryptochrome' is suggested for the pigment, since it closely resembles, and may be identical with, the pigment formed in the well-known protein-ochrome reaction, obtained when tryptophan or a trypsin digest of protein is treated with bromine water, and extracted with amyl alcohol. The tryptochrome test will show free tryptophan in dilutions down to about 1 in 100,000. None of the other common amino-acids gives the reaction. On prolonged boiling with sufficient iodate, indole forms a mixture of pigments, including what appear to be indirubin and isatin ; but the conditions are much more drastic than those required for tryptochrome, and persulphate is more effective than iodate. Addition of iodate to a faintly acid solution of adrenaline leads to formation at room temperature of an iodoadrenochrome[1]. Under such conditions, tryptophan gives no colour. Adrenochrome closely resembles tryptochrome in tint, but neither it nor indirubin shows the orange fluorescence characteristic of tryptochrome.

Structure of tryptochrome. (1) Analysis of the product crystallized from a mixture of chloroform and light petroleum gives the percentage composition : C, 69·9 ; H, 4·6 ; N, 13·9, corresponding to the formula $C_{17}H_{14}O_2N_3$. (2) The reaction requires the free α-amino-group of the tryptophan. It is not given by unhydrolysed proteins, or by β-indolepropionic acid, or by tryptophan after treatment with nitrous acid or formaldehyde. (3) The reaction requires an unsubstituted α-carbon in the pyrrole ring. (4) Reduction in acetic acid by magnesium or zinc yields a leuco-product that gives no catechol reaction with molybdate or phenolic reaction with iron. The leuco-product slowly reoxidizes to tryptochrome on aeration. Hence it is concluded that tryptochrome, unlike adrenochrome, is not a quinone.

The evidence now obtained suggests that tryptochrome is an indirubinoid derivative.

The preparation and properties of tryptochrome are being investigated in the Chemical Department of this University by Mr. W. A. Boggust, aided by a grant from the Medical Research Council of Ireland. I am very grateful to Prof. Wesley Cocker for these facilities and for the interest he has taken in the work.

W. R. Fearon

Department of Biochemistry,
Trinity College,
Dublin.
April 20.

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Alkaline Phosphatase and Tumour Inhibition

In the course of bioassays of extracts of normal male urine[1,2] for tumour-inhibiting properties, we have investigated their effect on alkaline phosphatase present in certain tumours by Gomori's histological technique. Similar examinations were carried out using other tumour-inhibitory substances, namely, stilbœstrol[3] and colchicine[4,5].

For the purpose of denoting the quantity of alkaline phosphatase in the tissues under investigation, we have used mouse kidney tissue as a comparative standard. All tissues, treated and untreated tumours and kidney, were incubated in the same jar and their further treatment carried out under identical condions. Inbred albino mice were used as experimental nimals.

(1) *Tumours investigated.* Transplants of Twort-ammary carcinoma, sarcoma and carcinoma induced y subcutaneous inoculation of crystallized methyl-holanthrene, a transplant from the induced car-inoma, spontaneous mammary carcinoma in mice nd their transplant. The Twort-mammary car-inoma shows a high concentration of alkaline phos-hatase, so also do the transplants of the spontaneous ammary carcinoma in the first generation, but a lesser degree. The other tumours referred to bove contained little or no demonstrable alkaline hosphatase.

For the purpose of continuing our investigation wort-mammary carcinoma were used.

(2) *Tumour-inhibiting substances.* (*a*) Toluene tract of urine and certain fractions thereof (pos-bly related to *H* 11), single dose 0·8 or 1·6 mgm.) Stilbœstrol, single dose 0·25 mgm. (*a*) and (*b*) ere dissolved in 0·05 ml. of arachis oil and injected traperitoneally twice a day on seven consecutive ays. (*c*) Colchicine, 0·02 mgm. in 0·2 ml. of water, e mitoses arresting dose[5], given subcutaneously vice a day on three or five consecutive days. Mice ere dissected when their body temperature dropped 32·8° C. or less.

Untreated tumour-bearers or mice treated with achis oil were used as controls.

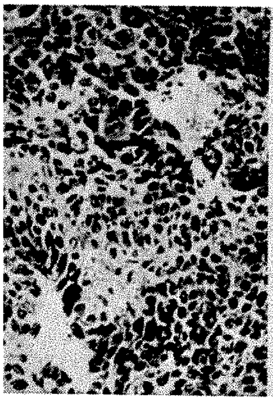

Fig. 1. × 200

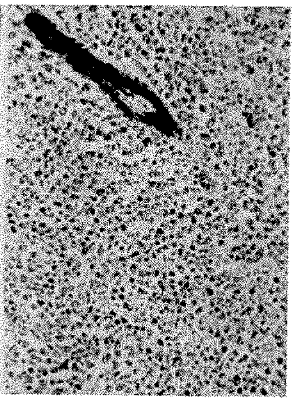

Fig. 2. × 200

Results. (*a*) Urinary extracts : a marked diminution d, in some cases, almost a complete absence of aline phosphatase even in highly cellular portions the tumours. The accompanying photomicrographs control and treated tumours of approximately e same growth-rate and cellularity show these fferences (Fig. 1, injected with arachis oil, 63 sq. m.; Fig. 2, treated with extract, 60 sq. mm. rface area). It was our experience, however, that e amount of alkaline phosphatase demonstrable s approximately inversely proportional to the gree of inhibition of growth.

(*b*) Stilbœstrol : no diminution, but perhaps an rease in alkaline phosphatase. The adrenals of e treated mice, when compared to the controls, ow a marked deposit of alkaline phosphatase in the bcapsular layers of the zona glomerulosa. This pearance may be of interest as it is claimed that generation of the adrenocortical cells commences in is area.

(*c*) Colchicine : alkaline phosphatase diminution e to cellular degeneration of tumours.

The cellular or other structure of each tumour was checked by hæmatoxylin-eosin staining of alternate sections.

It would appear that growth inhibitors present in normal male urine directly or indirectly reduce the alkaline phosphatase content of certain tumour cells.

R. F. Fleming
O. Peczenik

Department of Pathology,
Hosa Research Laboratories,
Sunbury-on-Thames, Middx.
May 12.

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Effect of Sputum on Streptomycin

In a small series of seventeen cases of whooping cough treated with streptomycin, no beneficial effects were noted. The children receiving parenteral therapy, five hours after injection, had blood-levels of 2–12 units per ml. It was not possible to detect streptomycin in the blood of thirteen patients receiving aerosal therapy after 15, 30, 60 min. or 3 hr. The urine of these patients at no time during 24 hr. showed the presence of streptomycin.

Because of the inability to recover streptomycin after inhalation, *in vitro* tests were devised to observe the behaviour of streptomycin in the presence of lung extract, lung tissue, mucin and gastric juice; the sources of these substances were sputum, 6 gm. of guinea pig lung ground in 10 c.c. nutrient broth, 10 per cent potassium hyaluronate and human resting-gastric juice, respectively.

Using the streptomycin assay technique devised by Mitchison, clear-cut results were obtained. The 10-mm. column of assay agar containing *Staph. mayo* was layered with the test material and the zone of growth inhibition of staphylococci was measured.

The mucin of the gastric juice, in contrast to the lung extract, potassium hyaluronate and sputum, allowed full activity of the streptomycin. Sputum was either shaken with streptomycin in a bottle containing glass beads before it was layered on a column of assay agar, or the sputum was layered on the medium and the streptomycin inoculated on top of the sputum. The potassium hyaluronate was shaken with streptomycin before being transferred into the assay tube.

By plotting the zone of growth inhibition in mm. against the logarithm of a known concentration of 2, 3, 4, 5, 10, 50 units streptomycin per ml., a graph was obtained from which the streptomycin content of inoculated material could be read. When layered on to the agar, before incubation, all mixtures were known to have a final concentration of 5 units streptomycin per ml. After 18-hr. incubation these mixtures were shown to contain less than one unit per ml.

Table 1 represents two experiments. The mean in mm. of inhibition and standard deviation of ten tubes for each group is recorded. Table 2 represents the mean and standard deviation of six tubes which were layered with sputum collected from a patient at 0, 3, 6, 9 hr. after having received an intramuscular injection of 1 gm. streptomycin. (Patient's blood

Table 1. Mean and standard deviation of zone of inhibition produced by:

	Sputum shaken with streptomycin	Sputum layered on agar, streptomycin superimposed	Potassium hyaluronate shaken with streptomycin	Streptomycin (10 units/ml.)	Streptomycin (5 units/ml.)
Exp. 1	2·1±0·21	0·5±0·71	2·38±0·37	6·0±0·16	4·7±0·27
Exp. 2	2·9±0·48	0·1±0·32			4·9±0·05

Table 2. Mean and standard deviation of zone of inhibition induced by sputum, before and after parenteral streptomycin

Hours	0	3	6	9	Control, streptomycin 5 units/ml.
	0·5±0·71	0·4±0·44	0·6±0·52	0·6±0·52	4·9±0·05

5 hr. after receiving the streptomycin contained 7 units per ml.)

The differences between the three left-hand groups of Table 1 and either of the two right-hand groups, and the difference between the experimental groups and the control in Table 2 would have happened by chance much less than once in a thousand trials. This means that the difference between the means is highly significant.

The sputum, which was found to be alkaline, prevented the action of streptomycin either by a mechanical inhibitory action, or by a chemical inactivation, but not as a result of an acid reaction.

This observation helps to explain why organisms normally sensitive to streptomycin fail to be affected when embedded in sputum. The unsuccessful streptomycin trial in whooping cough may possibly be explained in this way. The disappointing results in the treatment of pulmonary tuberculosis can be understood, for on this basis tubercle bacilli, lying in sputum which has rendered the antibiotic sublethal, multiply and become resistant. The tubercle bacilli free in the spinal cord are destroyed, whereas those embedded in exudate at the base of the brain survive. When the tubercle bacilli lie on surface lesions such as ulcers of the larynx or vocal cords, the response to treatment is dramatic; but open phthisis is proving resistant to treatment.

Thanks are due to the Non-tuberculosis Streptomycin Trials Committee for the streptomycin and to Dr. B. Woolf and Miss E. Duncan for the statistical assay.

HERTA SCHWABACHER
Ministry of Health Laboratory,
Sector IV,
Watford.

Reconstruction of Laccase from its Protein and Copper

THE conception that oxidases are metallo-protein compounds in which the metal plays an essential part in the catalytic activity of the enzyme was introduced by Gabriel Bertrand[1] in the course of his studies on laccase, the oxidizing enzyme present in the latex of the Indo-Chinese lacquer tree. As crude preparations of laccase contained an appreciable amount of manganese, Bertrand assumed that this metal forms the active part of the oxidase. A more recent study of this problem by Keilin and Mann[2], based upon highly purified enzyme prepared on a large scale from the latex of different lacquer trees, produced evidence that the active metal is not manganese but copper. This view, however, was challenged by Didier Bertrand[3], who claimed to have isolated an enzyme of higher activity which contained 0·15 per cent manganese and only 0·014 per cent copper.

While studying the properties of laccase, an attempt was made to split the enzyme into its two constituent parts and to reconstruct it from its protein and a metal. The method used was that devised by Kubowitz[4] in the course of his study on the polyphenol oxidase of potato. The experiments were carried out as follows:

(1) The activity of the enzyme was tested in the Barcroft manometers. The following system was used: 10 mgm. pyrocatechol or hydroquinone, a suitable amount of laccase preparation, 0·1 *M* phosphate buffer *p*H 6·7 to a final volume of 3·3 ml. The manometer was shaken at about 160 cycles per min. and readings were made for the first six minutes.

(2) Enzyme preparations of activity (Q_{O_2}) varying from 3,000 to 18,000 in presence of pyrocatechol were obtained from the latex of the Indo-Chinese lacquer tree (*Rhus succedanea*) by fractional precipitations with alcohol and ammonium sulphate and by further purification with tricalcium phosphate gel.

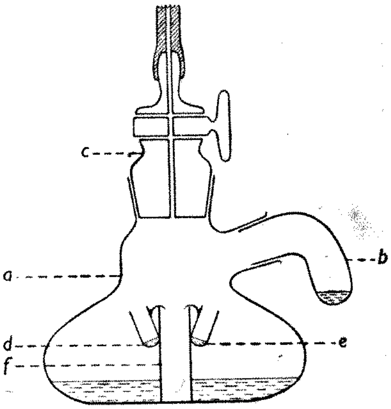

Fig. 1

(3) The splitting of the enzyme was performed in a modified flask of the Barcroft differential manometer (see Fig. 1). The flask (*a*) of about 30 ml. capacity has a side bulb (*b*) with a ground joint so that the contents of the bulb can easily be run into the flask by giving it a half-turn. The flask is provided with a stopper and tap (*c*) which can be connected with a vacuum pump and to a source of pure nitrogen. Two small dangling tubes (*d* and *e*) are suspended by means of platinum hooks from the lip of the centra tube (*f*) fused to the bottom of the flask.

4 ml. of either crude or purified concentrated enzyme preparation and 1 ml. 0·5 *M* phosphate buffer *p*H 7·0 are placed in the flask *a*. The dangling tubes *d* and *e* receive 2 mgm. catechol and 3·2 mgm. ascorbic acid respectively and the side bulb *b* receives 0·03–0·05 ml. 2 *M* potassium cyanide in 0·05 *M* potassium hydroxide. After evacuating the flask and filling it with pure nitrogen, catechol and ascorbic acid are added to the enzyme by dislodging the dangling tubes, and then cyanide is added from the side bulb

The mixture is left standing for 30 min. at room temperature. The flask is then opened and its contents are cooled to 0° C. and saturated with solid ammonium sulphate. The precipitated enzyme is centrifuged off and washed with 50 ml. of saturated ammonium sulphate containing 0·02 *M* potassium cyanide. The precipitate is dissolved in the minimum amount of water and dialysed for 12 hr. at 0° C. against 3 l. of 0·01 *M* phosphate buffer pH 7 and for a further 36 hours against 3 l. 0·005 *M* phosphate, which is changed three times.

The enzyme preparation thus obtained has almost completely lost its catalytic activity in the oxidation of catechol or hydroquinone.

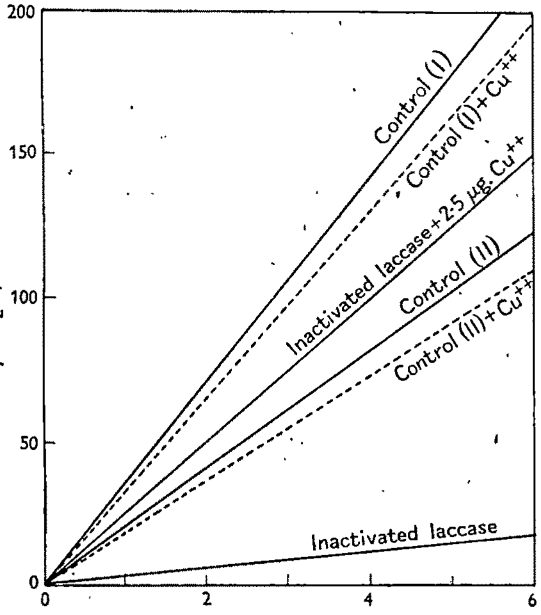

Fig. 2

(4) For the reactivation of this enzyme preparation, 2·5–12 μgm. of cupric, ferric or manganese ions are added (as cupric and ferric sulphates or manganese chloride) to 2 ml. samples of the inactivated enzyme preparation and left standing at room temperature for periods varying from 30 min. to 3 hr. The catalytic activities of these samples were then tested and compared with those of the untreated control samples (I) estimated at the beginning of the experiments, the control samples (II) treated only with ammonium sulphate and dialysed, and the samples inactivated by cyanide treatment. These experiments show that the activity of the cyanide-treated samples of laccase was not affected by the addition of either ferric or manganese ions, but was markedly increased by the addition of very small quantities of cupric ions. Fig. 2, which summarizes the results of the experiments with cupric ions, shows that the addition of 2·5 μgm. of this metal to the inactivated enzyme raised its activity to a level occupying an intermediate position between the controls I and II. That the activity of this reconstructed enzyme is somewhat higher than that of the control II is probably due to the fact that cyanide protected the protein of the inactivated enzyme from slow but irreversible changes which were proceeding in the control preparation II when it was submitted to precipitation and dialysis. It is important to note that the small concentration of cupric ions which strongly activated the cyanide-treated enzyme had no catalytic effect on the oxidation of either catechol or hydroquinone, and when added to the control enzyme preparations slightly inhibited their activities (Fig. 2).

These experiments clearly demonstrate that laccase is a copper-protein enzyme.

My thanks are due to Prof. D. Keilin, for his help and advice.

A. Tissières

Molteno Institute,
University of Cambridge.

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Localization of Polyphenoloxidase in the Chloroplasts of *Beta vulgaris*

The chloroplast as the seat of chlorophyll pigments in plants occupies a unique position in the economy of the green cell. In recent years there has been a renewed interest in the reactions and properties of chloroplasts as a result of the work of Hill[1,2] and Hill and Scarisbrick[3,4], who demonstrated that the reaction characteristic of photosynthesis in green plants, the evolution of oxygen, occurs in appreciable quantities in isolated chloroplasts under the influence of light and in the presence of suitable oxidants.

In the course of an investigation of oxygen evolution by isolated chloroplasts, it was deemed important to explore their enzymatic composition. Of special interest were considered enzymes capable of participating in oxidation-reduction reactions and, more particularly, those localized principally, if not entirely, in the chloroplasts. This communication presents evidence that a copper enzyme, polyphenoloxidase (otherwise known as tyrosinase or catecholase), is localized in the chloroplasts of spinach beet (chard), *Beta vulgaris*.

In a preliminary experiment, it was found that the addition of catechol to a crude leaf extract of spinach beet leaves was followed by a rapid uptake of oxygen. This suggested the presence of a polyphenoloxidase in the leaves, and it became of interest to determine whether the enzyme is found in the chloroplasts or in the cytoplasmic fluid obtained after the separation of chloroplasts and their fragments.

Leaves of plants grown in sand cultures were mashed in a Waring blender and the green extract fractionated by high-speed centrifugation (approximately 25,000 *g*) into a suspension of chloroplast fragments and a 'cytoplasmic fluid' practically free of chlorophyll.

Polyphenoloxidase activity of the two fractions was tested by using catalytic amounts of catechol with ascorbic acid as a substrate[6]. Consistent with the well-established[6,7] copper-protein nature of polyphenoloxidase, the activity of this enzyme in the chloroplasts was inhibited with cyanide and carbon monoxide. The carbon monoxide inhibition was insensitive to light[6]. The enzyme was also inhibited by more specific copper poisons such as sodium diethyldithiocarbamate[8].

The procedures used for disintegrating leaves were necessarily drastic and resulted in disruption of cytoplasmic bodies, including the chloroplasts. The possibility was therefore considered that the localization of polyphenoloxidase activity in the chloroplasts could be attributed to preparatory technique. On *a priori* grounds this was considered unlikely: the enzyme persisted in the chloroplast fragments and was absent from the cytoplasmic fluid, into which it would be expected to pass in case of disruption of the chloroplasts. Nevertheless, experiments were carried out with the experimental procedures modified in several respects, giving special attention to differences in technique which might have accounted for such divergent reports as were found in the literature.

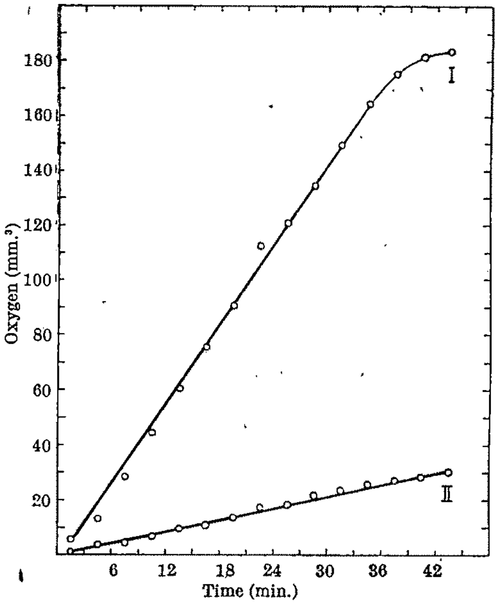
First, the possibility was considered that if the enzyme were originally present in the cytoplasmic fluid, then the high-speed centrifugation used for separating the chloroplast fragments might have sedimented the enzyme as well. This point was tested by adding a crude potato polyphenoloxidase to the leaf mash prior to the high-speed centrifugation. Upon subsequent fractionation of the mash into chloroplast fragments and cytoplasmic fluid, the added potato polyphenoloxidase was recovered in the cytoplasmic fluid. The polyphenoloxidase activity of the chloroplast suspension was not enhanced.

Warburg and Lüttgens[9], working with similar preparations from spinach and sugar beets, attributed about a quarter of the polyphenoloxidase activity of the crude green leaf extract made at *p*H 6·5 to chloroplast suspensions and the remaining three-quarters to the cytoplasmic fluid. These authors considered the *p*H of the extract important. At an acid reaction, at *p*H 5 for example, they found that a major portion of the cytoplasmic polyphenoloxidase was precipitated and in a subsequent centrifugation was recovered with the chloroplast fragments.

Although the preparations used in this investigation were uniformly made at *p*H 6·5, it was undertaken to test the effect of hydrogen ion concentration on the distribution of polyphenoloxidase by extracting the chloroplast suspension at the more alkaline *p*H 7·3. The results indicated that, as with other preparations, the polyphenoloxidase activity of leaf extracts made at *p*H 7·3 was also localized in the chloroplasts.

Bonner and Wildman[10] studied the respiration of spinach leaves and concluded that polyphenoloxidase is their terminal oxidase. Unlike the present findings, however, these authors reported the presence of polyphenoloxidase as confined to the cytoplasm rather than to the chloroplasts. The technique used by Wildman and Bonner[11] involved grinding the chloroplasts in a Charlotte colloid mill, with resultant disintegration of chloroplasts into chlorophyll-containing granules and non-chlorophyllous 'stroma'. These authors[11] are aware that their conclusions as to the distribution of enzymes between chloroplasts and cytoplasm can be properly interpreted only with reference to their own manipulative technique. It was already noted that in the same plant, spinach, Warburg and Lüttgens[9] found polyphenoloxidase both in chloroplast fragments and in cytoplasm. The spinach-beet used in the present investigation is a chenopodiaceous plant related to sugar beet and spinach.

It seemed desirable, in view of the results of Bonner and Wildman[10], to subject the already disrupted chloroplasts comprising the chloroplast suspensions used in this investigation to further disintegration. This was done by grinding the green leaf extracts with glass beads for 10 min. in a Mickle tissue-disintegrating machine, prior to the high-speed centrifugation. A microscopic examination of the ground chloroplast suspension disclosed uniform round particles more than 1 millimicron in diameter. This further subdivision of the chloroplast fragments failed to dislodge the polyphenoloxidase. As before, the enzyme was found in the chloroplast suspension rather than in the cytoplasmic fluid. The results are presented in the accompanying graph.



Polyphenoloxidase activity of chloroplast fragments and cytoplasmic fluid of spinach beet. Curve I: disintegrated chloroplast suspension containing 0·8 mgm. of chlorophyll. Curve II: cytoplasmic fluid containing 0·02 mgm. chlorophyll, after removal of disintegrated chloroplasts. Reaction mixture contained 2·4 mgm. ascorbic acid and 0·02 mgm. catechol in $M/15$ potassium phosphate buffer (*p*H 6·5). Temperature of bath, 20° C.

The localization of a copper-protein oxidase in cellular bodies so intimately identified with the process of photosynthesis raises at once the question of the possible participation of this enzyme, directly or indirectly, with one or more of the biochemical reactions which are linked with the process of photosynthesis in those green plants which contain polyphenoloxidase[12]. The answer to this question must await further experimentation.

A full account of these experiments will be published elsewhere.

DANIEL I. ARNON*

Molteno Institute,
University of Cambridge.
July 19.

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* Fellow of the John Simon Guggenheim Memorial Foundation. Permanent address: Division of Plant Nutrition, University of California, Berkeley.

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DEFINITIONS OF BOND-ENERGY IN PHYSICAL CHEMISTRY

THE expression 'bond-energy' continues to be used in at least two senses: (*a*) for the *mean* contribution from each bond of a given type to the total heat, $-\Delta H$, of formation of the molecule from its constituent atoms; (*b*) for the energy, ΔH, required to disrupt the molecule at a particular bond into two fragments.

As was first pointed out by Fajans[1], and later developed by Sidgwick and Pauling, the 'bond-energy', usage (*a*), of a given bond X—Y, shows a remarkable degree of constancy over a wide range of compounds, provided that the valency of neither X nor Y alters. But the 'bond-energy', usage (*b*), may vary markedly with the molecular environment of the bond. Despite frequent warnings[2], confusion between these two interpretations of 'bond-energy' still exists, and it seems to us desirable that the simple but ambiguous expression 'bond-energy' should be abandoned in favour of two separate expressions specific for the usages (*a*) and (*b*).

For usage (*a*), the expression 'mean bond-energy term' has already been proposed[3]. We would further suggest the use of the symbol $E(X\text{—}Y)$ to denote this quantity. The relation between $E(X\text{—}Y)$ and the thermochemical data for a molecule XY_n is given by

$$n\,E(X\text{—}Y) = -\Delta H_{298}$$

for the reaction

$$X_{(g)} + nY_{(g)} \rightarrow XY_{n(g)},$$

that is, the heat of formation of the gaseous compound from the free atoms of its constituent elements, the 'atomic heat of formation'. We suggest the use of a superscript a in discussing enthalpy terms for reactions in which the initial state of the system is that of free atoms, and we follow Bichowsky and Rossini[4] in using Q for $(-\Delta H_{298})$. The particular $-\Delta H_{298}$ term in question, above, has then the symbol $Qf^{a}{}_{(g)}$, which, if considered too cumbersome, might be modified to Q_a. For the heat of formation of the gaseous compound from its elements *in their standard states*, we suggest the symbol $Qf^{s}{}_{(g)}$, while for the $-\Delta H_{298}$ for the formation reaction in which both the set of initial elements and the final compound are all in their standard states, the symbol Qf^0 follows from the universally accepted convention of Lewis and Randall[5].

For the usage (*b*), we would suggest the expression 'bond dissociation energy' and the symbol D together with a specification of the particular bond; for example, $D(XY_{n-1}\text{—}Y)$. In the case of polyatomic molecules there is not necessarily an identity between the quantities $E(X\text{—}Y)$ and the individual $D(X\text{—}Y)$ values, the only connexion being that, for a given molecule, the sum of all the E terms shall equal the sum of the D values for each stage in the stepwise dissociation of the molecule into free atoms.

In constructing tables of mean bond-energy terms, Sidgwick and Pauling adopted the convention of measuring the atomic heats of formation with respect to ground-state atoms. Recently, Long and Norrish[6] have expressed the view that in dealing with compounds of tetravalent carbon, the E values for carbon bonds should be assessed, not from the $s^2p^2\ {}^3P$ ground-state but from the $sp^3\ {}^5S$ excited state. They urge this on the grounds that molecules such as CH_4 (for example) are built up from the tetravalent ${}^5S$ carbon atom and not from the divalent ${}^3P$ ground-state. This change in the zero from which the total energy content is to be measured should be correspondingly reflected in the symbols used; for example, by using Qf^{a*} in place of Qf^{a}, and E^* in place of E. In this connexion we are unable to agree with the statement of Long and Norrish[6b] that Pauling's table of mean bond-energy terms "contains values deficient in the case of links involving carbon", for Pauling's E values are no less true in respect of his definition of a mean bond-energy term than are the E^* values of Long and Norrish, which are based on a different definition.

If one adopts consistently the point of view that in the specific case of tetravalent carbon compounds E^* terms are preferable to, or more significant than, E terms (because of the building up of such compounds from $C({}^5S)$), one must recognize the necessity of discarding E terms in favour of E^* terms for a large number of bonds other than those involving carbon. An example is provided by the beryllium hydride molecule BeH, which, although dissociating to give a ground-state ${}^1S$ beryllium atom, would be considered as built up from the excited ${}^3P$ state; similarly with the sodium chloride molecule NaCl, since this 'derives' essentially from the ion-pair $Na^+\ Cl^-$, despite its dissociation into ground-state atoms. These two examples are relatively simple ones; in others, for example, hydrogen fluoride, HF, it is rather difficult to identify the atomic species from which the molecule is built up. In general, it seems to us that the Pauling convention leads to mean bond-energy terms in a more simple and less ambiguous manner than would result from a consistent application to all compounds of the convention used by Long and Norrish in respect of carbon compounds.

In connexion with their view that, in tetravalent carbon compounds, E^* values are more significant than E values, Long and Norrish make the specific point that it is reasonable to correlate E^* (C—H) in CH_4 with $D(CH_3\text{—}H)$, whereas a correlation with E (C—H) would be meaningless. They develop from this point an attack on the problem of deciding between the two spectroscopically permissible values for 'L_1', the ΔH_0 for the reaction

$$C_{\text{graphite}} \rightarrow C({}^3P)_{(g)}.$$

Their numerical correlation of E^* (C—H) in CH_4 with $D(CH_3\text{—}H)$ leads them to conclude that $(L_1 + x) \sim 190$ kcal./gm. atom, where x is the excitation energy, ΔH_0, for the atomic transition $C(s^2p^2, {}^3P) \rightarrow C(sp^3\ {}^5S)$. Recently, Shenstone[7], by experimental observation, has given the value of x as 96·4 kcal./gm. atom. This throws some doubt on the assessment of $(L_1 + x) \sim 190$ kcal., since such a value would imply that L_1 is less than 100 kcal. The assessment of $(L_1 + x) \sim 190$ kcal. is based on two assumptions: (i) that the bonds in the $\cdot CH_3$ radical are roughly equivalent in strength to those in CH_4 (that is, the 'energy of reorganisation', of the $\cdot CH_3$ radical is small), and (ii) that the tetracovalent state of the carbon atom in CH_4 is identical with the ${}^5S$ state of the free carbon. But, with regard to (i), since we cannot either describe with certainty the character of the C—H bonds in the $\cdot CH_3$ radical (sp^3 or sp^2 bonding ?), or make due allowance for the interaction between non-bonded hydrogen atoms in $\cdot CH_3$ or CH_4, the reorganisation energy cannot be simply estimated, and might be quite different from the value chosen by Long and Norrish; and in respect of (ii) Van Vleck[8], in a detailed discussion of this specific point in 1934, concluded that the 'valence-state' cannot be identified with any one of the six atomic states of the carbon atom corresponding to the configuration sp^3, but is rather to be considered as a linear combination of all six levels (Van Vleck computed that the 'valence-state' lies *c.* 164 kcal. above the ^3P ground-state). Accordingly, although we recognize the power of the argument of Long and Norrish regarding the assessment of L_1, we are unable to accept it as conclusive, and are generally of the opinion that further direct experimental work, probably on the dissociation of CO or CN or on the later stages of the stepwise dissociation of CH_4, is necessary to settle this important problem.

Note added in proof.—In connexion with the final sentence of our note, we would direct attention to the new direct measurement of L_1 by Brewer, Gilles and Jenkins[9] referred to by Pitzer[10]. They obtain the value 170·39 ± 0·20 kcal. for L_1 at 0° K.

H. A. SKINNER
H. D. SPRINGALL

Department of Chemistry, The University,
Manchester 13.

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I am very grateful to the courtesy of the authors of the foregoing letter and the Editors of *Nature* for the opportunity of appending a reply to the criticisms involved.

In the previous paper with Prof. Norrish[1], the remark that Pauling's listed values of bond-energies contain values which are deficient for links involving carbon is consistent with the fact that Pauling, in his section on the energies of covalent bonds[2], describes the covalent bond by a wave function in which the coefficients of the various ψ values are such that make the bond-energy a maximum. Having thus introduced the concept of bond-energy, Pauling, in comparing thermochemical bond-energies, naturally makes no attempt to divorce their meaning from the wave-mechanical representation, which, on the contrary, would seem to be required by the above definition of Skinner and Springall in the case of compounds of tetravalent carbon. In this connexion, it has frequently been pointed out[3] that the carbon atoms must have the sp^3 configuration to provide the appropriate wave functions. Accordingly, the low values of the carbon bond-energies calculated thermochemically from the ground s^2p^2 state are 'deficient according to Pauling's *usage*, since they bear to the required values no closer relation than the fivepence change bears to the cost of a sevenpenny article for which a shilling has been paid. The two usages are not, in our opinion, based on different definitions, the example quoted by Pauling by way of definition being identical with our manner of definition.

It is true that the same principle must be applied to a large number of bonds other than those involving carbon. Cases in point are the boron trihalides, which require the unpairing of the s electrons on the boron atom and its promotion to the sp^2 configuration. For co-ordinate links to oxygen, on the other hand, as in the amine oxides and oxyacids of chlorine, for example, the question is one of pairing the two unpaired electrons on the oxygen atom, that is, bringing it from a triplet to a singlet state. None of the examples quoted by Skinner and Springall involving varying degrees of bond polarity create any more difficulty to the one point of view than to the other so far as covalent links are concerned, and it is difficult to see their relevance to the discussion. For heteropolar molecules such as Na^+Cl^-, the bond-energy is not to be confused with the ionic attraction, which is related to the dissociation energy by an algebraic function of the ionization energy of the metal atom and the electron affinity of the non-metal atom. In cases such as the BeH molecule, the relevant atomic states required to give a stable molecular orbital are not normally in doubt, even though the dissociation scheme may involve the avoidance of crossed potential energy curves. It is the contention of this note that an application of the principles of electron-pairing to the selection of atomic terms for the derivation of bond-energies does not in itself lead to ambiguity, and that failure to apply these principles has on occasions led to erroneous conclusions, as pointed out previously[1,4].

It is not a fair statement of the facts to say that we assumed the bonds in CH_3 and CH_4 to be roughly equivalent in strength, since these strengths are interrelated with L_2, for which limits were derived in our paper. It likewise follows from these limits that the reorganisation energy of CH_3 on its formation from CH_4 is small. It may need to be pointed out here that, according to the initial definition we gave[1] for the bond-energy E, the energy of reorganisation calculated from experimental data is a *net* effect which includes the effects due to any possible change in the bonding to sp^2 and repulsion between the hydrogen atoms (as well as all other secondary effects within the molecule such as that due to delocalization of the bonding electrons[3]), so that the remarks of Skinner and Springall concerning these factors are beside the point and do not apply here. The same conclusions also follow from the original definition of energy of reorganisation[5]:

$$\text{energy of linkage} = \text{energy of dissociation} + \text{energy of reorganisation}.$$

It is, of course, possible to define bond-energies in such a way that all these effects are separated out, but we adopted the more usual convention of including them.

The remaining point concerning the 'valence-state' of carbon as calculated by Van Vleck[6] is also one of convention. Adopting Van Vleck's convention, it is necessary for the sake of consistency to calculate bond-energies from the 'valence-states' of all other atoms (which in the case of oxygen and nitrogen, for example, are *not* the ^3P and ^4S states respectively), the energies of some of these states having also been calculated[7]. On this basis, the criticism put forward by Skinner and Springall conflicts with their own definitions laid down at the outset of their communication. Again, we adopted the usual convention of referring bond-energies to atomic states. The identification of the tetravalent state of carbon with the ^5S level seemed at the time, in the absence of a spectroscopic value, to be confirmed by the calcuations of Ufford[8] and experimental data concerning he CN radical[1]. The discrepancy with the recent bservations of Shenstone[9] will be dealt with in a uture communication. It is in no sense responsible or the discrepancy between our conclusions and hose of Springall[10] concerning the heat of atomization of carbon, this being due to entirely different easons which are discussed in a forthcoming paper.

In conclusion, it seems to me that the expression 'mean bond-energy term' is an unfortunate choice. As originally employed for polyatomic molecules by Butler and Polanyi[11], a constancy in energy is ssumed for any one kind of link from molecule to molecule, differences in the dissociation energies being ttributed entirely to resonance energy of the resulting adicals. This point of view ignores changes in the nergy of unruptured links during a dissociation process, whereas the statement that bond-energies ccording to Skinner and Springall's usage (*a*) show "a remarkable degree of constancy" seems difficult o maintain in the face of much experimental evidence. f this were so, then every process of the type

$$CH_4 + CO_2 \rightarrow 2H_2CO,$$

n which the number of each type of bond remains he same, would be thermoneutral, whereas this is far from being the case. The example quoted is ndothermic to the extent of about 60 kcal., which must be attributed to changes in the energies of the C—H or C=O bonds or, more probably, both. The xtent to which the bond-energies (as distinct from he dissociation energies) of C—H, C=O and many ther bonds do, in fact, vary has received frequent onsideration in the literature[12].

L. H. LONG

University College,
Exeter.

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GERMAN MOTOR ROADS

BEFORE the War much interest was taken in Great Britain in the German *Autobahnen*. Their design and construction were well described then in both the technical and popular press. The system is the only modern road network planned on a national cale and is worthy of most careful study in order that practice in Britain and elsewhere may profit as much as possible from German experience. The ecent B.I.O.S. Overall Report*, entitled "German Motor Roads, 1946", is therefore particularly valuable in that it gives comprehensive information on the present state of these roads. The report, which contains thirty-nine excellent plates, is clearly and uccinctly-written and can be strongly recommended o the general reader.

The roads have been laid out on new ground, independently of existing roads, so as to link the main cities and industrial areas. The great extent of the system is emphasized by the fact that although a length of some 2,380 miles of dual-carriageway road is already in service, only about one half of the length originally planned has been completed. One of the chief impressions gained by the observers was of the high quality maintained throughout rather than of any exceptional excellence in particular sections, which were nowhere better than has been achieved elsewhere. This consistency is attributed to the policy of working to a single standard determined centrally, and of employing contractors carefully selected for their ability to undertake work of such a magnitude. The designs of the later roads were modified in the light of the experience gained from those already in service.

An admirable feature is the absence of extensive cracking of the concrete surfaces; this has been achieved by building on a gravel foundation, the material being imported if it was not already available locally. The elaborate plans adopted at crossings and road junctions to avoid the conflict of traffic lanes are well known; when adequately signposted, these are not found to be confusing. Another striking feature is the design of bridges; a great variety of construction has been used to suit local conditions and the workmanship is described as being of outstanding merit. Fifteen photographs in the report give a good idea of the lightness of effect achieved in over-bridges and of the pleasing design of the under-bridges; the latter carry the roads across valleys and are often larger than are met with in common practice owing to the stringent gradient restrictions which were maintained. Care has also been taken to blend the roads into the landscape by careful location, by rounding the slopes of cuttings and embankments, and by the method of planting adopted.

The report finally concludes that "the lay-out and alignment of the German motor roads are of a sufficiently high standard to suggest a degree of safety and sense of security above that obtained on ordinary main roads in Britain". Undoubtedly we can learn much not only from the felicities of this great experiment but also from its defects, a number of which are recorded and illustrated. R. H. MACMILLAN

* British Intelligence Objectives Sub-committee Overall Report No. 5. (H.M. Stationery Office, 1948.) 1*s*. 6*d*. net.

CONSTITUTION OF THE PLANETS

MORE than thirty pages of the first part for this year of the Monthly Notices of the Royal Astronomical Society are devoted to "Reports on the Progress of Astronomy", under which is included "The Constitution of the Planets", "Solar Activity", "Comets" and "Double Stars". By far the longest of these is the first, and it is possible to glance at only a few of the points dealt with by Rupert Wildt.

Quite recently our view that satellites could not retain atmospheres has been shown to be incorrect, as methane absorption has been discovered in the spectrum of Titan. The atmosphere of Titan, which is stable under present conditions, would have its stability endangered if its temperature were raised by only 100° C. Hence, if the evolution of the satellite passed through a stage of high surface temperature—as is believed to have happened with all the members of the solar system—the atmosphere of Titan must have been formed subsequent to that period. Kuiper believes that the same argument applies, with almost equal force, to Mars and perhaps to Venus and the earth also. He points out that the existence of methane on Titan suggests a genetic relation to its primary or to the other giant planets, and shows that the satellite cannot be the product of capture from an elliptical orbit extending into the interior region of the solar system.

At the end of the review it is pointed out that there are four different groups of phenomena which are worthy of some attention as possible clues to the history of the solar system. These are: (1) The correlation between the mass of a planet and the size and composition of its atmosphere-oxides on the terrestrial planets and hydrides on the giant planets. (2) The existence in Saturn's system of two types of satellites with densities greater than that of rock and less than that of water. (3) The nature and origin of the envelopes of low density characteristic of all the giant planets. The theory of Kuhn and Rittmann rules out the possibility of gravitational separation leading to the formation of a heavy core and more especially in the giant planets; and if their view should be accepted, the marked concentration of density towards the centre of the giant planets would favour the accretion theory of planetary formation. (4) The mean chemical composition of the planets in relation to the composition of the sun. As it is possible to explain the scarcity of light elements on the terrestrial planets by dissipation, no further cosmogonic inferences can be made so far as this is concerned. Of course, if the planetary matrix were much richer in lighter elements than the bulk of the sun, some doubts would be thrown on the formation of the planets by sudden ejection from the sun, which would have been accomplished by an unavoidable loss of hydrogen. When more accurate values for the mean composition of the sun and giant planets are available, they may facilitate a choice between the rival theories of the origin of the solar system, through a sudden catastrophe with subsequent rapid condensation, or through gradual accretion.

OSLER AS A SCIENTIST*

By SIR ARTHUR MACNALTY, K.C.B.

SIR WILLIAM OSLER is famous for many things. He was a great physician of two continents, a scholar, a humanist, a teacher and a medical administrator. His work as a scientist has perhaps received less recognition, yet it is revealed on every page of his famous text-book of medicine. As Harvey Cushing wrote[1]: "The volume, indeed, was what might be called a practical pathology in which were given the results of modern investigation, microscopical, bacteriological, and chemical. On this foundation was built up the symptomatology and diagnosis of disease. . . ." His school-master, the Rev. W. A. Johnson, at Weston, near Toronto, introduced him to the study of biology, geology and the use of the microscope. At eighteen years of age, Osler began to tabulate and study his collection of the Diatomaceæ; and his interest in biology was stimulated further, when he entered the Toronto Medical School in 1868, by Dr. James Bovell. "I am at Dr. Bovell's every Saturday and we put up preparations for the microscope," he writes.

His first publication was a short sketch entitle "Christmas and the Microscope" (*Hardwicke's Scienc Gossip*, London, Feb. 1, 1869), in which he describe the diatoms and Infusoria he identified in a bottle c water. In 1870 he presented to the Natural Histor Society of Montreal the results of his studies on th Diatomaceæ of Canada, enumerating 109 specie under twenty-nine genera and describing the structur mode of division and propagation of the diatom[2]. I 1877 he read a paper before this Society on Canadia fresh-water Polyzoa[3] and published a supplementar note on this paper in the *Canadian Naturalist*, 1881 He mentioned a species of *Cristatella* as having bee found in abundance and described a new species c *Pectinatella*.

In 1872–73 Osler had spent fifteen months in th Physiology Laboratory, University College, Londor working at physiology and histology under Pro Burdon-Sanderson. While there he was offered th chair of botany in McGill University; but declined i as insufficiently qualified for the post. At Universit College he began working "On the Action of certai Reagents—Atropia, Physostigma and Curare—on th Colourless Blood-Corpuscles"[5]. The published result were negative. In 1873 he made his most importan contribution to scientific knowledge by investigatin with Edward Schäfer the form and movement of th blood platelets. Though a few previous workers, fo example, Bizzozero and Hayem, had observed thes bodies, "the third element of the blood", it was Osle who saw them first in the circulating blood an carefully described them, and his observations wer presented before the Royal Society by Burdon Sanderson in 1874[6]. Afterwards, he published severa papers and lectures on the blood, including one on th development of blood corpuscles in the bone-marrow All this work established Osler's reputation as a original investigator.

Returning to Montreal in 1874 as lecturer Institutes of Medicine, he studied the 'entozoa', an R. Ramsay Wright, professor of biology at Toront named a trematode worm, which Osler had found the gills of a newt, *Sphryanura Osleri*[8]. Osler, a professor of physiology in the Veterinary Colleg Montreal, and vice-president of the Montreal Vete inary Medical Association, also worked at comparati pathology, being one of the first to realize its impor ance in relation to medicine. He published sever papers on this subject during the next few years. I the first of them, on a form of bronchopneumonia i dogs, he described a previously unknown parasit nematode as the causal agent[9]. This organism w afterwards renamed *Filaria Osleri* by Cobbold i 1879. The most important of the other papers dea with hog cholera[10], echinococcus[11], cestode tube culosis[12] and the parasites in the Montreal po supply[13]. As a by-product of this latter investigatic he took up the subject of trichinosis and echinococc infections in man. He studied the parasites in th blood of the frog, demonstrating and classifying *Ran mugiens*, the *Trypanosoma Sanguinis* (Grubby) an the *Drepanidium ranarum* (Lankester)[14].

Osler confirmed Koch's discovery of the tuberc bacillus as the cause of tuberculosis in 1882; but never became an adept in bacteriological techniqu Harvey Cushing, his biographer, considered that first he inclined towards Bastian's belief in spontaneo generation, and by the time that Pasteur's views ha been accepted, he had abandoned experiment medicine and comparative pathology for the clinic study of disease. The call to Philadelphia to professor of clinical medicine in the University of Pennsylvania in 1884 marks the end of Osler's investigations as a pure scientist in the fields of zoology and physiology. In these fields he had achieved reputation as a trained microscopist and had made important contributions to knowledge. As W. T. Councilman said : "He could easily have become a great scientist, but he chose the path which led to the formation of the great clinician which he became ; a worthy associate of the great men who have made English medicine famous"[15].

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* A paper read to the Osler Club on July 12.

Already at Montreal Osler had used the microscope in his pathological studies and continued to promote pathological research in association with clinical investigation in the Philadelphia and Baltimore periods. Thus his Goulstonian Lectures on malignant endocarditis[16], based entirely on autopsies performed in Montreal, contained the first comprehensive account in English of the disease and are largely clinical and pathological, but not experimental. He suggested that malignant endocarditis was invariably of bacterial origin ; he stained the organisms in the tissues and made a few inconclusive inoculation experiments ; but left to others the task of bacteriological investigation of this malady.

One of Osler's last pieces of microscopical investigation was his confirmation in 1886 of Laveran's discovery of the malarial parasite[17]. It was due to Osler's prompt appreciation of this discovery that the prevalent theory of a mysterious nocturnal 'miasma' was overthrown in the United States, and in his Baltimore Clinic, a few years later, he insisted that no diagnosis of malaria should be made without a microscopic examination of the blood. His hæmatological studies led him to take a special interest in diseases of the blood, and he described in 1902 "cyanosis with polycythæmia"[18], since known as 'Osler's disease'. A hereditary malady characterized by multiple telangiectases associated with hæmorrhages[19] is also styled 'Osler's disease'.

Throughout his professional life, William Osler applied his scientific knowledge to the study of clinical disease and brought the laboratory to the bedside. His teaching in this respect has greatly influenced the progress of clinical medicine. He referred to this guiding star of his work in the following words : "To the physician particularly a scientific discipline is an incalculable gift which leavens his whole life, giving exactness to habits of thought and tempering the mind with that judicious faculty of distrust which can alone, amid the uncertainties of practice, make him wise unto salvation"[20].

[1] Cushing, H., "The Life of Sir William Osler", **1**, 359 (Oxford, 1925)
[2] *Canad. Naturalist and Quart. J. Sci.*, 1870–71, N.S., **5**, 142 (Montreal)
[3] *ibid.*, N.S., **10**, 399 (1883).
[4] *ibid.*, N.S., **11**, 473 (1881).
[5] *Quart. J. Mic. Sci., Lond.*, N.S., **13**, 307 (1873).
[6] *Proc. Roy. Soc.*, **22**, 391 (1873–74).
[7] *Trans. Assoc. Adv. Sci.*, Salem, Mass., **31**, 512 (1883).
[8] Wright, R. R., "Contributions to American Helminthology", *Proc. Canad. Inst.*, N.S., **1**, No. 1 (1879).
[9] "Verminous Bronchitis in Dogs", *Veterinarian, Lond.*, **1**, 387 (1877).
[10] "On the Pathology of the So-called Pig Typhoid", *Vet. J. and Ann. Comp. Path., Lond.*, **6**, 385 (1878).
[11] *Trans. Path. Soc., Phila.*, **13**, 222 (1885–87).
[12] *Amer. Vet. Rev., N.Y.*, **6**, 6 (1882).
[13] *Canada Med. and Sci. J., Montreal*, **11**, 325 (1882–83).
[14] *Canad. Naturalist, Montreal*, N.S., **10**, 406 (1883).
[15] *Johns Hopkins Hosp. Bull.*, **30**, 197 (1919).
[16] *Brit. Med. J.*, **1**, 467, 522, 577 (1885).
[17] *Trans. Path. Soc., Phila.*, **13**, 255 (1885–87) and *Brit. Med. J.*, **1**, 556 (1887).
[18] *Amer. J. Med. Sci., Phila.*, N.S., **126**, 187 (1903).
[19] *Johns Hopkins Hosp. Bull.*, **12**, 333 (1901).
[20] "The Leaven of Science", *Univ. Med. Mag., Phila.*, **6**, 573 (1893–94), and in "Æquanimitas" (London, 1904).

SCIENCE OF THE AMARYLLIDS

THE American Plant Life Society, organised for the increase and diffusion of knowledge concerning plant-life, issues the year-book "Herbertia", which is devoted to the Amaryllids. Issues for 1946 and 1947 appeared together late in 1947 (from the Society, Box 2398, Stanford, California), and contain some useful papers of scientific interest. A detailed account of "the karyo-systematics of the sub-genus *Ajax* of the genus *Narcissus*" (Vol. 13, 1946) is contributed by A. Fernandes and Rosette Fernandes of Portugal. Of about eighteen species, fourteen are diploids, normally with $n = 7$. *Narcissus hispanicus* is constituted of diploid and triploid forms, *N. tortuosus* is triploid, and *N. bicolor* tetraploid. Fifteen somatic chromosomes are found in *N. asturiensis*, *N. minor*, *N. pumilus* and *N. pallidiflorus*. Since all the species have the same karyotype, this supports the idea of Baker (1888) that the group is a single, very polymorphic Linnean species. The different forms have arisen by gene mutation and polyploidy.

A useful description of narcissus disease symptoms and control is given by Charles J. Gould (Vol. 13, 1946), with several photographs. Perhaps the most interesting to British readers is a virus disease rather appropriately named 'decline', but also known as 'white streak'. A corresponding paper on insect and mite pests of narcissus by E. P. Breakey mentions the narcissus bulb fly, the lesser bulb fly and bulb mites, all of which are already known in Great Britain. It is usual to grow Amaryllids for their garden beauty, but M. J. Cox and M. M. MacMasters show (Vol. 14, 1947) that starch can also be prepared from the tuberous roots of *Alstrœmeria aurantiaca* and *A. chilensis*. Granules from the former are simple, but those from the latter have an unusual compound nature. Both give pastes which have similar characteristics to other root starches.

There are also shorter articles on all aspects of Amaryllid culture, breeding and classification.

JOHN INNES HORTICULTURAL INSTITUTION

FOR thirty-eight years, the John Innes Horticultural Institution has been carrying out detailed investigations in plant culture, genetics, breeding and other matters. 'J.I.' composts are now widely used and have perhaps done more than anything else to make the name of the Institution familiar to gardeners. The annual report for 1947, recently issued, gives the results of many continued researches. M. B. Crane has obtained a certain amount of resistance to pear scab, *Venturia pirina*, from crosses between the pear varieties Giffard and Conference. Rogues in tomatoes are shown by D. Lewis to appear most frequently when the plants are grown at high temperatures (26° C.). The same author has analysed seven X-ray induced mutations of the incompatibility gene of *Œnothera*. They do not confer complete self-compatibility ; but the work is being continued. K. Mather has investigated the three types of gene which affect heterostyly in *Primula sinensis*. The difference of morphology and physiology between pin-eyed and thrum-eyed flowers is determined by the major genotype, and finally adjusted by the polygenotype. Miss A. Vines has studied breeding system and genetic isolation in *Antirrhinum*, and A. J. Bateman has estimated the effect of various isolation systems on contamination in seed production.

Work on plant improvement by crossing has been carried out for uniform coloration of fruit in tomato (G. M. Haskell), and for combining the dwarf habit of *Phaseolus vulgaris* with the extended inflorescence of *P. multiflorus* (L. G. Wigan).

The Cytology Department, under Dr. C. D. Darlington, director of the Institution, has worked on the effect of cell gradients in controlling the development of nuclei in the pollen grain. The occurrence of dwarf pollen has engaged the attention of L. F. la Cour, who discusses the relative merits of segregation and differentiation as a cause. Further studies include the effect of X-rays on meiosis, and chromosome breakage by temperature shock. An interesting development in the Garden Department, under W. J. C. Lawrence, is the effect of artificial lighting on the yield of tomato plants. Daylight fluorescent tubes lit for 6 hr. a night for the first twenty nights after germination resulted in a much heavier yield of fruit, particularly in the first three weeks of picking.

The Institution is still carrying out its long-term programme of removal to Bayfordbury, Hertford; but it is expected to be some time before the transfer is complete.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Officer at the Division of Industrial Chemistry, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1765 (September 4).

Head (male) of the Poultry Department at the Ulster Dairy School (for girls), Cookstown, Co. Tyrone—The Establishment Officer, Ministry of Agriculture, Stormont, Belfast (September 4).

Lecturer in Agriculture and Farm Bookkeeping, and a Lecturer in Agriculture, Farm Implements, Building Construction, etc., at the Cheshire School of Agriculture, Reaseheath—The Director of Education, County Education Offices, City Road, Chester (September 4).

Instructresses (2) in Dairying and Poultry-keeping—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (September 4).

Chemist, and a Physicist—The Secretary, Hosiery Research Council, 4 First Avenue, Sherwood Rise, Nottingham (September 4).

Research Physico-chemist at the Research Institute of the Foot-and-Mouth Disease Research Committee—The Director, Research Institute, Pirbright, Surrey (September 4).

Demonstrator in Chemistry and Biochemistry with a special interest in Physical Chemistry—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (September 4).

Lecturer in the Engineering and Mining Departments to take Electrical Technology and Mechanical Engineering with mining qualifications—The Registrar, University College, Cathays Park, Cardiff (September 4).

Lecturer in Entomology, an Agricultural Economist, and an Assistant Agricultural Economist—The Registrar, The University, Bristol 8 (September 4).

Lecturer or Assistant Lecturer in Physics—The Principal, College of Technology, Manchester (September 6).

Biologist (Technical Officer) as Head of the Biological Section of the Technical and Scientific Register—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.351/48A (September 6).

Mechanical Engineer (Ref. C.528/48A), and a Standards and Co-ordination Engineer (Ref. C.529/48A), at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 6).

Agricultural Economist (male)—The Registrar, Wye College, Wye, Ashford, Kent (September 7).

J. G. Graves Medical Research Fellowship for full-time research in some branch of medical science approved by the Faculty of Medicine—The Registrar, The University, Sheffield 10 (September 11).

Assistant in the Engineering Department, London H.Q.—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (September 11).

Editorial Assistant (with degree in physical science with bias towards physics and mathematics) to the Royal Society—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.270/48A (September 11).

Lecturer in Anthropology with special reference to India—The Secretary, School of Oriental and African Studies, University of London, London, W.C.1 (September 11).

Senior Lecturer in Mathematics at the New England University College, Armidale, New South Wales—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (September 15).

Assistant Bacteriologist (with an Honours Science Degree in Bacteriology), and an Assistant Biochemist (with an Honours Degree in Science and special experience in Biochemistry), to the Northern Regional Hospital Board—The Secretary and Administrative Medical Officer, Raigmore Hospital, Inverness (September 15).

Professor of Botany at Fouad I University, Cairo—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 15).

Assistant Lecturers (2) in the Department of Civil Engineering—The Professor of Civil Engineering, Queen's University, Belfast (September 15).

Research Officer in the Building Research Section, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1547 (September 18).

Assistant Lecturer or Lecturer in Agricultural Economics—The Registrar, The University, Leeds 2 (September 22).

Experimental Officers and Assistant Experimental Officers at the Department of Atomic Energy, Springfields, Lancs, to carry out experimental work arising from the metallurgical development involved in the production of atomic energy—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.391/48A (September 25).

Principal Research Officer in the Microbiological Division of the National Chemical Research Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (September 30).

Fisheries Assistant and Naturalist (temporary) for research at the Marine Biological Station, Port Erin—The Registrar, The University, Liverpool (September 30).

Chair of Mechanical Engineering—The Registrar, The University, Leeds 2 (September 30).

University Lecturer, preferably with special qualifications in Fluid Dynamics, Atomic Physics or Algebra—The Secretary of the Appointments Committee, Trinity College, Cambridge (September 30).

Readership in Metallurgy in the Department of Coal, Gas and Fuel Industries—The Registrar, The University, Leeds (September 30).

Kennedy Chair of Mechanical Engineering at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 7).

Director of Research at the Hosiery Research Council's Research Station at Thorneywood House, Nottingham—The Director, National Hosiery Manufacturers' Federation, 104 Regent Road, Leicester (October 15).

Chair of Geology at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 25).

Professor of Civil Engineering, and a Professor of Electrical Engineering, at the Thomason College of Engineering (Roorkee University)—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 412A (October 30).

Chair of Zoology at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 1).

Fisheries Officers in Malaya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London S.W.1.

Tsetse Fly Ranger by the Government of Nyasaland, for tsetse fly survey and reclamation duties—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21794/3F.

Scientists (*a*) with research and practical experience in Coal Mining, Coal Preparation and Carbonization and Briquetting (Ref. TT/70), and (*b*) to take charge of the Chemistry Laboratories and with all-round research experience with specialist knowledge in Coal Chemistry Analytical work, Metallurgy or Coal Tar (Ref. TT/71)—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting appropriate Ref. No.

Superintendent of the Scottish Laboratories, involving responsibility for all chemical, mechanical and micrographic testing and for advisory service to Scottish members—The Secretary, British Cast Iron Research Association, Alvechurch, Birmingham.

Geologists for research on concentration of iron ore (*a*) with special knowledge of petrology or sedimentary rocks, (*b*) with experience of ore dressing problems—The Personnel Officer, British Iron and Stee Research Association, 11 Park Lane, London, W.1.

Research Assistant in Statistics (preferably with Degree in Mathematics)—The Lecturer in the Design and Analysis of Scientific Experiment, 91 Banbury Road, Oxford.

Senior Engineer in the Land Drainage Branch of the Public Works Department, Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in Radio Engineering—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Visiting Demonstrator in the Department of Bacteriology—The Secretary, King's College of Household and Social Science Campden Hill Road, London, W.8.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Catalogue

Technique: a Journal of Instrument Engineering. Vol. 2, No. [illegible] April. Pp. 9–16. Transmission Measuring Set, Type D–514–A. (Bulletin B.610.A.) Pp. 2. (Beckenham: Muirhead and Co., Ltd., 1948.)

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SECOND THOUGHTS ON UNIVERSITY EXPANSION

THE almost simultaneous publication of the Nuffield College Statement "The Problem Facing British Universities" and the symposium on "Entry and Careers" in *The Universities Quarterly* for August provides valuable material for further discussion on the expansion of the universities. The former Statement brings together much useful statistical information as well as collecting in its chapters on the demand for university graduates estimates of intake to the professions which are not otherwise conveniently accessible. Moreover, in the further chapter on the flow from the schools the Statement does something to meet a point made by Dr. Eric James, high master of the Manchester Grammar School, at the British Association conference on "The Place of Universities in the Community" last year, as well as to supply a factual background to Dr. J. F. Mountford and Mr. James Hemming's contribution to the symposium. Indeed, the Statement contains so much factual information that it is not easy to see the wood for the trees, and the conclusions seem to indicate that the members of the Nuffield Committee have not been entirely sure of themselves for that reason.

The Statement sets out in the first place to survey the chief demands made on universities, and after reviewing those made by the organised professions and other regular occupations which rely for recruitment on university graduates, including the demand for admission from overseas students, which is expected to be strong for some time, it considers the extra-mural work of the universities and the position of the higher technical and other specialized institutions. While the Statement does not commit itself to any quantitative estimate of the extent of university expansion, the Committee regards a permanent expansion as probable and appears to be satisfied that there is little risk of the large number of graduates failing to find employment. On the other hand, it formed the opinion that in the aggregate present demands are probably exaggerated, and that if the demands are pressed separately and dealt with piecemeal without consideration of their interrelation and aggregate effect, there may be real danger that legitimate but sectional needs will be met to the neglect of other needs of greater importance to the maintenance and development of the universities.

The Statement is thus first and foremost a challenge to fresh thought about the purpose and functions of a university, and as a result of that thinking to determine principles by which sound decisions can be made in balancing new claims against existing duties or one new claim against another. The Nuffield Committee does not, it is true, go very far in its analysis. It insists that in the first place there must always be an element of general education or culture in the teaching a university gives, and that, in the second place, this teaching must be given by scholars and men of science who are themselves working at the frontiers of knowledge. A university must maintain a reasonable range of studies, and not allow its desire to meet any one claim to turn it into a specialized institution restricted to serving the needs of a single profession or field of research, nor must any aggregate demands for teaching be allowed to deflect its staff from pursuing their own studies and research. The Committee observes here that it is at least a possibility that in the endeavour to give everyone whatever he wants, the universities may end by giving nobody what he requires.

The two chief suggestions made in the Statement to relieve the universities in meeting the immediate and short-term problems of expansion will be discussed in due course. The Committee recognizes that there is no satisfactory solution to the problem of meeting under present conditions the sudden expansion in the demands made on the universities. Its suggestion as to the extension of the extra-mural work of the universities has a bearing, however, on the long-term problem of expansion with which the universities are simultaneously faced.

The Statement suggests that universities which are adequately staffed might extend the opportunities which they offer to part-time students already qualified by previous education by allowing such students who are prevented from full-time residence to spread their study over a longer period than the usual full-time period, and by the provision of short special courses of the refresher type for those who can only come for a short period. The emphasis thus placed on the extra-mural and regional responsibilities of the universities is welcome: no short-term policy even which severely restricted the discharge of such responsibilities could wisely be accepted. Nevertheless, the Statement does not make it clear how the continuance or extension of such functions will contribute to ease either the short-term or long-term expansion. Like the question of size, on which also the Statement briefly comments, these functions appear to be mentioned chiefly as essentials to be kept in mind in deciding the exact purpose and functions of the universities.

Where the Statement is most disappointing is not so much in not indicating the Committee's own conception of a university and the precise purposes and functions it should serve, as in the absence of any constructive suggestion as to how we are to formulate such a conception or definition or to deal with those questions of geographical distribution of universities and the distribution of university resources among different projects where some co-ordination and concerted effort are essential. It rejects the proposal for a royal commission on universities as imposing a further burden on university administrators and teachers who are already overtaxed, without offering much hope of any kind of an early solution of problems. But to the crucial question whether the universities and the present University Grants Committee are competent to effect such a survey of needs and reforms or whether an external agency is required it gives no answer; but merely states the arguments for the alternative courses.

These arguments are admirably put, but what is required at the moment is decision. The Nuffield College Statement makes curious reading on this point, with Lord Lindsay as one of the signatories. Lord Lindsay's plea in the House of Lords debate on the universities in May of last year for a comprehensive review of the situation as a whole by some body other than the University Grants Committee is perhaps the most convincing argument yet advanced, not for the departmental committee which he suggested, but for the comprehensive and comparative survey which a Royal Commission alone could be expected to make.

However right it may be to hesitate to designate men and women for such a task when our ablest administrators are already often seriously overworked, that exigency is no more valid a reason for not examining the whole problem at the highest level than it is for not carrying out that survey of the machinery of government at the Cabinet and ministerial level for which the Select Committee on Estimates called in a recent report. Failure to conduct either survey may, and almost certainly will, involve waste of man-power at all levels immensely out of proportion to that involved in conducting the survey. So far as the universities are concerned, the brake on expansion imposed by the building situation may well afford the necessary breathing space for such a survey if a prompt decision is made as to the instrument to be used to conduct the survey. Nor need, it might be added, a royal commission, as opposed to the University Grants Committee, or some sub-committee of that body, employ the time of more than a very few of those actively engaged in university administration or teaching. Not only is there a sufficient reservoir of able minds with some experience and understanding of university problems, but much of the information is already being accumulated by various independent means or bodies; these activities and results require bringing together in a composite picture upon which judgment and decision can be based.

Except in respect of science students, where the analysis of available figures is somewhat limited, the Nuffield College Statement provides a fairly detailed comparison of the expansion of the different universities and university colleges in 1945–47 as compared with the situation before the War. The most interesting feature of the symposium in *The Universities Quarterly* already noted is the reference to a number of inquiries already conducted by the Technical Personnel Committee set up by the Ministry of Labour and National Service under the chairmanship of Lord Hankey, some of which do not appear to have been published. The quotations from these reports are complementary to the information in the Nuffield Statement and help to fill in some of the gaps that exist in our knowledge of the present situation and the probable demand for particular classes of graduates.

It is well known that while in the autumn of 1947 the number of students in British universities had risen from the pre-war 50,000 to roughly 77,000, the number of science students had practically doubled and stood at 14,500. As regards arts students, 'if the student population remains at about 80,000, there are expected to be about 12,000 graduates in each year from 1951 as against 7,000 before the War. In spite, however, of this increase in the number of science students, no substantial increase in the output of graduates available for employment outside the universities is expected before 1950. Thereafter there should be a rapid increase to about 5,000 each year or double the pre-war output. The first substantial increase in graduates in technology will likewise not be effective industrially until 1950, owing to the demands of military service, but by 1951 the output should be 3,400 each year as compared with 1,500 pre-war.

These are figures of which not only the universities but Government Departments as well as the universities should take careful note, and they should certainly guide the Advisory Council on Scientific Policy in considering the distribution or re-distribution of scientific man-power. Moreover, when the development plans of both large and small firms are already impeded by their inability to secure the recruits they require for research and production, with all that involves for industrial recovery and export, the situation disclosed by Mr. L. E. Ball in regard to particular categories is disturbing.

Mr. Ball, the secretary of the University of London Appointments Board, states in this article that there are at present sufficient chemical appointments vacant to absorb all new graduates in chemistry up to 1949 and that demand appears to be increasing steadily. Again, the Technical Personnel Committee, according to Mr. Ball, estimates the demand for chemical engineers for the next five years to be 240 a year as compared with a present annual output of less than 100. The reduction in new construction has, however, reduced the demand for engineers, and in engineering generally it seems that supply is in excess of demand.

This report from the Technical Personnel Committee would seem to be one of three reports which, according to Mr. Ball, have already been issued. One relating to mycologists and microbiologists, stated to have been issued in July 1947, indicated that the present output of microbiologists and mycologists is adequate and that a large expansion is not justified. A similar statement has been made of architects, and generally such inquiries as have been made by the Ministry of Labour and bodies like Political and Economic Planning indicate that most of the professional organisations do not expect any large increase in numbers once their war-time gap has been filled. Mr. Ball, however, expresses the hope that other reports dealing with chemists, biologists and physicists will come from the Technical Personnel Committee without delay, and the figures for physics honours students quoted by Sir Lawrence Bragg were presumably collected for this Committee.

Sir Lawrence Bragg points out that the honours physics schools of our universities are now producing about 600 graduates annually in place of a little more than 200 before the War, and returns from the universities indicate that this number is likely to be maintained for the next few years. Of these graduates in 1947 some 31 per cent entered careers in university or government research as against 29 per cent in pre-war years, 19 per cent entered industry in place of 30 per cent, and only 12 per cent took up a school teaching career as against 29 per cent before the War.

These figures are no less disturbing than those for chemistry graduates, and although the symposium in *The Universities Review* does not give any clear idea of the magnitude of the university expansion at which we should aim, it reinforces the argument for a comprehensive review of the whole situation and points also to the importance of associating industry with this review. Even from a short-term point of view the distribution of scientific man-power needs to be watched closely or there may be as serious repercussions on the flow of students to the universities for science courses as through the inability of industry to recruit the scientific workers it needs now so imperatively for research and production. Moreover, it seems clear also that only with the help of industry can serious unemployment among those who have graduated in arts be avoided during the next four years. Only in industry can openings be found for a considerable surplus over those who can find places in teaching and the professions, and there is real call for business men and industrialists to re-examine their recruiting policy and reconsider their needs for competent managers at the lower salary levels as well as at the directorate levels

At the entry side, both Sir Lawrence Bragg and Mr. J. Hemming direct attention to the question of quality. There seems to be little doubt that Great Britain's reserves of innate intelligence are sufficient to provide annually another 50,000 students of as high mental ability as those attending before the War. There is some doubt as to whether all those students would be forthcoming with the other specific aptitudes, including cultural standards, to make the most of a university life. Mr. Hemming is hopeful but Sir Lawrence is dubious. He has formed the impression that while we have not been missing many first-rate people, we are admitting to honours courses too many who would have profited more by training in much less ambitious courses.

The question of selection of students will be brought to the fore when the Working Party in State Scholarships and Major Awards reports to the Minister of Education shortly. The question of the cost of university education on which Mr. P. F. Vowles just touches in the concluding article in this symposium is bound to become increasingly prominent in discussions on university expansion. However fully we may subscribe to the belief that university education is an investment, it must be recognized that both the universities and the State have a duty to see that the considerable sums involved are wisely spent. It has been estimated that it costs £3,000 to provide a student at Cambridge with a three-year course. Even if his parents are prepared to pay £300 towards it, £2,700 has still to be found from public or university funds. Expenditure at the provincial universities is much less, but neither there nor at Cambridge can the nation as a whole afford to spend such sums on individuals who possess neither the brains nor the personality to profit from them.

Neither the Nuffield College Statement nor the symposium in *The Universities Review* does much more than indicate the range of problems to be solved and the imperative need for dealing with them as a whole and not piecemeal. Both challenge creative thinking about the purposes and functions of a university. Both indicate the urgent need for decision as to the body to whom that overall review is to be entrusted and for swift action as soon as the facts can be fully assembled and considered judgment made. It seems equally clear that if the nation's reserves of intelligence are to be trained and distributed to the best advantage, in that review must be joined the best minds that not only the universities but also industry and the nation as a whole can supply.

EVOLUTION IN MANKIND

A New Theory of Human Evolution

By Sir Arthur Keith. Pp. x + 451. (London: Watts and Co., Ltd., 1948.) 21*s.* net.

THIS book is the fruit of a long life of scientific work and meditation by a distinguished thinker with strong intuitions, trying to look towards a synthesis as yet seen 'through a glass darkly', and trying to make that vision clearer without limiting possibilities of its future adjustment. There is no attempt to force the facts to fit preconceived dogma, no riding of a pet theory to exhaustion.

The basic idea is derived mainly from Darwin, Romanes and Gulick. It is that isolated small, inbred groups are likely to diverge. This view is strengthened by the work of the geneticists, who show that in such a group dominant genes are likely to spread generally among the members, especially if they carry some character of value in the environment concerned. Defective genes may bring rapid extermination, especially if emphasized by close inbreeding.

Keith emphasizes the smallness of the hunter-collector groups in several environments; and he might have made more of the probability that in that stage of social-economic development, Britain is not likely to have had more than a few hundred people in scattered small groups. He directs attention very justifiably to the territorial bases of the little early group which he, in common with all other scientific observers, regards as a basal feature of our heritage from prehuman ancestors. Society is not primarily a human construction, and whatever we may say about social elaborations, they are, as it were, shoots on a prehuman trunk. The territorial basis may be a hunting-range, including perhaps a water supply and so on; the group will typically resent intrusions of strangers and will combine to defend the territory. Here we have Spencer's code of amity within the group and code of hostility outside it, both features of the ethical make-up of mankind, the disharmony between which is our permanent problem. But Keith is concerned with the fact that the code of hostility promotes inbreeding and differentiation, in language and custom as well as in physique; and, at an early stage, the more diversity the less interbreeding. Differences of language and custom are thus factors of isolation which he thinks may be more powerful than mountain or desert belts.

The small group has tended to remain poor, and larger associations of groups have come into existence, with decreasing uniformity in physique, but sometimes enforced uniformity in language and custom Inbreeding, dangerous as well as sometimes useful, i less and becomes less still when one group conquer another, and the conquerors, mainly young men, tak to themselves the girls of the conquered people. The larger and more complex group has more to defend and around this gathers the emotion of patriotism this in turn promotes breeding within the group, so the self-conscious, patriotic group may differentiat itself, even physically, from others in the course of time. A tribesman, says Keith, is apt to transfer hi own emotions and impulses to his tribe or group, and we know the power of that group impulse, especiall in connexion with the code of hostility. Russe Wallace was the first to emphasize group-solidarit and the accompanying selection between groups as a factor of evolutionary differentiation.

Keith emphasizes fœtalization as a factor of evolutionary differentiation. The forehead and many other features in women are usually nearer the fœtal stage than those of men. Mongol features, so called including a low and retracted nasal bridge, an epicanthic fold over the upper eyelid and protuberant eyeballs, are fœtal and transitory in a proportion of Europeans, but durable in parts of Eastern Asia and among the majority of Hottentots. These resemblances are not necessarily indications of close genetic relationship.

It has seemed best to try here to give a fairly general picture of Keith's views. The book reviews many stages of human social, as well as physical differentiation and gives the author's considered opinions. He adheres, for example, to the view that the Piltdown skull and jaw belonged to one and the same individual, arguing against the opinion that they are of different species but not mentioning the bare possibility that the skull might be that of a female and the jaw that of a male.

Keith's idea of inbreeding groups as in process of differentiation leads him to think of them as possibly races in the making; but most groups of the presen time are heterogeneous and likely to remain so, and it might be better to use some term other than tha of race in this connexion.

The book is one for careful meditation, and is an interesting monument of a respected and beloved personality.

H. J. FLEURE

TOWARDS A MATHEMATICAL SOCIOLOGY

Mathematical Theory of Human Relations

An Approach to a Mathematical Biology of Social Phenomena. By N. Rashevsky. (Mathematica Biophysics Monograph Series, No. 2.) Pp. xiv + 202 (Bloomington, Indiana: Principia Press, 1947. 4 dollars.

IT is only in quite recent times that mathematical methods have been applied in the social science or, indeed, in those fields, such as psychology, wher the natural and the social sciences overlap. The use of mathematical-statistical methods in the handling of data, as in biometrics or econometrics, has developed rapidly in recent years. The employment o mathematics as a tool of analysis in the development of theory has been neither as general nor as successful Mathematical economics, like mathematical biology is taking its place in the general body of theory, and the time is ripe for extensions into other social sciences. What the author of this book attempts is a sketch of the possibilities of a mathematical sociology. He is where the mathematical economist or biologist was some decades ago, experimenting with alternative formulations and various types of simplification. He has a wider and more difficult field than the economist or biologist but; since his science overlaps with theirs, he can draw upon their experience.

I can give no more than a brief indication of the scope of the author's essay. He attempts a theory of the way in which classes or groups are formed, of their size and number. He considers the interaction of one group with another within the social structure and, in particular, the various kinds of conflict from economic exploitation to war. He develops the characteristics of individualistic as against collectivistic societies. He has a good deal to say on the dynamics of the growth and decay of groups; for example, the controlling power of a group, derived by inheritance from past generations, may become unstable. He finds that a rather general formulation involves complicated integral equations; but, by simplification of his models, he is able to proceed with differential equations and with ordinary problems of maximum and minimum.

The author would, I think, agree with me in stressing two aspects of his work. One is that he is experimenting with various mathematical formulations, most of which may not lead to anything fruitful. Even so, the work is not wasted. It is always useful to translate into mathematical terminology the different theoretical situations studied; in this case the growth and interactions of groups in the social structure. This serves, at least, to clarify the nature of the assumptions on which the theory rests and to distinguish sharply between the various possibilities.

The second aspect is that, eventually, any mathematical theory must be developed to the point where it can be put to the test with actual data and lead to prediction. The author's theoretical constructions are, he admits, crude and oversimplified descriptions of a modern society. But, if only for illustrative purposes, he ventures to introduce actual data from time to time to match against his theoretical results.

Against these merits must be set certain weaknesses, many perhaps inevitable in a pioneering study. I think the author has been ill-advised to publish his work in book form so early in its development. With more time, he might have shown greater discrimination in his selection of formulations for development; he might have cut out some weaker threads and tied up some of the stronger but loose ones. He is at his weakest where he analyses the economic aspects of social groupings. He admits that much of what he does must appear crude to an economist, but feels that his simple approach is necessary to "bring out the social aspect of the interrelation of economic classes" (p. 40). Perhaps so, but I feel that he can only say this after a close examination of the work of mathematical economists. His references make it clear that he has not read widely in this field. He is much influenced by two or three writers, particularly G. C. Evans (referred to throughout as G. E. Evans), whose work dates back to the 1920's and early 1930's. He displays no knowledge of later work, particularly in economic dynamics, which would be of more help to him. He would find, for example, that mathematical economists first followed physicists in using differential equations but afterwards turned to difference equations as more appropriate to their subject, and (incidentally) discovered them to be just as easy to handle. His assertion that "no successful application of mathematics to social phenomena has been made" (p. iv) is not true of at least one branch of the social sciences.

R. G. D. ALLEN

THE UNIFORM CALCULUS

A Text-Book of Mathematical Analysis

The Uniform Calculus and its Applications. By R. L. Goodstein. Pp. xii + 476. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 30*s*. net.

THE problem of presenting the infinitesimal calculus to schoolboys and university students who seek to acquire a knowledge of it for applications in other fields is notoriously difficult. Methods based upon geometrical intuition lack rigour and to the thinking student produce an impression of mystery. Methods based on a rigorous theory of real numbers are suited only to the student who is to become a mathematical specialist.

Dr. Goodstein proposes to avoid the difficulty by a simplification of the calculus itself, by restricting his treatment to functions which possess uniform differentiability. The foundation-stone is the notion of a convergent sequence of terminating decimals, which is then extended to convergent sequences the terms of which are endless decimals. The notation $0(r)$ is used to signify any number which is zero to r places of decimals, that is to say, a number the positive value of which is less than $1/10^r$. A function $f(x)$ is said to be uniformly differentiable in the interval (a,b) if we can find functions $f'(x)$ and $n(r)$ such that

$$\frac{f(X)-f(x)}{X-x} = f'(x) + 0(r)$$

for any numbers X, x in (a,b) which satisfy $X - x = 0(n(r))$.

The (uniform) derivative $f'(x)$ thus defined exists for all the usual elementary functions which the student is likely to encounter, in particular for the circular and exponential functions.

It is then proved that a uniform derivative is a continuous function, and that a function uniformly differentiable in (a,b) is continuous in (a,b).

On this basis, and with suitable definitions of integrals, the uniform calculus is built up in such a manner that the ideas can be appreciated by a student who has only a modest knowledge of arithmetic and algebra.

The first eleven chapters contain all the calculus that is needed for the ordinary and advanced papers of the higher school certificate examinations. The whole book covers the calculus syllabus for the general honours degree of London and provincial universities and the London special degree.

The demonstrations are lucid and often original, and the student should profit by the examples of technique so well illustrated in every chapter. The standard functions e^x, $\sin x$, $\cos x$ are defined by their expansions in power series and are introduced in a natural and satisfying manner.

The author has purposely given no diagrams in order to prevent the possibility that geometrical intuition may disturb algebraic reasoning. One might, however, expect a certain amount of sales resistance from a certificate student to the statement that the area bounded by a simple closed curve is

$$\left| \tfrac{1}{2}\int_{t_0}^{t_1} (xy' - x'y)dt \right|,$$

with the added note that a rigorous proof belongs to the theory of double integrals and is postponed to Chapter 17.

The book is certainly a contribution of outstanding merit to the very few serious efforts which have been made to present limiting processes to the student at a level which he can readily understand, and which at the same time will leave him nothing to unlearn at a more advanced stage. The book contains more than four hundred worked examples.

L. M. MILNE-THOMSON

SCIENCE IN RELATION TO HISTORY

Science and its Background

By Lieut.-Colonel H. D. Anthony. Pp. ix + 304. (London: Macmillan and Co., Ltd., 1948.) 10*s.* 6*d.* net.

THERE are many ways in which authors have dealt with the history of science. This important subject can appear as a plain chronology of scientific development without any account of its relations to contemporary thought, it can take the form of a series of 'great lives' given with anecdotal treatment, or it may trace the parallel evolution of philosophic thought at each stage. The work here reviewed is eclectic in its methods: it envisages the story of science through history, and, moreover, a history which takes account, as all histories should, of human development and the evolution of social institutions. The author, a former grammar school headmaster, is the chief inspector of education in the British Army, and if the contents of the book are an indication of what is done in adult education in the Services and elsewhere it is a happy sign of the times. In its three hundred pages the book deals with many subjects. The author has succeeded in being succinct without being superficial by a careful selection of the most important topics for his purpose.

The form of the book is original in its layout and in the grouping of the material. The great movements in the advance of scientific knowledge are considered under the following headings: the beginnings of science in the "Rivers Period", the Mediterranean Period (Classical and Medieval), the Atlantic Period (Renaissance to Modern), the World Period (International Conflict and World Co-operation).

The main need in the teaching of science at present is not an improvement in practical techniques, nor of further specialist subdivisions of the science subjects. The dichotomy between what so often passes in school and university for science and culture is a matter which exercises the minds of many mid-twentieth century thinkers. There is an urgent need for seeking a new synthesis, and as a guide the book here reviewed would make a good introduction. The author is always fair, and evinces no emotional, political or religious biases which make a mockery of the scientific spirit and mar so many works on the relations of science with other forms of human activity.

The book should be read by every sixth-form pupil, whether of arts or science. For the lay-reader requiring a short, readable and accurate account of the growth of science in its human context, it is difficult to see how it could be improved.

The production of the book in general and its pictures and time-charts in particular reach a high standard.

W. L. SUMNER

INSECTICIDES AND FUNGICIDES

A Catalogue of Insecticides and Fungicides

Vol. 1: Chemical Insecticides. Compiled by Prof. Donald E. H. Frear. (Annales Cryptogamici et Phytopathologici, Vol. 7.) Pp. xii + 204. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1947.) 6.50 dollars.

THERE is a large and expanding literature concerned with the control of insect pests by the use of chemicals, derived either from plants or synthesized in the laboratory. The number of compounds tested for this purpose is already very great, and the relevant information is scattered through many original papers. Many workers in this field undoubtedly have references to much of it filed away, but it is only the relatively widely used compounds that are essentially borne in mind when particular problems arise. Not only so, but in all branches of human knowledge the recording and indexing of information demands great expertness if it is to be readily available. Prof. D. E. H. Frear has obviously applied considerable expertness and a vast amount of labour in accumulating and arranging this catalogue of compounds, tested or employed at one time or another for the control of insect pests, with the appropriate references to original or review papers and to the patent literature.

The compounds are not arranged alphabetically, and before the catalogue can be used with advantage it is essential that the coding system employed be studied with some care and mastered. This requires a certain amount of knowledge of chemical terminology; but briefly, a code number is assigned to each constituent group of a compound, which is specified by arranging these in consecutive order, beginning at the lowest. Thus D.D.T. is expressed by a number, 855–952–1011, which was turned up quite rapidly, only to find no references to the literature were given; the author, however, explicitly rules out from his survey the better-known insecticides for which review papers and monographs are in abundant supply. It is for the less-known compounds that this record will be of use to the research worker. It is, perhaps, natural that the greater proportion of the references are to papers in American journals and to the bulletins of American research stations, but if this experiment succeeds, doubtless the range will be made wider in future editions.

It is to be regretted that the alphabetical index of the compounds has been relegated to the end of Volume 2, since if insecticides and fungicides deserve separate volumes—which they do—they should each have had their own index. It would not only have made this volume of greater value to those investigators whose knowledge of chemistry might be deficient, but also it might have made the array of facts in the book more rapidly accessible to others.

CENTENARY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

By Dr. F. R. MOULTON
Administrative Secretary

FROM September 13 until September 17 the American Association for the Advancement of Science will hold in Washington, D.C., the centennial celebration of its founding. It was born in Philadelphia, Pennsylvania, on September 20, 1848.

The A.A.A.S. (to use the customary abbreviation of the present time) owes much, particularly in its earlier years, to the pattern set by the British Association for the Advancement of Science, which was organised in 1831. There were still earlier scientific societies in Great Britain and also in the United States, but they were somewhat different in character. The American Philosophical Society of Philadelphia was formally organised by Benjamin Franklin in 1743, and the American Academy of Arts and Sciences was granted a charter in Boston in 1780. The first attempt at establishing a truly national scientific society in America was the launching in 1816, under political sponsorship, of the Columbian Institute for the Promotion of Arts and Sciences. It flashed like a meteor and soon disappeared. Some years later, in 1840, the National Institution for the Promotion of Science was established by an Act of Congress. In 1844 it held a meeting at which John Tyler, then president of the United States, delivered the opening address. Government officials of high rank served as chairmen of the scientific sessions, at which forty-three papers were presented. The Institution never held another meeting.

A few years earlier, in 1837, Dr. John Collins Warren, of Boston, had attended a meeting of the British Association. It impressed him so favourably that upon his return to America he actively began to promote the establishment of a similar society in the United States. The failures of grandiose plans on one hand, and the limitations and weaknesses of small special societies on the other, directed the attention of American men of science to the founding of a scientific society national in scope and embracing all the sciences. This culminated on September 20, 1848, in establishing the American Association for the Advancement of Science, with an initial membership of 461. At the first meeting about thirty papers and oral communications were presented before the "Section of Natural History, etc.", and about as many before the "Section of Physics, etc.", the two subdivisions of the Association at that time.

The first period in the existence of the A.A.A.S. extended from its founding in 1848 until the outbreak of the Civil War between the northern States and the southern States, in 1861. In this interval of fourteen years thirteen meetings were held in different cities in the eastern part of the United States, and one was held in Montreal, Canada. The two original Sections of the Association were gradually divided into more specialized fields. The membership varied from the initial 461 in 1848 to a maximum of 1,004 in 1854.

In 1861 the Civil War broke out, and for five years the A.A.A.S. held no meetings, it elected no presidents or other officers, it issued no publications, and memories of its earlier meetings were dimmed. However, a meeting was held in 1866; but it was not such a meeting as earlier ones had been. The attendance was small, the papers presented were few, and the membership of the Association had declined below that with which it started. The conditions prevailed, generally, for about a decade, or until 1878.

In 1878 the membership of the Association was 962; in 1888 it had increased to 1,964, and it remained at about that level until 1900. Members of the A.A.A.S. were at its beginning and always have been on an annual basis, their dues being paid but once a year. Initially the dues were 1 dollar a year, but increased to 2 dollars in 1851, to 3 dollars in 1874, and finally to 5 dollars in 1920. Beginning with 1900 each member received with his membership a subscription for the weekly journal *Science*, and since 1915 a subscription for either *Science* or *The Scientific Monthly*. At the beginning of this calendar year (1948) the annual membership dues, including a subscription for either of the two journals, became 6.50 dollars a year.

An evolution in the structure and functions of the A.A.A.S. began in the closing decades of the nineteenth century and has continued until the present time. With the progressive specialization in science, the number of sections of the A.A.A.S. steadily increased. As their memberships grew they gave rise to the organisation of special societies—in mathematics, physics, geology, botany, etc. Many of these societies grew rapidly, and their memberships increased to such an extent that it became desirable for them to meet separately in order to obtain adequate accommodations in any American city. In a sense these developments appear to be the reverse of the integrations of science that were achieved when the Association was founded. But integrations of the sciences consist of something more than simultaneous meetings. The interrelations among them have been preserved by maintaining fifteen sections of the A.A.A.S., covering broadly all the principal sciences, the joint programmes of which with one another at the Association's meetings provide the cross-fertilization of ideas so important for vigorous scientific progress.

The outcome of this evolution in the organisation of American science has been a federation of co-operating scientific societies—the A.A.A.S. and its 207 affiliated and associated societies, the combined membership of which now totals several hundred thousands. Each of the 120 affiliated societies has either one or two representatives on the Council of the Association, who together constitute a large majority of the Council; the 87 associated societies are not represented on the Council. The affiliated and associated societies pay no membership fees or dues to the Association or fees for participating in its meetings. The harmony and co-operation of these many scientific societies in advancing science and human welfare present an inspiring example in a contentious and disordered world. It is the purpose of the A.A.A.S. to co-operate much more widely in the future with similar scientific societies in other countries and continents.

Now turning from a brief sketch of the evolution of the plans and ideals of the Association, the statistical story will be resumed, for it is the combination of both the principles and the practices of an organisation that measures its success. Membership statistics of the Association during its first half-century have been sketched. In 1900 the total membership of the Association was 1,925. In that year the weekly journal *Science*, owned and edited by Dr. J. McKeen Cattell, became the official publication of the Association. By 1908 the membership had become approximately 8,000, and it remained about the same until the close of the First World War, after which it increased rapidly for a decade. It exceeded 15,000 in 1928 and 18,000 in 1938. Now it exceeds 40,000.

There has been a geographical expansion of science, as well as a great increase in the number of men of science, in the United States. In 1916 the Pacific Division of the Association was organised by members of the A.A.A.S. who lived in the great and now populous States on the Pacific coast, about three thousand miles from the large cities in the East and two thousand miles from those in the Middle West, the regions in which meetings were generally held. In 1920 the South-western Division was similarly organised for the convenience of members who live in the south-western States. These Divisions of the Association are wholly autonomous in the election of their officers, the organisation of their annual meetings, and their relations with other scientific societies in their respective areas. The Pacific Division now has more than 4,600 A.A.A.S. members and the South-western Division nearly 800.

Perhaps the most effective way of describing the current policies and activities of the A.A.A.S. is to present a few statistics of the meeting that it held in Chicago during December 26–31, 1947. Although registration at the meetings of the Association has not been generally required, there were 4,940 registrants at the Chicago meeting, each of whom received a general programme. There were, in addition, several thousand persons for whom programmes were not available. As an illustration of the number of men of science at the meeting from a limited field, the official tabulated attendance at the annual "Biologists' Smoker" was 5,575—substantially greater than the total registration from all fields.

There were registrants at the Chicago meeting from every one of the forty-eight States, and also from Alaska and Hawaii. There were seventy-three registrants from Canada, twenty-eight from India and fourteen from China. There were 105 registrants from California, about 2,000 miles westward from Chicago, and 102 from Massachusetts, about 1,000 miles in the opposite direction.

A total of 2,019 papers were on the programme, of which 1,809 were presented orally, 46 consisted of demonstration and informal discussions, and 164 were read by title only. They were distributed among 340 sessions, the maximum number held simultaneously being 41.

It should not be assumed from the large number of men of science attending the "Biologists' Smoker" that the meeting was dominated by biologists or by scientific workers from any other particular field. Nor should it be assumed that the number of men of science was small from the fields in which there are large special scientific societies (the American Chemical Society, for example, or the American Medical Association), which hold their own large meetings quite independently of other scientific societies. At the Chicago meeting of the Association 4,288 registrants recorded their fields of specialization, in part, as follows: fields in which the special societies meet with the A.A.A.S.—zoology (822), biology (498), botany (903); fields in which the special societies hold independent meetings—chemistry (678), physics (296), medical sciences (354), agriculture (176), education (100).

As a consequence of the large attendance at the Association's meetings of specialists from every field of science, it is possible to organise and hold joint symposium programmes on subjects that are not limited by the usual boundaries of the various sciences.

An important feature of the Chicago meeting of the A.A.A.S. last December was the address of Dr. James B. Conant, retiring president of the Association and the president of Harvard University, entitled "The Role of Science in Our Unique Society". There were also ten scholarly addresses by retiring vice-presidents of the Association which in general were surveys or summaries of the fields of science of the Association's sections of which they were the respective chairmen.

In addition to these official programmes, there were seven sessions for special lectures or discussions of various aspects of the role of science in human affairs. Finally, there were fifty symposia on broad sectors of science of high current interest and importance.

As the present officers of the Association look back over the century of progress in organised American science made by their predecessors they have only feelings of gratitude and admiration for the high ideals which moved them and the success which crowned their efforts. As the present officers look with anxiety toward the future they can only say (to paraphrase the closing words of Milton's "Paradise Lost") that all the world is before them and Providence their guide. To paraphrase the opening invocation to "Paradise Lost", they can only say to the Heavenly Muse, what in us is dark, illumine, what is low, raise and support, that we may rise to the height of the great opportunities before us and justify our confidence in the powers of science to improve the lot of man.

ANTIBIOTIC ACTIVITY OF GROWTH-FACTOR ANALOGUES*

THE most striking reactions associated with the growth of micro-organisms are synthetic ones, particularly those concerned with protein synthesis. The synthesis of each compound is a stepwise process, each step being catalysed by an enzyme; if the necessary enzyme is in some way inhibited or has been lost during evolution of the organism, then growth will be slowed down or stopped unless the product of the reaction in which that enzyme was involved is now provided in the external environment. When the synthesis of a compound essential for growth is impossible through natural loss of an enzyme system, then that compound becomes for the organism a 'growth-factor'. By this term it is not meant to imply that the compound in question is not essential for those organisms which do not require it to be present in the external environment; all growth-factors investigated have been shown to be synthesized by a wide variety of organisms which do not require them pre-formed and, where these are known, to have the same functions as in the more exacting organisms. Thus it seems justifiable to consider all growth-factors as 'essential metabolites' and to regard the differences in requirements for them as differences in synthetic ability of the organisms investigated. On this basis, interference with the functioning or further utilization of the essential metabolite would produce the same metabolic lesion in those organisms which are able to synthesize it as already exists naturally in those which are not.

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* Based on a discussion held at the Royal Society on June 17. There took part in the discussion, which was opened by Sir Paul Fildes, F.R.S., Dr. D. D. Woods, Dr. H. McIlwain, Dr. T. S. Work, Dr. H. N. Rydon and Dr. F. L. Rose; Dr. J. Walker, Dr. A. Albert and Prof. M. Stacey also contributed.

The concept of 'substrate competition' was already well established at the time that the mode of action of the sulphonamide drugs was demonstrated. For example, malonate was known to be sufficiently like succinate to be able to form a complex with succinic dehydrogenase, but to be unlike it enough not to go through the stages of dehydrogenation and dissociation. If enough malonate was present, most of the enzyme became involved in formation of the more stable complex; the enzyme was, in fact, inhibited by malonate which was competing with succinate for the attention of the enzyme. This inhibition could be reversed by increasing the concentration of succinate, renewed by adding more malonate, and so on. In just such a way the sulphonamides are held to compete with *p*-aminobenzoic acid, and to prevent its further utilization. Although a certain amount is known about the functions of *p*-aminobenzoic acid, little is known about the receptors with which the competition is concerned Possibly the sulphonamides form complexes with an enzyme or series of enzymes, analogous to the malonate–succinic dehydrogenase complex. Possibly they form complexes with a compound normally associated with *p*-aminobenzoic acid and thus interfere with its function; it has been suggested that reductone may be such a compound, and reductone-*p*-aminobenzoic acid and reductone-sulphonamide complexes have been demonstrated.

Whatever the exact point of attack of the sulphonamides, it was clear that they acted by competing with *p*-aminobenzoic acid, shown to be a growth-factor for a wide variety of organisms, and considered to be an essential metabolite at least for those which are sulphonamide-sensitive. Realization of this, together with the marked chemotherapeutic success of the sulphonamides, stimulated the development of the Fildes–Woods 'rational approach' to chemotherapy. Briefly, it was suggested that analogues of known bacterial growth-factors (or essential metabolites) might be found to bear the same relationship to the parent growth-factor as the sulphonamides bear to *p*-aminobenzoic acid and thus prevent their utilization (or synthesis). Such analogues should prevent or slow bacterial growth and might thus prove to be of use as chemotherapeutic agents.

Several hundred analogues of compounds known to be of importance to the cell have been synthesized and many of them possess the predicted bacteriostatic property *in vitro*. Of the active compounds many are inactive *in vivo*, and others are too toxic to the host to be considered as chemotherapeutic agents. Only certain analogues of pantothenic acid (for example, phenylpantothenone) retain their property of inhibiting growth of the micro-organism *in vivo* and at the same time fulfil the other requirements of a chemotherapeutic drug; had it not been for the development of other antimalarial drugs, phenylpantothenone might to-day be regarded as a practical achievement for the rational approach. Superficially, however, this approach has yielded nothing of chemotherapeutic value; but certain points must be considered before passing judgment. The first concerns the choice of factor. Such is the fundamental similarity of metabolic patterns in all cells that an agent which interferes with a given process in one cell is likely to interfere in a similar way with the metabolism of another cell, independent of species. The repetition of metabolic patterns is seen most clearly in the case of the B group of vitamins. Members of this group have an extremely wide distribution as essential metabolites, and analogues of them have been synthesized and tested in the greatest number. It is not difficult, therefore, to understand the failure of these analogues in chemotherapy, for they interfere with the same fundamental processes in both parasite and host; indeed, several analogues, such as those of aneurin, nicotinic acid and folic acid, have produced in mammals syndromes indistinguishable from those produced by simple dietary deficiencies of the factors concerned.

The relationship between an inhibitory compound and the growth-factor on which it is modelled tends rather to be taken for granted. An analysis of any existing relationship and of the metabolic effects produced by the antagonism is desirable not only for a proper understanding of the mode of action of the analogue (and thereby of the corresponding growth-factor) but also so that the development of more efficient inhibitors should proceed logically. Evidence for the existence of a relationship is of three main types. First, the actual existence of a mutual antagonism has to be demonstrated between growth-factor and analogue. This aspect has been very widely studied and has been the subject of several reviews. Second, even though such an antagonism is established, it should not be assumed that growth inhibition is solely due to it. Specificity of action should be examined in as wide a variety of organisms as possible, and reversal of the inhibition should be limited to the growth-factor in question and to any compounds which may replace it in the growth of organisms requiring it. Finally, the effects produced by the analogue should be just those which are seen as the result of a nutritional deficiency of the growth-factor.

It is desirable also that the exact point of attack of the inhibitor should be investigated. This presents a complex problem, for the various possible processes which can be interfered with are all closely interrelated, and it is not easy to separate primary and secondary effects. Of the three main points at which an analogue can cause a block, the first two, assimilation of the growth-factor and its elaboration into a functioning form, are particularly difficult to separate. No instance of an analogue preventing the assimilation of a growth-factor is known, though little work has been done on this aspect. Most work has been concentrated on the metabolism of the factor once it has entered the cell, and this includes studies on the further elaboration of the growth-factor molecule. As instances, the conversion of *p*-aminobenzoic acid to folic acid and its inhibition by sulphonamides, and the conversion of glutamic acid to glutamine and its inhibition by the sulphoxide of methionine might be cited as examples. In the second example it is also known that the methionine sulphoxide does not interfere with the assimilation of glutamic acid from the external environment but only with its conversion after entry into the cell. The third point at which analogues may exert their effect is during the actual functioning of the growth-factor, that is, at the point of catalysis. Here again there is very little information available, although the hydrazide of glutamine has been shown to inhibit the breakdown of glutamine to glutamic acid and ammonia, and to be correlated with the inhibition of the growth of streptococci caused by the hydrazide.

To obtain by the rational approach analogues which possess the selective toxicity so necessary for successful chemotherapy, processes must be blocked which are quantitatively more important, or peculiar, to the parasite. It seems unlikely that the sulphonamides are the only analogues of an essential metabolite which fulfil this requirement; with increase in our knowledge of the metabolism of micro-organisms and of the parasite-host relationship, it is probable that more agents will become available. The sulphonamides owe their chemotherapeutic success to the inhibition of a reaction which seems to be absent from animals but essential to micro-organisms (and to members of a number of other species). In several bacteria the sole defect produced by the sulphonamides seems to be an inhibition of the incorporation of *p*-aminobenzoic acid into the folic acid molecule. Animals cannot carry out this synthesis and rely upon a supply of pre-formed folic acid being present in the diet; in other words, the biochemical lesion induced in sensitive organisms by the sulphonamides already exists in the host. Nevertheless, the host may be partially dependent on factors synthesized by its intestinal flora; the effect of sulphonamides on such syntheses may account in part for the toxicity sometimes seen in sulphonamide therapy. Moreover, it is known that much of the folic acid present in animal tissues and fluids is in the form of conjugates, a form not available to the parasite. The position, then, is that formation of folic acid by the host-dwelling parasite is blocked from below by the sulphonamides and from above by natural lack of the enzymes necessary for releasing folic acid from its conjugates; the host, on the other hand, relies on a supply of pre-formed folic acid and converts it largely to a form not available to the parasite.

A similar situation may explain the partial success of analogues of pantothenic acid, for this factor is known to exist in animals in the form of co-enzyme A, a more complex molecule. Although micro-organisms carry out a similar elaboration of pantothenic acid, they do not seem to be able—through inability to absorb it or through slight differences in structure—to make use of animal co-enzyme A to supply their own requirements.

The sulphonamides, and possibly also analogues of pantothenic acid, thus provide examples of compounds which interfere with reactions peculiar to the parasite and exploit qualitative differences in metabolism. Further inhibitors of this type, as already stated, will develop logically from the finding of further synthetic reactions of the parasite. A hopeful field, already opening out, is associated with peptide metabolism. Species specificity of structure is nowhere so marked as in the proteins, and it is in their synthesis that species-specific biochemical reactions are most likely to be found. For example, a certain amino-acid sequence in a simple peptide might be harmless or even favourable to one species, but toxic, through slight differences in sequence from normal peptides of that species, to another. It is interesting to note in this connexion that several of the naturally occurring antibiotics are peptides. One of them, lycomarasmin, is the tripeptide seryl-glycyl-aspartic acid. Its toxicity towards *Lactobacillus casei* and the tomato plant (it is the active agent of the tomato-wilt fungus *Fusarium lycopersici*) is annulled competitively by strepogenin, also a peptide and a growth-factor for a number of organisms. The observed biological relationship suggested a possible chemical relationship (using the rational approach 'in reverse'), and the synthesis of seryl-glycyl-glutamic acid yielded a compound with some strepogenin activity, both as growth-factor and as antagonist to lycomarasmin. On this and other grounds, it is not impossible that other natural antibiotics may turn out to be analogues of essential metabolites; there is already some evidence for this in the case of streptomycin.

For successful chemotherapy, though, it may not be necessary to restrict attention to reactions which are peculiar to the parasite. The temporary blocking of processes quantitatively more important to the parasite than to the host might prevent growth of the former for long enough to allow the natural defences of the host to overcome the invader without seriously damaging the host.

Another point to be considered is that, although the rational approach has yielded little in the way of chemotherapeutic agents, it has provided metabolic tools of the greatest value in investigating the actual function of the growth-factors. As they inhibit specifically the synthesis or utilization of the growth-factor, they provide a chance of tracing the primary effect of that factor. For example, γ-3,4-urylenecyclohexylbutyric acid, an analogue of biotin, inhibits the growth of *Lactobacillus arabinosus*, and this inhibition is reversed competitively by biotin. The amount of biotin required to overcome the inhibition by a given concentration of the analogue is decreased ten-fold if oxaloacetic acid is present. This indicates that one function of biotin is in the synthesis of oxaloacetic acid.

Similarly, use of the sulphonamides has contributed greatly to knowledge of the function of *p*-aminobenzoic acid, which is involved in the synthesis of folic acid, purines, thymine, methionine, lysine, serine and possibly valine. Inhibition of the synthesis of folic acid by sulphonamides has been demonstrated in a direct way. Further use of the analogues in such researches may well reveal points suitable for chemotherapeutic interference.

When a suitable growth-factor or essential metabolite has been selected for modification, it has yet to be decided what changes are to be wrought in the original molecule to produce an efficient inhibitor. So far it has only been possible to predict in a very general way whether a given analogue is likely to prove inhibitory. Trial and error may be costly of time and fail completely to give an active compound, for it is not enough to go on simple pictorial analogy. It is not enough because an analogue may look like a metabolite and yet lack the chemical groupings necessary for combination with, for example, an enzyme; and because it leads to over-emphasis of the geometry and under-emphasis of the chemistry of the molecule. At the same time, pictorial analogy is too much, for it leads to possible overloading of the analogue with unnecessary groups which have nothing to do with the attachment of it or the metabolite to the enzyme. In order to model inhibitors more successfully on essential metabolites two things at least must be known: first, the structure of the metabolite to be imitated; and secondly, the precise way in which it associates with the bacterial enzyme to which it is related as substrate, co-enzyme or product.

Many attempts have been made to explain the action of the antimalarial drugs on the basis of their being metabolite analogues, and there is much evidence, both chemical and biological, that quinine, 'Mepacrine' and 'Pamaquin' and possibly also the more recent anilinopyrimidines act as inhibitors of reactions involving riboflavin, at any rate in bacteria. As pointed out above, the fact that a substance chemically related to a growth-factor can compete with that growth-factor does not of necessity imply that an associated growth inhibition can be correlated with the metabolite analogy. Thus the final biological proof that these antimalarials are active solely because tinthey erfere with the action of flavin derivatives has yet to be provided. The newer and highly successful 'Paludrine' was developed by logical chemical steps from 'Mepacrine'; yet in no system has it been shown as a riboflavin competitor. There is no biological evidence for the mode of action of 'Paludrine', but it has been suggested that either by chelating a metal or by nature of the intrinsic size and shape of its cation (there is evidence that it exists as a pseudo-triazole involving a hydrogen-bond) it may possess a structure similar enough to that of the porphyrins to interfere with their metabolism. It is also possible that, as also in the case of the natural antibiotics, discovery of the mode of action of 'Paludrine' may disclose a new essential metabolite.

Had oxine (8-hydroxyquinoline) not already been well known as a chelating agent, the strong antibacterial activity of it and its derivatives might have been difficult to explain, particularly as the lethal action against Gram-positive organisms is far more powerful at low concentrations ($10^{-5}M$) than at higher ones ($3 \times 10^{-3}M$). The hypothesis advanced to explain their action against Gram-positive organisms, and backed by much experimental evidence, is this: at low concentrations the oxine chelates cobalt (cobalt is the only metal which will reverse the inhibition) and thus exposes the bacteria to the action of a second metal which catalyses the oxidation of a chemical group protected by the cobalt. Stronger solutions of oxine protect the organism by removing the injurious metal as well. The second metal has been identified as ferrous iron, and it seems that in the presence of lethal concentrations of oxine the organisms actually die of iron poisoning. Although oxine and its derivatives are not growth-factor analogues, their action is to prevent the normal functioning of essential ions, and a consideration of them is germane to any discussion on chemotherapy. Their mode of action, a disturbance of an existing balance with lethal results to the micro-organism, is worth considering in connexion with other antibacterial agents.

So the biochemist and the chemist, by producing changes in the structure of compounds already known to show a selective toxicity towards the parasite, may produce more and more efficient chemotherapeutic agents. But inevitably, as more is learned of the comparative biochemistry and physiology of micro-organism and potential host, and of those synthetic processes which are more peculiar to the micro-organism, the biologist will seek the closer co-operation of the chemist so that together they may plan, synthesize and test new chemotherapeutic agents.

PARTITION CHROMATOGRAPHY ON PAPER, ITS SCOPE AND APPLICATION

By Dr. R. CONSDEN

Wool Industries Research Association, Leeds

WITHIN the last twenty years, chromatography has become increasingly important as an analytical tool. The purpose of this article is to review the uses of partition chromatography on paper, which, since its inception four years ago[1], has had a wide application and which promises to become as well established as the older forms of chromatography. It should be emphasized, however, that, as mixtures, especially from biological sources, may be very complex, preliminary separations[2-5] may often be necessary before paper chromatography can be used to the best possible advantage. For recent developments in all types of chromatography, the reader is referred to a number of articles indicated in footnotes 6–9.

Partition chromatography was first developed by Martin and Synge[10] at the laboratories of the Wool Industries Research Association. In this type of chromatogram, separations are achieved because of the differences in partition coefficients between aqueous and non-aqueous phases of the components of a mixture. Using silica gel as the supporting medium for the aqueous phase and eluting with certain water-saturated immiscible organic liquids, separation and estimation of a number of acetyl-amino-acids were effected. This provides a relatively simple and valuable method for the quantitative analysis of some half-a-dozen amino-acids in protein hydrolysates, after acetylation. With the free amino-acids themselves, it was found that owing to their strong adsorption by the silica gel, separations could not be achieved. However, cellulose, in the form of filter paper, was found to be suitable as the stationary support. In this method, a filter paper strip, carrying a mixture of amino-acids (a few micrograms of each) near its upper end, is hung from a trough containing water-saturated solvent (for example, *n*-butanol, phenol, *s*-collidine), the whole system being in an atmosphere saturated with respect to solvent and water vapours. The solvent syphons down the strip, and after a suitable time the amino-acids are revealed by drying the paper and spraying with a solution of ninhydrin and then gently heating. (A simplification of this method—'ascending' chromatography—has been recently reported[11].) It was found that the movement of amino-acids corresponded fairly closely with that calculated from their partition coefficients, thus demonstrating that the cellulose, as in the case of silica gel, acts as an inert support for the aqueous phase. This type of chromatogram is of value because of its simplicity and because many analyses may be carried out on one paper strip, using only very small amounts of material. An early application[12] was to show that *nor*-leucine was not present in spinal cord, as had been originally supposed.

No single solvent has been found which will separate all the common amino-acids on a paper strip; but a more complete separation can be obtained in the 'two-dimensional' technique in which the mixture applied near one corner of a filter paper sheet is chromatographed in one direction with one solvent and then in a direction at right angles with another solvent. The components are thus distributed over the area of a sheet, and by choosing two solvents with different properties, such as *s*-collidine for one direction and phenol for the other, most of the common amino-acids are separated, only $\frac{1}{3}$–$\frac{1}{2}$ mgm. of protein being required, and all may be separated by additional one-dimensional chromatograms in other solvent systems. On a two-dimensional sheet, the amino-acids occupy characteristic positions, depending on the solvents used, and 'maps'[1,14–17] have been published showing the positions of ninhydrin colouring constituents of biological mixtures.

Ninhydrin has been found to be the best general indicator for the amino-acids as it is very sensitive and little affected by traces of solvents left on the paper after drying. However, as is well known, it is not specific for the amino-acids; any substance having both free amino- and free carboxyl-groups, such as peptides and non-α-amino-acids, gives colours, while less intense colours are given by nitrogen bases, including amino-acid esters. Though not so sensitive as ninhydrin, β-naphthaquinone sulphonic acid (Folin's reagent) is a useful general indicator, and amino-acids and peptides can be located by their weak fluorescence in ultra-violet light[18]. A number of more specific indicators are available, though, in some cases, thorough removal of solvent from the paper may be necessary, prior to their use. Diazotized sulphanilic acid is an even more sensitive reagent for histidine than ninhydrin. For tryptophan, *p*-dimethylaminobenzaldehyde in acid solution is useful, and with reduced tryptophan, 2:4-dinitrophenylpyridinium chloride gives a strong cerise colour. Other useful reagents are potassium iodoplatinate for amino-acids which carry the thio-ether link (for example, methionine and lanthionine), and periodic acid in conjunction with Nessler's solution for the aliphatic hydroxy-amino-acids. The ingenious use of *D*-amino-acid oxidase by Synge (unpublished) for revealing configuration has been applied by Jones[19] to show that the leucine residues of aerosporin have the *D*-form. Dent (private communication) has developed a method for distinguishing between α- and non-α-amino-acids, by removal of the former as their copper complexes; and the latter, which do not readily form copper complexes, are revealed by ninhydrin.

An early application of the two-dimensional paper chromatogram was by Edman[13], who demonstrated the amino-acids in hypertensin hydrolysates. Modifications of amino-acid residues in a protein after chemical treatment can often be easily observed. Thus, small amounts of lanthionine and cysteic acid have been demonstrated to be present in hydrolysates of wool tips[14], showing that the action of weather and light have modified some of the combined cystine. Cysteic acid has been shown to be present in hydrolysates of wool which had received various oxidizing treatments[3,14], and some destruction of proline and tyrosine has been observed after chlorination of wool. A not unimportant use of paper chromatography is as a control for synthesis[20] and separations[3,21], and to test the purity of substances. Mention should be made of its growing use as a control for various industrial processes involving utilization of amino-acid and peptide mixtures, such as in penicillin and streptomycin production; but, so far, little has been published in this connexion.

New or unsuspected constituents can be revealed and it is often possible, from its position on the chromatogram, to make a reasonable guess as to the nature of a new substance. For example, Consden, Gordon and Martin (unpublished) observed what was considered to be a weakly basic substance in elastin hydrolysates, and this was confirmed by subsequent electrodialytic experiments. Jones[22] demonstrated the presence of α-γ-diaminobutyric acid in aerosporin, and Borsook *et al.*[23] showed that lysine was metabolized by guinea pig liver to α-aminoadipic acid. Amino-acids, other than the α-variety, and amino-acids not common in animal proteins appear to be widely distributed in plant and bacterial extracts such as α- and γ-amino-butyric acids[15,16]. Indeed, plant extracts offer a vast field for paper chromatography, and already the first reported applications[15,24] have yielded much valuable information, both as regards new constituents and metabolism. The non-protein nitrogen fraction of plants may sometimes contain only relatively few ninhydrin colouring constituents. For example, Consden and Gordon (unpublished) found that an aqueous extract of tea contains only three such substances in strength, namely, aspartic and glutamic acids, and the third, now under investigation, is believed to be a mono ester of glutamic acid. There are obvious applications of paper chromatography in the study of plant extracts to agriculture and animal nutrition.

In the medical field the usefulness of paper chromatography has been shown by Dent[25] in studies of pathological urines and in determining the fate of proteins after digestion[26]; and there is a great potential use for radioactive isotopes, as is evident from metabolic studies with radioiodine[27], radiocarbon[23], and radiosulphur[28].

There is a fast-growing list of substances other than amino-acids to which paper chromatography is applicable, and which can only be referred to briefly here. An important field was opened up by Partridge[29,30], with the sugars, and the introduction of specific indicators[31] should prove to be particularly useful. Another potentially important field, especially for the study of prosthetic groups, are the flavines[32] and purines[33]. Other substances reported to be separable on paper chromatograms are anthocyanine pigments from petals[34], organic acids[35], adrenalin and related substances[36], creatine and creatinine[37], penicillins[38] and vegetable tannins[39].

Extension to quantitative analysis has enhanced the usefulness of paper chromatography. For many purposes, a rough estimate of a given amino-acid may be usefully made by comparison of the intensity of its ninhydrin spot with that of known amounts of the same amino-acid chromatographed under the same conditions[3,40]. This is clearly capable of industrial application. A refinement of this visual comparison method for both sugars and amino-acids has been reported[41]. The ninhydrin colours themselves have been used for estimations after extraction from the paper[40]. Extraction of amino-acids as their copper complexes, followed by polarographic determination of the copper, has been described[42,43]. This method was used to estimate the five amino-acids produced after hydrolysis of gramicidin S[42]. Alternatively, the copper can be estimated colorimetrically[44], and this method was used by Jones to show that the proportion of leucine to threonine in hydrolysates of aerosporin is 1 : 3 [22]. An interesting isotope dilution method has been described[44a] in which amino-acids are first converted to *p*-iodobenzenesulphonyl derivatives containing radio-active iodine or sulphur and then estimated on paper chromatograms by counting. Quantitative analysis on paper chromatograms of substances other than amino-acids have been devised, notably for sugars and their derivatives[45,46].

Perhaps the most important application of paper chromatography is to elucidate the sequence of amino-acid residues in proteins and polypeptides. This is a problem of fundamental importance, but has long been unsolved because of the lack of methods for handling complicated mixtures of peptides which result from partial hydrolysis; and, in fact, very few peptides have been isolated and identified[47] by the traditional chemical methods. However, simple peptides behave on paper chromatograms as satisfactorily as amino-acids, and techniques have been devised[4] to separate and identify lower peptides in complex mixtures. The sequence of the amino-acid residues of gramicidin-S was thus established[48] as -(α-valyl) - ornithyl - leucyl - phenylalanyl - prolyl-. Tyrocidin appears to incorporate the sequence -valyl-ornithyl-leucyl- and probably the sequence -aspartyl-glutamyl-tyrosyl- in its structure (Consden, Gordon and Martin, unpublished). There would appear to be a promising field for similar investigations of other polypeptides, the list of which is rapidly growing, consisting of residues of a few varieties of amino-acid or having molecular weights intermediate between simple molecules and proteins.

With the proteins themselves, the mixture arising from partial hydrolysis is likely to be vastly more complex, and it is too much to expect that the structure of a protein could be pieced together from the peptides identified. So far as I am aware, wool is the only protein which has been examined in this way, and preliminary reports have been given by Martin[49] of the identification of nineteen dipeptides of aspartic and glutamic acids[50] and of a number of peptides from the less completely investigated neutral and basic fractions of partial hydrolysates of wool[51]. One conclusion from these studies is that a substantial proportion of the glutamic acid is linked with itself in the wool polypeptide chain. Recently, Consden and Gordon[5] have described techniques for identifying peptides of cystine, and it can be concluded that, in wool, cystine is linked *via* one of its amino-groups and *via* one of its carboxyl-groups to residues of glutamic acid and to residues of most of the neutral amino-acids and that a substantial proportion of proline residues, if not next to, are not far from, cystine residues. The possibility of identifying a large number of peptides in partial hydrolysis mixtures should be a big step forward in our knowledge of protein structure.

It has not been possible to deal adequately here with all aspects of paper chromatography, especially pending publication of the many important developments which are now rapidly taking place. However, enough has been indicated to justify the confident expectation that, before long, this technique will be in common use in many laboratories.

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OBITUARIES

Mr. S. G. Brown, F.R.S.

SYDNEY GEORGE BROWN died on August 6 at Sidmouth, where he went to live on his retirement. He was seventy-five years of age.

Born in Chicago in 1873, his father having gone there to live, he was brought to Great Britain at an early age. He was educated at Harrogate College and University College, London. On leaving college he served as an apprentice in the works of the late Col. Crompton at Chelmsford, where he was principally engaged on calculations and design of dynamos and motors. In 1908 he married Alice Stower, niece of Prof. John Perry, whose close friendship he enjoyed until the time of the latter's death.

It is by his numerous inventions that Mr. Brown became famous. He claimed to have taken out about a thousand patents, commencing when sixteen with a home-made phonograph. In 1899, when only twenty-six years of age, he produced the drum cable relay used in submarine telegraphy. This was followed by the magnetic shunt and other devices connected with duplex working over long-distance cables. Also at this time, with Sir Henry Hozier, he demonstrated a system of directional beam wireless using a parabolic reflector of wire. Signals were transmitted for over a mile between a coastguard station and a lighthouse at Beachy Head. These distances were later increased. This patent was dated 1899.

Finding difficulties in getting his inventions manufactured, he opened in 1910 his own workshops near Liverpool Street, London. After two moves to obtain more space he decided in 1915 to have his own factory built, for which purpose he purchased a large site in Acton, London.

In 1910 he patented his reed type telephone earpiece, by means of which wireless messages could be read when otherwise inaudible. They were adopted as standard by the Royal Navy. He worked on electrical aids for the deaf and was possibly the first to demonstrate bone conduction for hearing. In 1909 he perfected various types of relays for the purpose of amplifying feeble currents both for use in wireless and telephony. This was in the days before the introduction of the thermionic valve. Early in 1914 one of these, the microphone relay, was accepted by the Royal Air Force for use in aeroplanes. By its use wireless messages could be received during flight. The same relays were used by the Admiralty for extending the range of signalling at sea.

Mr. Brown conducted considerable research on rare metals for contact purposes. At the request of the Admiralty he designed the electro megaphone for loudspeaking on warships. One form of this instrument is used on the London Underground Railways for speech between guard and driver. The late Admiral Lord Fisher personally wrote thanking Mr. Brown for his work on relays for detonating mines, using the current from a selenium cell operated by the rays of a searchlight.

The greatest of Mr. Brown's inventions, however, and the one that he himself ranked as his highest achievement, was his gyroscopic compass. The two principal features are the vertical axis and the liquid ballistic. By the first, friction is reduced to a minimum by raising and lowering the whole of the north-seeking parts, including the gyro wheel, at more than a hundred times a minute, using a column of oil, pump-operated. To overcome quadrantal error, common to all gyro compasses, he replaced the solid weight used to precess the compass by a liquid which was free to flow from side to side of the wheel during the rolling of the ship. To work in conjunction with his compass he designed an automatic helmsman which makes it possible to steer a course at sea direct from the compass. He further made a multiple repeater for the ease of steering by hand, also a recorder on which the course of the ship can be plotted on a moving chart. His last invention was a gunnery control compass. This demanded an extreme accuracy at sea only previously associated with a laboratory compass working in a stationary position on land. Such a compass was completed and had passed Admiralty requirements when its adoption was delayed owing to the Second World War making its application impracticable.

With the introduction of broadcasting, Mr. Brown turned his mind to mass production, thousands of pairs of headphones being produced daily. He gave the name to the loudspeaker. While he produced many types fitted with horns he foresaw the development of the large cone diaphragm back in 1910, when he referred to its possibilities in his receiver specification.

During the First World War, Mr. Brown served on the Research Committee for the Detection of Enemy Submarines, the Inventions Board and the Admiralty Ordnance Council. He was elected a fellow of the Royal Society in 1916. In March, 1909, he read a paper before the Royal Institution on "Submarine Telegraphy", and in 1920 one on the "Gyroscopic Compass".

Apart from his activities with the Company that bears his name, he founded and was chairman of the Telegraph Condenser Company.

With all his inventions Mr. Brown acted as his own designer. He was an accomplished engineer capable of giving advice in any department of his works. He was held in great respect by his staff, with whose assistance he earned a great reputation for the high quality of all his work. H. PASMORE

Prof. Marcel Brillouin

THE Nestor of French physics, Marcel Brillouin, formerly professor of physics in the Collège de France, died on June 16 at the age of ninety-four. He belonged to a generation of men of science who could not only master the whole realm of their subject but also make important original contributions to almost every branch of it. As a result they were able to present that subject to their students in a most perfect form, thus providing them with a solid foundation for their own future activities in this field. Prof. Brillouin's lecture courses at the Collège de France provide an outstanding example of this almost extinct art, and many of them have been published in book form, like the well-known "Leçons sur la viscosité des liquides et des gaz".

Like many great physicists, he started as a mathematician at the École normale; but his natural inclination soon diverted him first to mechanics and later to physics as a whole. Thus he acquired skill in the use of mathematics as well as in the handling of apparatus which enabled him to carry out investigations requiring refined experimental and mathematical techniques at the same time, which is so rarely found in physicists of the present generation.

Only a brief indication of Brillouin's most important research subjects can be given here. In hydrodynamics he did fundamental work on the theory of discontinuity surfaces in liquid flow and the formation of vortices on similar lines to Helmholtz, and in aerodynamics he developed a theory of the dispersion of sound. In thermodynamics he devoted himself to the study of permanent deformations of solids and to the specific heat of black body radiation, and he derived the proportionality of this quantity with the third power of absolute temperature. The kinetic theory of matter was enriched by Brillouin's contributions to the theory of diffusion and viscosity in gases and liquids, and he also took part in the once topical controversy on the apparent contradiction in statistical mechanics between the reversibility of the laws of dynamics and the irreversibility of those of thermodynamics. He was very much interested in geophysics as well, and he contributed to this branch of applied physics by papers on the circulation of the atmosphere, the formation of rain, the theory of the tides, etc. An outstanding piece of research in this field consisted in a series of precision measurements of gravity within the Simplon tunnel aiming at a determination of the shape of the 'geoid'. Although naturally his main activity was in the domain of 'classical' physics, he was nevertheless actively interested in the theory of relativity and in quantum theory, where he made an early attempt to give a representation of quantum phenomena in terms of a continuum theory.

It was a source of great satisfaction to Brillouin that the successor to his chair was one of his own sons, Léon Brillouin, who, carrying further the work of his father, has become one of our leading theoretical physicists. R. FÜRTH

Prof. Beatrice Edgell

THE death of Prof. Beatrice Edgell, professor emeritus in the University of London, takes from us one of the significant figures in the development of British psychology. Born in 1871, she was of the same generation as McDougall and C. S. Myers, with whom she collaborated in the pioneer work of the British Psychological Society and with whom she helped to establish the traditions on which the study of psychology is still based in British universities. Trained first in philosophy at the University College of Wales, Aberystwyth, she turned to experimental psychology and studied at Würzburg, where the use of experimental method was being developed in the study of the processes of thought and judgment. Throughout her life she combined her interests in philosophy and in experimental psychology, though with a special leaning to the latter, and from 1897 until 1933 she was head of the Department of Philosophy and Psychology at Bedford College in the University of London.

At a time when in many universities psychology was at best a subordinate partner of philosophy, her position as professor of psychology in charge of both subjects was unusual. The laboratory she established bears witness to her concern for exact and objective experimental method aided by the best material equipment then available. Her chief publications ("Theories of Memory" (1924), "Mental Life" (1926) and "Ethical Problems" (1929)) indicate the two sides of her interest, as does the fact of her contributing both to psychological journals and to the *Proceedings of the Aristotelian Society*. Her example and influence thus aided the development of psychology in Britain as an independent experimental science which still retained the stabilizing effect of philosophical discipline. Her psychological interests centred largely on the cognitive aspect of mental experience, especially memory and perception, and she also paid particular attention to the experimental approach to æsthetics. As a teacher, however, she was stimulating over a wider range. "Ethical Problems" was written specially with the view of helping nurses, and her text-book, "Mental Life", was intended for students preparing for social work. Precise of mind and emphatic of utterance she was an excellent teacher, and she is held in affectionate respect by a large number of former students, many of whom are now engaged in psychological work applied to industry, education and various branches of social work.

In her retirement Prof. Edgell still occupied herself with psychology, including its newer developments. She was recently, for example, using the Rorschach test with critical appreciation. She continued to help students, and to take an active interest in the British Psychological Society, of which she was a past president and honorary fellow. During the War she wrote a history of the Society, part of which she read at the annual meeting of the Society in 1946. This was the first occasion on which many of her younger colleagues had met her, and they will remember her as they saw her then, frail, alert and indomitable.

NEWS and VIEWS

Psychological Medicine in Glasgow: Prof. T. Ferguson Rodger

DR. T. FERGUSON RODGER has been chosen as the first occupant of the newly founded chair of psychological medicine in the University of Glasgow. Dr. Rodger graduated in science and medicine at Glasgow in 1927–29 and holds the diploma in psychological medicine of the University of London. During 1931–32 he worked at Johns Hopkins University, where he was a pupil of Adolf Meyer. From 1933 until 1939 he was senior assistant at Glasgow Royal Mental Hospital (Gartnavel), and an assistant to the lecturer in psychiatry in the University. Throughout the War he served in the Royal Army Medical Corps as consulting psychiatrist at Headquarters, Land Forces, South-East Asia, and at General Headquarters, India. Latterly, he has been a commissioner of the General Board of Control (which functions under the Lunacy, Mental Treatment and Mental Deficiency Acts). Dr. Rodger has specialized in psychosomatic medicine. He was responsible for research into the methods of selecting officers for the army. He has also published work on fibrositis and on night-blindness.

Pathology in Glasgow: Prof. G. L. Montgomery

GEORGE LIGHTBODY MONTGOMERY has been appointed to the St. Mungo-Notman chair of pathology (associated with the Royal Infirmary, Glasgow) in succession to Prof. John W. S. Blacklock, who has moved to St. Bartholomew's Hospital, London. Prof. Montgomery graduated at Glasgow (M.B., Ch.B., 1928; M.D., 1946), and also holds the Ph.D. degree of the University of St. Andrews (1936). After holding appointments at Glasgow Royal Infirmary, in 1931 he became lecturer in clinical pathology at St. Andrews and assistant pathologist at Dundee Royal Infirmary. Since 1937 he has been Gardiner research lecturer in the pathology of disease in infancy and childhood in the University of Glasgow, and pathologist at the Royal Hospital for Sick Children, Yorkhill. During almost the whole of the

War he served on the Directorate of Pathology at home, in the Central Mediterranean and in South-East Asia. His researches include work on the renal function in various morbid states, on diseases of childhood (with special reference to non-tubercular infections of the lung), and on the healing of lung injuries. He has recently taken part in the trials of streptomycin carried out by the Medical Research Council.

Victor Meyer (1848–97)

Among the many eminent German chemists of the latter half of last century, none enjoyed a higher reputation than Victor Meyer, who entered the University of Heidelberg in 1865 at the age of seventeen and, twenty-four years later, was chosen to succeed his old master Bunsen in the chair of chemistry there. Meyer was born at Berlin on September 8, 1848, being the son of a Jewish calico manufacturer. His home influences had tended towards the literary and artistic rather than the scientific, and Meyer, it is said, wished to become an actor, for which he had all the natural gifts. At Heidelberg, however, he came under the spell of Kopp, Kirchhoff, Helmholtz and Bunsen, and after a time became assistant to the last. From Heidelberg he went to Berlin to work under Baeyer, and successively held posts at Stuttgart, Zurich and Göttingen, before returning to his *alma mater*. With a fine voice, handsome presence and impressive manner, he became known as one of the best lecturers in Germany. With his other gifts he combined a passion for work, and was responsible for some three hundred memoirs. His most important investigations are referred to in the Memorial Lecture on Meyer delivered to the Chemical Society on February 8, 1900, by Sir Edward Thorpe, who had known him for thirty years. Unfortunately, his great mental activity brought on insomnia and he had several spells of ill-health. His death took place on August 8, 1897, when he was but forty-eight years of age. He had received many honours from scientific societies, and among these was a Royal Medal from the Royal Society awarded him two years after he had succeeded Bunsen.

Dedication of Private Woodlands

In the Forestry Commission Booklet No. 2 (H.M. Stationery Office, London, 1948) the purpose of the scheme for the dedication of private woodlands is explained. This purpose is to encourage the application of systematic management to private woodlands, become necessary, it is said, in the interests of national security because the reserves of standing timber have been greatly depleted during and since the War; and it might be added are still suffering from more or less crude over-felling, especially in the hardwood areas. Under the scheme the owner undertakes to use the land in such a way that timber production is the main object; to work to a plan to be approved by the Forestry Commission; to employ skilled supervision, and to keep adequate accounts. The object of the scheme is to ensure that replanting or regeneration of woodlands cut during the War shall proceed with continuity and rapidity, that this work in its young stages must be looked after until the young woods are established and, it is to be proposed, after that stage has been reached. Owners must make up their minds as to whether they are prepared to work the scheme; if they agree, they will receive State financial assistance. If the owner is unwilling to join the scheme or keep his woodland areas in proper order, the State will acquire them. Finally, some system of control of the sylviculture of private woodlands is deemed necessary.

To give effect to the scheme a deed of covenant in England and Wales and an agreement in Scotland will be entered into by which both the State and the owner undertake respective obligations as already mentioned. The Forestry Commission, as the agent of Government, will undertake to provide financial assistance to the owner on one of these bases at the owner's option: (1) To repay to the owner 25 per cent of the approved net annual expenditure on a dedicated woodland by way of loans which are described in the pamphlet. (2) To make payment to the owner as follows: (*a*) a planting grant of £10 per annum for every acre planted or replanted, softwood or hardwood, after date of dedication; (*b*) loans in addition to (*a*) on terms to be settled according to individual circumstances, the terms being given in the pamphlet; (*c*) a maintenance grant for fifteen years of 3*s*. 4*d*. per acre per annum on every acre dedicated that is planted properly and maintained; (*d*) a maintenance grant for fifteen years of 3*s*. 4*d*. per acre per annum from the date of dedication, on all productive woodlands other than new plantations covered already by (*c*) and (*d*). These grants will be reviewed and revised as may be necessary after five years from 1946–47 on the basis of ascertained costs. Dedication will run with the land and will not be affected by change in ownership.

New German Hydrographic Journal

With the first issue of the *Deutsche Hydrographische Zeitschrift* (1, No. 1, January, 1948), to the forthcoming appearance of which reference was made in *Nature* of August 16, 1947, p. 219, the publication of post-war articles by German oceanographers and other marine scientists and technicians commences. The first paper, by K. Kalle, deals with the problem of marine production and reviews research material and methods of investigation. Kalle compares the probable amount of marine production with the yields known from continental soils of the temperate zones. W. Hansen in the second article gives a general mathematical treatment of the oscillations of inertia in open and land-locked seas. The old nautical problem of the dip of the horizon is attacked once more theoretically, by H. Chr. Freiesleben. He derives a formula which, in order to be strictly employed, demands measurements of the air-temperature at the horizon immediately above the sea-surface. Another short but interesting contribution, by F. Errulat, describes a series of measurements of the earth-magnetic field on the Dacia Bank (between Madeira and Morocco); he concludes that the Bank has a core of eruptive rocks. The field of nautical technique is represented by a description of a direction-holder named "Polkreisel", by P. Christoph. Moreover, there is an article on the German Hydrographic Institute, its origin, its tasks, and its organisation by the director, Dr. Böhnecke, and finally there are obituary notes on several notable German scientists who had worked on nautical science and on oceanography. In the next issue (No. 2/3) of the *Zeitschrift*, which was expected to be distributed in the beginning of August 1948, there is to be (with other papers) articles on the bottom geology of the southern and middle Baltic, on a fundamental geodetic problem in sea-surveying, on magnetic storms, and on resonance oscillations of bights and the mouth correction for seiches.

Trade Unions in Industry

As part of a general production drive, the Trades Union Congress is inviting trade unionists to extend their knowledge of management in industry. Through its publicity organ *Industrial News*, the Congress has announced that it is co-operating with the National Institute of Industrial Psychology, the British Institute of Management, the Government Committee on Industrial Productivity and the Administrative Staff College in seeking ways to make workshops more happy and efficient places. Experiments are to be carried out on the problems of the effects of boredom in industry, the means of minimizing labour turnover and the training of new employees. The Trades Union Congress is asking members of trade unions to co-operate with these organisations by seeking goodwill for their officers at places suitable for experiment.

Cultivation of Root Vegetables

Bulletin No. 120 of the Ministry of Agriculture and Fisheries (H.M. Stationery Office. 9*d.* net) deals with all phases of the commercial cultivation of carrots, beetroot, parsnips, turnips, swedes and other minor root crops. A new revision (August 1947) of the third edition has recently appeared, and brings the subject-matter up to date. The most modern additions deal with row-crop cultivation, irrigation, and the control of weeds.

Precession of an Unsymmetrical Top

It has been known since the time of Lagrange's "Mécanique Analytique" (1788) that a rigid body smoothly pivoted at one of its points O and symmetrical about an axis passing through O can have steady motions of precession in which the axis of symmetry rotates uniformly about the vertical while the solid itself rotates uniformly about the axis of symmetry; but it has been generally supposed that there is no corresponding result if the body is unsymmetrical. However, G. Grioli (*Annali di Mathematica*, **26**, 1; 1947, and *Rendiconti dell' Accademia Nazionale dei Lincei*, **4**, 420; 1948) has shown that under certain conditions we can have steady precession of an unsymmetrical body about a non-vertical axis. If G is the centre of mass, it is necessary that OG should be perpendicular to one of the two circular sections of the momental ellipsoid at G, and that the axis of precession should be inclined to the vertical at a definite angle which can be calculated from the same momental ellipsoid. If these conditions are satisfied, there is a doubly infinite set of motions in which OG is perpendicular to the axis of precession, and the solid rotates uniformly about OG in the same time as OG rotates uniformly about the non-vertical axis of precession.

Geotectonic Map of North-west Germany

Last year the first German publication on scientific geology since the War was issued by the Reichsamt der Bodenforschung, Hanover, namely, a general geotectonic map of north-west Germany, scale 1 : 100,000 (15 sheets, 200 marks). This map comprises all wells and geological as well as geophysical results from 1934 up to 1945. The new map is supplemented by formation data, stratigraphic symbols, profiles, surface contour lines, data of the depths, and geophysical data. Moreover, there is attached a general map, scale 1 : 1,000,000, of the structures and two hundred salt domes in this area. A volume of annotations of the map is projected.

Society for Visiting Scientists

The Society for Visiting Scientists (5 Old Burlington Street, London, W.1) has been able to extend its facilities and membership for scientific workers resident in the United Kingdom. The number of such members is no longer limited, and applications for membership from scientific workers interested in the Society's aims will be welcomed by the Executive Committee. Applicants should apply to the Assistant Secretary, mentioning one or more members of the Society who would be willing to be their sponsors. The subscription for members resident in the United Kingdom is three guineas per annum, with an entrance fee of one guinea. Visiting scientists from overseas are charged an entrance fee of five shillings only, and pay an annual subscription only if they reside in the United Kingdom for more than six months. The Society now has more than 1,300 members, about 1,170 of whom are overseas. In addition to the opportunity of meeting visiting scientists, and thus furthering international contact and friendship among men of science, the Society's premises offer useful club facilities.

National Foundation for Scientific Research, Brussels

The twentieth annual report of the National Foundation for Scientific Research, Brussels, for the year 1946–47, gives lists of members of the various commissions, and a note on the Inter-University Institute of Nuclear Physics. It also includes full details of the forty-five research grants made for the year 1947–48, amounting to 2,062,500 francs, and an analysis of the distribution of grants made since the establishment of the Foundation. Special grants for the period 1947–48 have been allotted to M. Biquet for sinking wells in water-bearing strata for the study of the freezing of dead ground at great depths (150,000 francs); to Prof. F. Mayence for excavation at Apamée (100,000 francs); to MM. Gratia, Florkin, Massart and Desreux for completing the existing installation of apparatus for electrophoresis by a high-quality optical apparatus of the Klett or Pearson type (100,000 francs); and to Prof. Piccard and Prof. Cosyns for submarine investigations at great depths. A list of publications during the year by those receiving grants during 1945–47, arranged under authors' names, is appended.

International Union of Crystallography

The first General Assembly and Congress of the recently formed International Union of Crystallography was held at Harvard University, Cambridge, Mass., during July 28–August 3 and was attended by some 350 crystallographers of ten nations. In recognition of his epoch-making contribution to the modern development of the subject, Prof. M. von Laue (Germany) was unanimously elected honorary president of the Union. Officers were elected as follows: *President*, Sir Lawrence Bragg (Great Britain); *Vice-Presidents*, A. Westgren (Sweden), R. W. G. Wyckoff (United States); *General Secretary*, R. C. Evans (Crystallographic Laboratory, Cavendish Laboratory, Cambridge); other members of the Executive Committee are M. J. Buerger (United States), P. P. Ewald (Great Britain), A. L. Patterson (United States), J. Wyart (France). Statutes and by-laws of the Union were adopted, and the adhesion of Great Britain, the United States, Canada and Norway was recognized. Commissions of the Union were established as follows: *Acta Crystallographica*, International Tables, Structure Reports, Crystallographic Apparatus, Nomenclature, Crystallographic Data. Crystallographers throughout the world interested in the work of any of these Commissions are invited to make contact with them through the General Secretary. The second General Assembly and Congress will be held in Europe during the summer of 1951.

Mechanization of African Agriculture

PROBLEMS likely to be encountered in the mechanization of African agriculture are to be studied by a mission which is visiting Uganda, Tanganyika, Nyasaland and Nigeria. The leader is Dr. J. R. Raeburn, of the Agricultural Economics Research Institute, Oxford, and he is accompanied by Mr. J. W. Y. Higgs, lecturer in agricultural economics, University of Reading, and Mr. R. K. Kerkham, Uganda Agricultural Service, who is at present stationed at the Uganda Agricultural Research Station. The terms of reference are: "To make a systematic survey of the sociological, economic, agricultural and technical problems which must be studied if mechanization of agriculture in the Colonies is to develop along sound lines, including *inter alia* the forms or organization required to achieve the best results (for example, whether mechanization should be on a co-operative, group or peasant basis), the most profitable lines of future research into problems arising out of mechanization, the economics of it and the types of tractors and implements which would be likely to be most suitable to the differing African communities, and such questions as the technical training of African craftsmen, the division and displacement of labour which will result from mechanization and its impact on current farming and social systems."

Colonial Service Appointments

THE following appointments in the Colonial Service have been announced: A. Bolton, plant breeder, Kenya; E. A. Rosenquist, botanist, Malaya; J. A. F. Gerrard, geophysicist, Uganda; A. D. Campbell, veterinary officer, Nigeria; D. W. D'Silva, assistant conservator of forests, British Honduras; H. T. Hayes, fisheries officer, Gold Coast; G. H. Lunam, fisheries officer, Nigeria; D. M. Rhodes, fisheries officer, Uganda; O. E. Symes, fisheries development officer, Nigeria; T. R. Hayes (principal agricultural officer, Uganda), assistant director of agriculture, Uganda; R. B. Jagoe (botanist, Federation of Malaya), senior botanist, Federation of Malaya; H. T. Pagden (entomologist, Federation of Malaya), senior entomologist, Federation of Malaya; D. H. Welsh (agricultural officer, Nigeria), principal of schools, Agricultural Department, Nigeria; D. B. Fanshawe (assistant conservator of forests, British Guiana), senior assistant conservator of forests, British Guiana.

Effect of Lightning Discharge

PROF. E. W. MARCHANT, 20, Harthill Road, Liverpool, 18, writes: "During a severe thunderstorm in Liverpool on July 31, the centre of the roadway was struck by lightning. The lightning discharge produced a crack about six feet long in the asphalte road surface near the centre of the road and close to a manhole cover, which, I understand, was open at the time of the storm. Six or seven pieces of melted tar were scattered over the road close to the crack. Heavy rain was falling at the time and the interesting thing about the discharge was that it struck the flat surface of the road, although, only thirty feet away on each side, were trees about twenty feet high."

Announcements

DR. ANDRÉ DANJON, director of the Paris Observatory, has been elected a member of the Section of Astronomy of the Paris Academy of Sciences, in succession to the late Dr. Henri Deslandres.

DR. W. A. MACFARLANE, director of fuel efficiency in the Ministry of Fuel and Power, has been lent by the Ministry to the Department of Scientific and Industrial Research for about two years for appointment as director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Offices in Washington. He will also be attaché for scientific matters in the British Embassy. In accordance with arrangements made at the time of his appointment, the present director of the Mission, Dr. F. N. Woodward, is returning to the United Kingdom towards the end of the year.

THE Public Health and Municipal Engineering Congress and Exhibition will be held at Olympia, London, during November 15–20. Further information can be obtained from the Joint Hon. Secretary, 84 Eccleston Square, London, S.W.1.

THE twenty-third annual conference of the Association of Special Libraries and Information Bureaux (ASLIB) will be held at Ashorne Hill, near Leamington Spa, Warwickshire, during September 17–20. Further information can be obtained from the Secretary, ASLIB, 52 Bloomsbury Street, London, W.C.1.

THE Council of the Royal Society of Arts is offering, under the Thomas Gray Memorial Trust, the objects of which are "the Advancement of the Science of Navigation and the Scientific and Educational interests of the British Mercantile Marine", a prize of £50 for an essay on "The Applications of Radar to Navigation". Further information can be obtained from the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

The South African Journal of Science of March 1948 reports the Oudtshoorn meeting in July 1947 of the South African Association for the Advancement of Science. It includes the presidential address by Prof. H. H. Paine, "The World View of the Physicist", and the addresses of the sectional presidents. Of these, Prof. C. C. Gillie reviewed "A Century of Astrophysics", Dr. C. N. C. Hamilton dealt with "Coal", Prof. A. Quintanilha with "The Problem of Cotton Production in Portuguese Africa", Dr. C. S. Grobbelaar with "Anthropometry and its Role in South Africa", the Abbé H. Breuil with "Ancient Raised Beaches and Prehistoric Civilizations in South Africa", and J. D. Rheinallt Jones with "The Development of Central and Southern Africa", including a few suggestions for research and action on some of the problems common to these territories. A number of the papers read at the meeting are also printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mechanism of the Oxidation of Gaseous Formaldehyde

RECENTLY, Axford and Norrish[1] have put forward a scheme for the oxidation of gaseous formaldehyde in the temperature range 325°–375° C. Though this scheme accounts for the experimental facts, we regard the proposed initiation reactions as unsatisfactory, for they suggest that formaldehyde is oxidized directly to formic acid, whereas it is highly probable that this does not take place in a single step. Our recent experiments on the oxidation of gaseous acetaldehyde[2] have led us to propose as an initiation process the reaction of an oxygen molecule with an acetaldehyde molecule to form the acetyl radical and the perhydroxyl radical (HO_2). If an analogous initiation reaction is postulated for the oxidation of formaldehyde, we have

$$\mathrm{HCHO + O_2 = HCO + HO_2}.$$

The formyl radical is thought to be unstable[3,4] above 100° C., and it can reasonably be assumed that at high temperatures it will split up rapidly to give carbon monoxide and hydrogen. Then our first step becomes

$$1.\quad \mathrm{HCHO + O_2 = H + CO + HO_2} \qquad k_1 \text{ initiation.}$$

The subsequent reactions we suppose to be the same as those put forward by Axford and Norrish,

$$\begin{array}{lll}
2. & \mathrm{H + HCHO = H_2 + CO + H} & k_2 \ \text{propagation-decomposition} \\
3. & \mathrm{H + O_2 + HCHO = H_2O + CO + OH} & k_3 \\
4. & \mathrm{OH + HCHO = H_2O + CO + H} & k_4 \\
5. & \mathrm{H + O_2 + HCHO = H_2O + CO_2 + H} & k_5 \\
6. & \mathrm{H + O_2} + X = \mathrm{HO_2} + X & k_6 \\
7. & \mathrm{H + O_2 + O_2 = HO_2 + O_2} & k_7 \\
8. & \mathrm{H + O_2 + wall = HO_2} & k_8
\end{array}
\begin{array}{l}
\\
\left.\begin{array}{l}\\ \\ \\ \end{array}\right\} \text{propagation-oxidation} \\
\left.\begin{array}{l}\\ \\ \\ \end{array}\right\} \text{termination}
\end{array}$$

Since the chains are started by reaction (1) and terminated only by reactions (6), (7) and (8) we have, following Axford and Norrish[1]:

$$k_1(\mathrm{O_2})(\mathrm{HCHO}) = k_6(\mathrm{H})(\mathrm{O_2})(X) + k_7(\mathrm{H})(\mathrm{O_2})^2 + k_8(\mathrm{H})(\mathrm{O_2})(S)/d$$

(for cylindrical vessels the ratio area/volume is $1/d$, approximately, so if (S) represents the surface activity per sq. cm., then $(S)/d$ is the surface activity per unit volume). From this we get

$$(\mathrm{H}) = \frac{k_1(\mathrm{HCHO})}{k_6(X) + k_7(\mathrm{O_2}) + k_8(S)/d}. \qquad (9)$$

For the equilibrium concentration of OH radicals we have

$$k_3(\mathrm{H})(\mathrm{O_2})(\mathrm{HCHO}) \doteq k_4(\mathrm{OH})(\mathrm{HCHO}).$$

Hence

$$(\mathrm{OH}) = k_3\,\frac{(\mathrm{H})(\mathrm{O_2})}{k_4}. \qquad (10)$$

Substituting for (H) from (9) into (10) we get

$$(\mathrm{OH}) = \frac{k_1\,k_3\,(\mathrm{O_2})(\mathrm{HCHO})}{k_4\{k_6(X)+k_7(\mathrm{O_2})+k_8(S)/d\}}. \qquad (11)$$

The rate of disappearance of formaldehyde is, therefore, given by

$$-\frac{d(\mathrm{HCHO})}{dt} = k_1(\mathrm{HCHO})(\mathrm{O_2}) + k_2(\mathrm{H})(\mathrm{HCHO}) + (k_3+k_5)(\mathrm{H})(\mathrm{O_2})(\mathrm{HCHO})+k_4(\mathrm{OH})(\mathrm{HCHO}). \qquad (12)$$

Substituting for (H) and (OH) from equations (9) and (11) we get

$$-\frac{d(\mathrm{HCHO})}{dt} = k_1(\mathrm{HCHO})(\mathrm{O_2})' + \frac{k_1k_2(\mathrm{HCHO})^2}{k_6(X)+k_7(\mathrm{O_2})+k_8(S)/d} + \frac{k_1(\mathrm{O_2})(\mathrm{HCHO})^2(2k_3+k_5)}{k_6(X)+k_7(\mathrm{O_2})+k_8(S)/d}. \qquad (13)$$

This is the same as equation (IV) given by Axford and Norrish on page 534 of their paper[1]; thus this modified scheme, also, accounts for the experimental results. It has, however, the advantage of a more clear-cut initiation step and also shows why one gets performic acid at low temperatures, for here the formyl radical will be stable and the following reactions can take place.

$$\begin{array}{llll}
\mathrm{HCHO} & +\mathrm{O_2} & = \mathrm{HCO + HO_2}. & (14) \\
\mathrm{HCO} & +\mathrm{O_2} & = \mathrm{HCOOO}. & (15) \\
\mathrm{HCOOO} & +\mathrm{HCHO} & = \mathrm{HCOOOH + HCO}. & (16)
\end{array}$$

This is analogous to the scheme which we are putting forward to explain the occurrence of peracetic acid in the low-temperature oxidation of acetaldehyde.

CHAS. A. McDOWELL
J. H. THOMAS
Dept. of Inorganic and Physical Chemistry,
University, Liverpool.

April 13.

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ANY initiation process which will provide one of the chain centres responsible for the propagation reaction, and the rate of which depends upon the product of the pressures of formaldehyde and oxygen, may be substituted for that which we propose without change in the structure of the kinetics. It is thus not surprising that there is no formal change in the derivation of the relationship which Messrs. McDowell and Thomas reproduce from our paper. Initiation reactions, however, can be distinguished by studying the overall activation energy of the chain reactions which they initiate and to which they make the principal contribution, and in choosing the most likely initiation reaction, reference must be made to the thermochemistry of the processes postulated. Now the overall temperature coefficient of the oxidation of formaldehyde at 350° C. indicates an energy of activation of about 20 k.cal., and nearly all of this is associated with the initiating process, for which the velocity coefficient is k_1. Thus the initiation process at the temperature studied cannot be more endothermic than c. 20 k.cal., and is probably less so. From the data of Bray[1] we may derive

$$\mathrm{H + O_2 = HO_2} + 52 \text{ k.cal.};$$

and combining this with

$$\mathrm{H + HCO = H_2CO} + 102 \text{ k.cal.},$$

we may calculate that the reaction

$$\mathrm{H_2CO + O_2 = HCO + O_2}$$

is endothermic to the extent of 50 k.cal. Since this figure must give a lower limit for the energy of activation, it would appear that the reaction cannot function as an initiating process for the formaldehyde oxidation in the range of temperature where the overall energy of activation is 20 k.cal.

On the other hand, from the heats of combustion of formaldehyde and formic acid, and the heat of dissociation of molecular oxygen, we may calculate a heat absorption of about 8 k.cal. for the initiation process:

$$HCHO + O_2 = (HCOOOH) = HCOOH + O$$

postulated by us. This endothermicity is less than the energy of activation at 350° C. and is thus in accord with the experimental results.

Our initiation reaction involves the formation of performic acid as a transition compound, followed by its decomposition to give an oxygen atom; this would explain the occurrence of performic acid at the lower temperatures at which it is stable, and a similar scheme would give peracetic acid in the case of acetaldehyde. We have never supposed that the reaction takes place in a single step as suggested by Messrs. McDowell and Thomas. On the other hand, there is no case for dogmatizing, and we hope to get further evidence from a more detailed study of the temperature coefficient of the reaction. There are reasons for believing that more than one initiation reaction can operate, each in a different temperature range, without essentially changing the kinetic scheme we have derived, and at higher temperatures the alternative which has been suggested is not excluded.

R. G. W. NORRISH

Department of Physical Chemistry,
University of Cambridge.

[1] Bray, *J. Amer. Chem. Soc.*, 60, 82 (1938). See also Rollefson, "Photochemistry", 276 (Prentice-Hall, 1939).

Further Experimental Evidence for the Theory of Quasi-Properties

Scott Blair, Veinoglou and Caffyn[1] have explained the rheological behaviour of certain complex materials in terms of 'quasi-properties'; that is, complex entities in which a number of magnitudes taken together describes the process which the material undergoes as a result of a specified test, the ordinary 'properties', such as viscosity and elasticity, being changed by the testing process itself.

The simplest illustration of this is the Nutting[2] equation

$$\psi = S^{\beta}\sigma^{-1}t^{k}, \qquad (1)$$

where S is stress, σ is strain, t is time, and where ψ is a constant which can only describe the relative behaviour of materials when quoted in conjunction with k and β, which are numbers specifying its dimensions. In the limit, when β and k have constant values for large groups of materials, ψ approximates in character to a physical property of the ordinary kind.

Many materials subjected to constant compressive or tensile stresses or relaxing at constant strain after rapid straining accurately obey equation (1); but a few, especially when relaxation follows a slow straining, show considerable discrepancies.

In our earlier paper* we proposed 'intermediate' fractional differential equations of the type:

$$\begin{array}{l}\text{Proto-}\\ \text{types}\end{array}\left\{\begin{array}{l}\left.\begin{array}{l}\eta = S \div \dfrac{d\sigma}{dt}\\ n = S \div \sigma\end{array}\right\}\chi_1 = S^{\beta} \div \left\lceil\dfrac{\partial^{\mu}\sigma}{\partial t^{\mu}}\right. \quad (2a)\\ \left.\begin{array}{l}\eta = t \div \dfrac{d\sigma}{dS}\\ \pi = t \div \dfrac{\sigma}{S}\end{array}\right\}\chi_2 = t^{k} \div \left\lceil\dfrac{\partial^{\omega}\sigma}{\partial S^{\omega}}\right. \quad (2b)\end{array}\right\}\frac{1}{X} = \left\lceil\frac{d^{\mu+\omega}\sigma}{dt^{\mu}.dS^{\omega}}\right. \qquad (2)$$

where $\lceil$ indicates fractional differentiation. Equation (2a) may be integrated to give:

$$\sigma = At^{k} + Bt^{k-1} + Ct^{k-2}, \qquad (3a)$$

and it was shown that the great majority of those of our data which did not obey equation (1) could be accounted for by introducing the second term of equation (3a) and, in a few cases, the third term.

We have now examined the rest of the anomalous data and have fitted both the integrated form of equation (2b):

$$\sigma = A'S^{\beta} + B'S^{\beta-1} \qquad (3b)$$

as well as the general integrated form of equation (2):

$$\sigma = (At^{k} + Bt^{k-1}\ldots)(A'S^{\beta} + B'S^{\beta-1}\ldots). \qquad (3)$$

(The product is preferred to the sum of equations (3a) and (3b), though both are valid integrations of equation (2).)

In all the data examined, we have found that with no more than two terms in each case, either equation (3a), (3b) or (3) fits our data within the limits of experimental error, which are satisfactorily low.

Since the ratios B/A and B'/A' have the dimensions of time and stress respectively and represent characteristics of the materials, it should be possible to write the three equations in dimensionless form by expressing all times and stresses in terms of these characteristics. Deviations from the simple Nutting equation are rarely large enough, however, for such a procedure to give reasonable accuracy.

In our earlier paper we explained that the fractional differentials with respect to time arise as a result of the use of the Newtonian definition of equality of time units, the acceptance of which *defines* the velocity of light, or of bodies free from the influence of other matter as constant.

Just as the Newtonian time-scale depends on the constancy of the magnitude of such velocities, so it seems that Newtonian definitions of equality of forces, unless directly involving Newtonian time, must depend on the concept of a straight line or of unchanging direction, that is, the *course* of a light ray or of a body uninfluenced by other matter.

For example, two forces, X and Y, might be defined as equal when, acting in the same direction on a body, a third force, Z, can be found which would balance either of them so that the body would not change its motion as a result of the simultaneous actions of either X–Z or Y–Z. If the body is of finite size, X (or Y) and Z must be acting in a straight line: if the body becomes a point, there can be no change in direction at this point.

The implications of this in relation to the stress fractional differentials (equations 2b and 3b) are discussed in a paper in process of publication (*Phil. Mag.*), in which the full experimental results are also given.

Our indebtedness to several colleagues who have helped us is expressed in our paper itself. Here we wish to acknowledge our gratitude to the British

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* The equations are here re-written in a slightly more convenient form.

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G. W. SCOTT BLAIR
National Institute for Research in Dairying,
University of Reading.

J. E. CAFFYN
Department of Physics,
University of Durham.

May 4.

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Ionic Reactions in Liquid Dinitrogen Tetroxide

THE fact that liquids other than water may serve as media for inorganic reactions is widely recognized; reactions in the well-known liquid ammonia and liquid sulphur dioxide systems are explained by postulating the ionization:

$$2NH_3 \rightleftharpoons NH_4^+ + NH_2^-$$
$$2SO_2 \rightleftharpoons SO^{2+} + SO_3^{2-},$$

although neither liquid has an appreciable electrical conductivity. Frankland and Farmer[1] in 1901 first considered the possibility that liquid dinitrogen tetroxide might serve as an ionizing medium, but were unable to find any inorganic salt which was soluble in the liquid. In view of the high solubility of many organic compounds, they concluded that the liquid was of a non-ionizing character and resembled in behaviour such organic solvents as benzene.

We have now obtained evidence that ionic reactions can be conducted in liquid dinitrogen tetroxide medium. Where electron-transfer can readily occur, all reactions so far investigated in this medium can be interpreted on the basis of the ionization:

$$N_2O_4 \rightleftharpoons NO^+ + NO_3^-. \qquad (1)$$

The existence of the nitrosyl radical is already established in other media[2,3], and we have found no evidence for dissociation of the N_2O_4 into NO_2^+ and NO_2^- under these conditions. Thus the alkali metals, including lithium, react rapidly but quietly with liquid dinitrogen tetroxide to yield the nitrate and nitric oxide:

$$Na + N_2O_4 \rightarrow NaNO_3 + NO. \qquad (2)$$

The reaction is not affected, except in velocity, by dilution of the dinitrogen tetroxide with an inert solvent such as benzene. The insoluble nitrate produced is free from nitrite. At temperatures approaching the boiling point of dinitrogen tetroxide (21·3°) the nitric oxide is evolved (although at low temperatures, or under pressure, some nitric oxide remains associated in the liquid phase as blue dinitrogen trioxide), and the reaction can be considered as a simple electron transfer from the sodium atom to the NO^+ ion, giving the resonance-stabilized nitric oxide molecule. Attempts to explain this reaction on the basis of dissociation of the medium into NO_2^+ and NO_2^- would involve the intermediate formation of the alkali metal nitrite, which we have found to be stable in contact with liquid dinitrogen tetroxide. Although some metallic oxides when allowed to react with dinitrogen tetroxide yield nitrite as well as nitrate, this is probably at least a two-stage reaction which may be explained thus: $MO + (2NO^+ + 2NO_3^-) \rightarrow M(NO_3)_2 + 2NO^+ + O^{2-}$, followed by $MO + 2NO^+ + O^{2-} \rightarrow M(NO_2)_2$, and the formation of nitrite here does not necessarily imply the presence of NO_2^- in the medium.

Ammonium chloride (in liquid ammonia) and thionyl chloride (in liquid sulphur dioxide) have many properties commonly associated with aqueous hydrochloric acid solutions. The corresponding compound in the liquid dinitrogen tetroxide system, nitrosyl chloride, is soluble in this medium and such solutions attack many of the metals which are resistant to the tetroxide alone, the degree of attack depending on the concentration of the nitrosyl chloride; nitric oxide is evolved, the insoluble product being either the metal chloride or the chloride associated with nitrosyl chloride as a complex of the type $(NO)_x[MCl_y]$.

The ionic dissociation of dinitrogen tetroxide (equation 1) is fully reversible in the liquid phase. Thus the reaction:

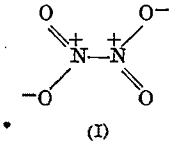
$$NOCl(\text{in } N_2O_4) + AgNO_3(s) \rightarrow AgCl(s) + N_2O_4(l)$$

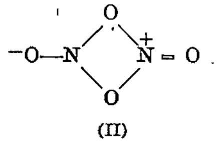
(comparable with the reaction between an aqueous solution of hydrogen chloride and an insoluble hydroxide) is complete in the direction indicated. However, if dry diethylammonium chloride is added to liquid dinitrogen tetroxide at 0° the reaction:

$$[Et_2NH_2]^+Cl^- + N_2O_4 \rightarrow NOCl + [Et_2NH_2]^+NO_3^- \qquad (3)$$

proceeds readily. The medium is immediately coloured red by the nitrosyl chloride produced, and diethylammonium nitrate may be crystallized from the solution; the process resembles that of hydrolysis. At higher temperatures the products of reaction (3) undergo further mutual interaction.

Full details of the work will be published elsewhere, but it is of interest here to compare the behaviour of dinitrogen tetroxide outlined above with its reactions where bonds of a covalent character are involved. Levy and Scaife[4] have shown that it adds to olefinic double bonds to give exclusively dinitro-compounds or nitro-nitrites. Again, both ammonia and diethylamine react explosively with it, yet ammonium and diethylammonium chlorides and nitrates are unattacked, so that the conversion of the base into the ionic form shields it from decomposition by dinitrogen tetroxide. We are led to the conclusion that the dinitrogen tetroxide molecule may undergo dissociation in two ways during reaction, giving either $(NO^+ + NO_3^-)$ or $(NO_2^+ + NO_2^-)$, and that the particular course followed depends upon whether the reacting groups are charged ions or covalent, uncharged molecules. It is not our desire here to support any particular structure for the dinitrogen tetroxide molecule; but our work on ionic reactions has shown that the molecule should be capable of dissociation into NO^+ and NO_3^- units as a result of simple electron transfer processes. Ingold[5] considers that the results of Levy and Scaife[4] provide additional and conclusive proof of structure (I).


(I)


(II)

Ionic dissociation of this molecule (equation 1) would involve the breaking of the N–O bond and transfer of the oxygen atom, whereas ionization of molecule (II) postulated by Longuet-Higgins[6] would involve no atom transfer, while at the same time satisfying physical evidence regarding symmetry[7].

C. C. ADDISON
R. THOMPSON

Department of Chemistry,
The University
Nottingham.
May 1.

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A General Solution for the Force Constants of Polyatomic Molecules

IT is well known that the fundamental vibration frequencies of polyatomic molecules can be predicted with an error of only 1 or 2 per cent by solving the secular equation with force constants obtained from related molecules[1]. The reverse process of solving for the constants in terms of the frequencies is, in general, impossible unless some special assumptions are made concerning the force field[2]. The following general solution is therefore of some interest.

The nth order secular equation can be written in matrix form as follows:

$$|dA - \lambda I| = 0. \tag{1}$$

The elements of d are the force constants d_{ij} in the general potential function:

$$2V = \sum_{i=1}^{n} \sum_{j=1}^{n} d_{ij}\Delta_i\Delta_j. \tag{2}$$

The Δ_i are valence-type co-ordinates, expressed in terms of N further co-ordinates z_j:

$$\Delta_i = \sum_{j=1}^{N} a_{ij}z_j, \tag{3}$$

all possessing any required symmetry properties, and the elements of A (related to the inverse kinetic energy matrix G used by Wilson[3]), are defined as follows:

$$A_{ij} = A_{ji} = \sum_{k=1}^{N} a_{ik}a_{jk}\frac{M}{m_k}, \tag{4}$$

m_k being the mass for the co-ordinate z_k and M some arbitrary mass, introduced in order that the A_{ij} shall be pure numbers. I is the unit matrix, and the quantity λ is defined as follows:

$$\lambda = 4\pi^2\nu^2c^2M, \tag{5}$$

ν being the frequency of vibration in cm.$^{-1}$ and c the velocity of light in cm. sec.$^{-1}$. The (N–n) null vibrations factorize out, giving (1). If the subscripts are ordered so that Δ_i is the approximate normal co-ordinate for ν_i, corresponding to the vibrational assignment, and if $\nu_1 > \nu_2 \ldots > \nu_n$, then the proposed general solution for the constants is obtained by equating to zero all elements below the diagonal of the determinant (1), thus reducing it to the product of n linear factors, and substituting λ_1 to λ_n in order in the n diagonal elements; that is:

$$\left.\begin{array}{l} \sum\limits_{i=1}^{n} A_{ki}d_{ki} - \lambda_k = 0, \; (k = 1, 2 \ldots n). \\ \sum\limits_{i=1}^{n} A_{qi}d_{pi} = 0, \; (p > q). \end{array}\right\} \tag{6}$$

The corresponding (unnormalized) normal co-ordinates are given by:

$$z_i^{\nu_k} = \sum_{j=1}^{k} a_{ji}\frac{M}{m_i}\,{}^k|A|_{kj} \tag{7}$$

$$\Delta_p^{\nu_k} = \sum_{j=1}^{k} A_{pj}\,{}^k|A|_{kj}, \; (= 0 \text{ for } p < k). \tag{8}$$

where ${}^k|A|_{kj}$ are first minors of the kth order determinant formed from the first k rows and columns of the matrix A. The normal co-ordinate for ν_i involves only the co-ordinates Δ_i to Δ_n; the method, in effect, factorizes out the frequencies in descending order, the molecule increasing in rigidity as factorization proceeds. If only the constants for the m lowest frequencies are required, only elements in the last m rows of (1) need be considered, without introducing any fresh approximation.

The above solution is found to give surprisingly good results with actual examples, and is easy to apply. For molecules in which all the fundamentals fall into the category of 'group vibrations', factorization of the secular equation will clearly give a close approximation; where $(\nu_i - \nu_{i+1})$ is small and Δ_i and Δ_{i+1} overlap, the approximation will not be so close, since the normal co-ordinate for ν_{i+1} would then certainly involve Δ_i; but only the constants d_{ii}, $d_{i(i+1)}$ and $d_{(i+1)\,(i+1)}$ will be much affected. The constants obtained in (6) are always real, and the normal co-ordinates defined in (7) and (8) correspond to the vibrations having idealized geometrical forms; thus, in valence vibrations the atomic displacement vectors lie directly along the appropriate valence bonds. Interactions which would normally be discarded are here generally found to be negligibly small; their retention gives the unambiguous solution.

The method can obviously be adapted to predict vibration frequencies, by substituting constants only in the diagonal elements of (1); the inconsistency in the force field can then be estimated by evaluating terms below the diagonal.

P. TORKINGTON

39*a* Palliser Road,
London, W.14.
May 6.

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Study of the Action of Ultra-violet Light on Urease by Means of the Ultracentrifuge

THE action of ultra-violet light on serum albumin has been studied with the ultracentrifuge by Svedberg and Brohult[1] and by Sanigar, Krejci, and Kraemer[2]. Irradiation of serum albumin at room temperature and at 0° C. causes the formation of low-molecular substances and a general inhomogenization of the protein.

It seemed worth while to perform a similar experiment with a protein having enzymatic activity in order to see if inhomogenization accompanies loss of activity, or is a process resulting from the absorption of quanta beyond those required on the average for inactivation. For irradiation, monochromatic light of 2537 A. was used, at which a quantum yield of inactivation of 0·000926 has been found[3]. Inactivation involves a 'one-hit' process, that is, only one quantum is required for inactivation, although many (1,100) quanta may be absorbed on the average without producing inactivation.

A solution (0·5 per cent) of crystallized urease, *p*H 7 in 0·02 *M* phosphate buffer, was sedimented at 60,000 times gravity. It gave a sedimentation constant, S_{20}, of 18·2 Svedberg units, with a heavier component, S_{20} equal to 27·5, present to the extent of about 20 per cent of the total protein. This compares within the experimental error with earlier results of Sumner *et al.*[4], who found S_{20} equal to 18·6 for the main component in their best preparation. After a loss in activity of 45 per cent by irradiation, a main component with S_{20} equalling 15·0 was present to the extent of 60 per cent of the main component of the control sample. Comparison showed an increase in the amount of material both lighter and heavier than the main component. In a second experiment the activity of one aliquot was reduced to 66 per cent by radiation, and of another aliquot to 63 per cent by heating in a water bath at 80°. After irradiation, a fairly sharp main component remained. Following heat denaturation, however, no clearly defined component was visible, the material having become extremely polydisperse and inhomogeneous.

These results show that the decrease in activity of the irradiated solutions was about equal to the decrease in concentration of the main component, and the average molecular weight of this component was somewhat decreased. This, together with the appearance of more heavy material, suggests that irradiation brings about a primary process of inactivation and depolymerization followed by aggregation of the depolymerized material. Adjustment of irradiated solutions to the isoelectric point is known to augment this second step by inducing precipitation[2]. That ultra-violet light is more specific in its action than is heat is also indicated. The latter agent produces a more general distribution of particle sizes resulting, doubtless, from a spectrum of energy which breaks bonds at random. Monochromatic light, however, which is selectively absorbed at aromatic residues[5], would tend to produce more well-defined fragments by breakage of bonds next to chromophores.

A. D. McLAREN
E. SHEPPARD
J. WAGMAN

Institute of Polymer Research,
Polytechnic Institute, Brooklyn.

May 3.

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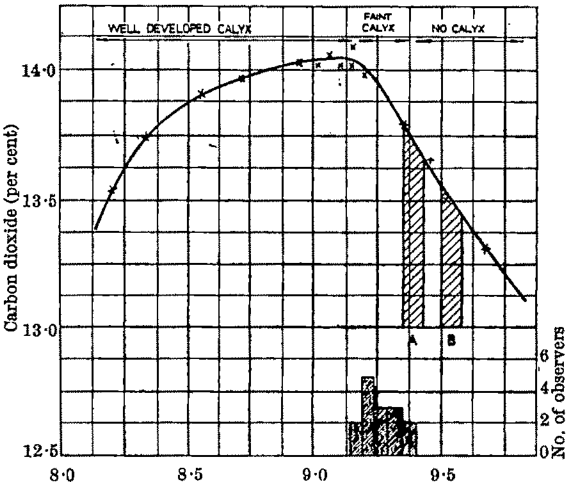
Use of the Calyx Burner to Determine Combustion Conditions

H. ROSTRON HINDLEY[1] has recently directed attention to the limitations of the calyx flame as an indicator of maximum carbon dioxide concentration in products of combustion. His letter seemed to us inconclusive, as the scale of air flow in the accompanying diagram was arbitrary and hence gave no indication of the magnitude of the possible error in terms of air/gas ratio. There was also no indication of the relation between the peak concentration of carbon dioxide and the theoretical mixture. It cannot be assumed that these two points would coincide under the combustion conditions prevailing in the calyx burner. As we had not previously considered the calyx flame as an indicator of maximum concentration of carbon dioxide, it was thought to be worth while making further tests with this application in mind.



Gas rate, 2·49 cu.ft./hr. throughout.
A, total air requirement calculated from analysis
B, ,, ,, ,, ,, using Wood's formula (lines indicate limits of probable error)

Using a calyx burner of the type described by Brinsley and Stephens, determinations of the total air requirement of Birmingham towns gas were made by three observers having considerable experience of calyx observation, one of whom was known from previous special tests to have sensitive colour vision. Comparison was made with twelve other observers used to scientific observations but having no special training in, or experience of, calyx observation. One of these observers was also known to have specially sensitive colour vision. At the same time a series of carbon dioxide determinations were made, and the total air requirements of the gas were calculated both directly from the gas analysis data and also using J. W. Wood's formula[2]. As an additional confirmation of the value of the maximum carbon dioxide concentration an analysis was made of the products of combustion from a Boys calorimeter and the carbon dioxide calculated on an oxygen-free basis. This confirmed the peak concentration shown on the full line in the accompanying diagram.

The point of disappearance of the calyx as determined by the two colour-sensitive observers fell consistently on the left-hand limit of the region marked 'no calyx'. The end points in the case of all the other observers except one fell between the right-hand end of the range marked 'well developed calyx' and the 'no calyx' limit. One observer had difficulty in seeing the calyx under any conditions. The frequency distribution of observations adjusted to a constant number of observations per observer is also shown on the diagram. Although the number of observers is insufficient to obtain a statistically valid distribution, this information is included for the sake of completeness. The extreme range of error in the determination of air/gas ratio was about ± 1·5 per cent, which is sufficiently accurate for most purposes connected with gas appliance design and with observations of gas quality.

It will be seen from the diagram that the end points of the two colour-sensitive observers agreed well with the values for the total air requirement calculated from the gas analysis data. The latter were definitely not coincident with the peak of the carbon dioxide curve.

A. R. BENNETT
D. HARRISON

Central Research Laboratories,
Radiation, Ltd.,
Aston,
Birmingham, 6.
May 5.

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[2] *Nature*, 157, 622 (1946).

A New Method for the Preparation of Adsorbents for Chromatography

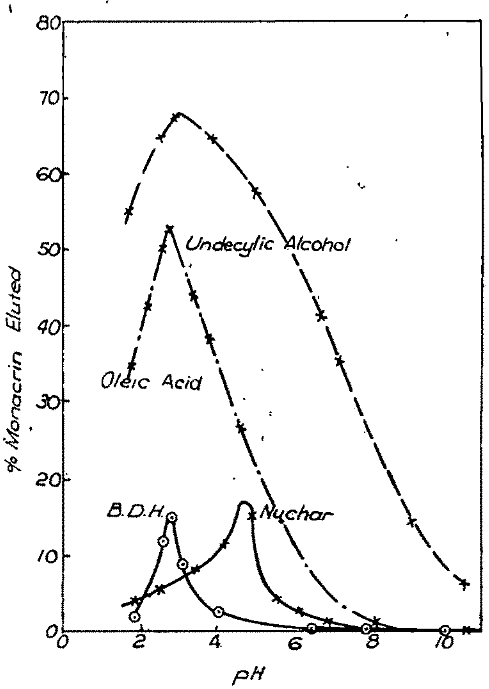
THE technique of chromatography, as used at present, is limited to a few adsorbents and usually to non-aqueous systems, due to the difficulty of elution of the adsorbate. However, aqueous systems could be used if adsorbents were available which permitted adsorption and desorption to be controlled by *p*H adjustment. This procedure is possible in some cases with synthetic ion exchange resins which have been used to a limited extent for the separation of mixtures of inorganic ions, organic bases such as thiamine, and some amino-acids. However, organic bases cannot always be recovered quantitatively even by elution with strong acids. 'Sodium cotton succinate' has been used for the quantitative adsorption and recovery of histamine, which could not be eluted quantitatively from ion exchange resins[1].

Activated charcoal has not generally been used for chromatographic separation of water-soluble substances because of its high adsorptive power and the subsequent difficulty of elution. It has been used for three-stage countercurrent adsorption of certain antibiotics such as penicillin, where an organic solvent is used for elution, followed by an additional extraction into buffered solution.

By adsorption of a surface-active or water-insoluble acid, for example, fatty acids or lecithin, as a 'primary' adsorbate, on adsorbents such as alumina, activated charcoal, or even carbon black, I have prepared a simple and versatile adsorbent similar in behaviour to an ion exchange resin. The adsorbent acquires the properties of the 'primary' adsorbate, and forms, under alkaline conditions, salts with cations or bases which may be considered as a 'secondary' adsorbate. The 'secondary' adsorbate can be eluted by acid solution. This eliminates the use of organic solvents and permits the immediate re-use of the prepared adsorbent.

Cationic surface-active agents, or insoluble bases, may be used in place of the fatty acids as a 'primary' adsorbate to prepare adsorbents for acids or anions. Similarly, the 'primary' adsorbate may be any substance that can form a complex with the materials to be separated or fractionated; for example, the lignin protein reaction might be utilized for the fractionation of some protein mixtures.

Typical curves for the adsorption of 'Monacrin' (5-amino acridine) directly on 'Nuchar' and B.D.H. decolorizing charcoal (reproduced herewith) are in agreement with the findings of Hauge[2], Olin[3] and Sastri[4], who showed that the adsorption of electropositive substances on activated charcoals is a minimum in the region of a characteristic *p*H termed the isoelectric point.



0·05 gm. adsorbent; 10 ml. 4 × 10^{-3} *m/L* 'Monacrin'

A similar curve is also shown for the adsorption of 'Monacrin' on B.D.H. charcoal pretreated with 20 per cent of its weight of oleic acid. Two distinct adsorption processes occurred. The curves indicate that above a *p*H value of approximately 6, the 'Monacrin' reacted with oleic acid to precipitate an insoluble salt on the adsorbent. In this *p*H range the salt formation was the principal adsorption mechanism, and strong adsorption was observed for both strong and weak adsorbents, such as B.D.H. charcoal and acetylene black. Below this *p*H-range, free base was liberated from the salt and was apparently adsorbed on the oleic acid layer, the degree of adsorption depending on the adsorptive power of the carbon. Thus B.D.H. charcoal showed a minimum adsorption amounting to 50 per cent of the 'Monacrin' at *p*H 3·0, whereas acetylene black similarly treated with oleic acid showed practically complete elution. Increasing the amount of adsorbed oleic acid in the pretreatment reduced the 'Monacrin' adsorption.

By selecting a carbon with a suitable isoelectric point, and an acid or base of the required strength, a great variety of exchange adsorbents can be prepared. For single-stage adsorptions, quantitative adsorption and elution of the adsorbate are desirable, and may be achieved by using a weak adsorbent such as acetylene black coated with oleic acid. Chromatographic separations require a stronger adsorbent to permit development.

The adsorption is also shown in the accompanying graph, under the same conditions, of 'Monacrin' on B.D.H. charcoal pretreated with 40 per cent of its weight of undecylic alcohol as 'primary' adsorbate. In this case salt formation cannot occur, and the 'Monacrin' is bound by adsorptive forces only, which appear to be electrostatic in nature[5]. Thus any factor which varies the dielectric constant of the 'primary' adsorbate film, and hence the surface charge, might be expected to alter the degree of adsorption. In this manner, a great variety of adsorbents may be prepared.

This work will be discussed in detail in a paper to be published elsewhere.

D. E. Weiss
Division of Industrial Chemistry,
Council for Scientific and Industrial Research,
Melbourne.

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[1] McIntire, Roth and Shaw, *J. Biol. Chem.*, **170**, 537 (1947).

[2] Hauge and Willaman, *Ind. Eng. Chem.*, **19**, 942 (1927).

[3] Olin, Lykins and Munro, *Ind. Eng. Chem.*, **27**, 690 (1935).

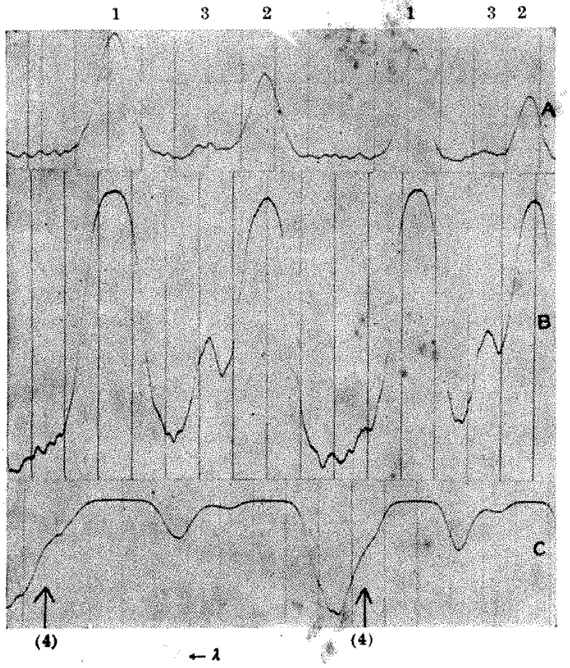
[4] Sastri, *Quart. J. Ind. Inst. Sci.*, **5**, 145 (1942).

[5] Kuchinsky, Burstein and Frumkin, *Acta Physicochimica U.R.S.S.*, **12**, 795 (1940).

Fine Structure of the Hydrogen α-Line

Though the doublet structure of the Balmer lines has been known for sixty years, attempts at a more complete resolution of the fine structure have met with difficulties owing to the large Doppler width of the individual lines. In the α-line, a third component arising from the transitions $2S_{1/2}$–$3P_{1/2}$ and $2P_{1/2}$–$3S_{1/2}$ was resolved by Williams[1] in 1938, using a deuterium discharge tube in liquid air; but the resolution was not complete enough to allow an accurate measurement of the positions of the components. From these results, Pasternack[2] deduced a displacement of about 0·03 cm.$^{-1}$ of the $2S_{1/2}$ level from its position given by Dirac's theory. This value was no more than a rough estimate, and only through the microwave experiments of Lamb and Retherford[3] was the reality of the shift established.

By using a deuterium discharge tube immersed in liquid hydrogen and run at very low current densities ranging from 2 to 6 milliamp. per sq. cm., we have been able to resolve the third component much more completely, and under conditions where the relative intensities are in qualitative agreement with the theoretical prediction for undisturbed atoms. Fabry-Pérot étalons with spacings of 5 mm. and 7·5 mm. were used.



The photometer tracing *A* shows the main components (1) and (2), the latter appreciably weaker as predicted by the theory. Tracing *B*, of a plate with longer exposure, shows the component (3) well resolved from (2). As the result of measurement of thirty-six fringes in eleven different exposures, the spacing (3)–(1) was found to be 0·183 ± 0·005 cm.$^{-1}$.

Though each of the three components is a blend of two unresolved lines, in both (1) and (3) one of the two constituent lines is so weak that its presence has only a small influence, a rough estimate of which is sufficient. With these corrections, our results lead to an upward displacement of the $2S_{1/2}$ level of 0·043 ± 0·006 cm.$^{-1}$.

This value does not agree well with the shift of 0·033 cm.$^{-1}$ found by Lamb and Retherford. These authors do not apparently claim great accuracy for their measurements; but an error of more than 10 per cent would have to be assumed to make them compatible with our results. The values of the radiation shift of the $2S_{1/2}$ level calculated by Bethe[4] and Dyson[5] are 0·033 and 0·034 cm.$^{-1}$, which agree with Lamb and Retherford's measurements, but not so well with ours.

With very long exposures, we have also been able to resolve and to measure a fourth component due to the transition $2P_{3/2}$–$3S_{1/2}$. On account of its small intensity, it had not hitherto been resolved from the fifty times stronger component (1). It can be seen in tracing *C*, in which the other lines appear broadened by over-exposure. The separation (1)–(4) was found to be 0·138 ± 0·006 cm.$^{-1}$.

The measurement of this new component allows the position of the term $3S_{1/2}$ to be determined. The value 0·138 of the separation (1)–(4) would give the position of the $3S_{1/2}$ term in almost complete agreement with Dirac's theory (only 0·003 cm.$^{-1}$ higher), whereas Bethe's theory predicts an upward shift of 0·011 cm.$^{-1}$. On account of the incomplete resolution, however, we do not claim that our value for this term is completely certain.

Further work is being done in an effort to achieve better resolution.

We are greatly indebted to Prof. F. Simon and his co-workers for the supply of liquid hydrogen.

H. Kuhn
G. W. Series
Clarendon Laboratory,
Oxford.

July 22.

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[1] Williams, R. C., *Phys. Rev.*, **54**, 558 (1938).

[2] Pasternack, S., *Phys. Rev.*, **54**, 1113 (1938).

[3] Lamb, W. E., and Retherford, C., *Phys. Rev.*, **72**, 241 (1947).

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Photodisintegration of Deuterium and Beryllium by Thorium C″ γ-Rays

The ratio has been measured between the numbers of neutrons emitted from sources made by placing 300 mC. of radium–thorium in the centre of spheres of heavy water and beryllium respectively. These sources emit neutrons according to the well-known reactions:

$$\mathrm{H}_1^2\,(\gamma,n)\,\mathrm{H}_1^1 - 2\cdot18\ \mathrm{MeV}. \qquad (1)$$

and

$$\mathrm{Be}_4^9\,(\gamma,n)\,\mathrm{Be}_4^8 - 1\cdot63\ \mathrm{MeV}. \qquad (2)$$

$$[\mathrm{Be}_4^8 \rightarrow 2\mathrm{He}_2^4 + Q].$$

Since thorium C″ emits a γ-ray of 2·62 MeV. energy, this leads to neutron energies of 0·22 MeV. and 0·80 MeV. respectively.

The heavy water used was of 99·6 per cent purity and was contained in a lead glass sphere 5 cm. in diameter with a cylindrical space 9 mm. long and 7·5 mm. diameter at the centre to contain the radium–thorium capsule. The beryllium was a machined sphere of pure beryllium metal 11 cm. in diameter, with a central cylindrical space 7·5 mm. long and 6 mm. in diameter. The relative numbers of neutrons emitted from these sources have been measured by slowing them down in a large tank of water and integrating the slow neutron density set up in this tank by using manganese foil detectors, the β-activity of which is afterwards measured by means of a Geiger counter with a thin aluminium wall. This ratio is

$$N_{\mathrm{Be}}/N_{\mathrm{D}} = 1\cdot26 \pm 0\cdot03.$$

From this ratio, and the data above, the ratio between the photo-disintegration cross-sections for beryllium and deuterium for a γ-ray energy of 2·62 MeV. energy can be calculated, a correction being applied for absorption of γ-rays in the deuterium and beryllium, making use of the absorption coefficients given in the "Handbook of Physics and Chemistry". The ratio then becomes

$$\frac{\sigma(\gamma n)\mathrm{Be}}{\sigma(\gamma n)\mathrm{D}} = 0\cdot35 \pm 0\cdot01,$$

a value in good agreement with the recently published work of Russell, Sachs, Wattenberg and Fields[1], who found values for $\frac{\sigma(\gamma n)\mathrm{Be}}{\sigma(\gamma n)\mathrm{D}}$ of 0·30 at 2·50 MeV. γ energy, and 0·43 at 2·76 MeV. γ energy.

A second determination was made using a 'long counter'[2] instead of a water tank to compare the neutron output of the two sources. These measurements give a value

$$\frac{\sigma(\gamma n)\mathrm{Be}}{\sigma(\gamma n)\mathrm{D}} = 0\cdot36 \pm 0\cdot03,$$

in good agreement with the first method.

D. L. ALLAN
M. J. POOLE
Atomic Energy Research Establishment,
Harwell, Didcot.
May 5.

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[1] Russell, B., Sachs, D., Wattenberg, A., and Fields, R., *Phys. Rev.*, 73, 6 (1948).

[2] Hanson, A. O., and McKibben, J. L., *Phys. Rev.*, 72, 8 (1947).

Cold Working of Aluminium at Low Temperatures

AT the suggestion of Prof. J. Reekie of the University of Toronto, I have carried out a few experiments on the cold working of aluminium at room and liquid air temperatures. These show that although the metal is spontaneously self-recovering during cold working at room temperatures, it shows lattice distortion effects if the plastic deformation is carried out at the temperature of liquid air and the specimen is maintained at that temperature. The aluminium used was 'H.S.' brand, supplied by Messrs. Johnson Matthey and Sons, Ltd. The X-ray back-reflexion method was chosen for investigation of lattice distortion.

An aluminium rod with quite small crystals was first cold-worked by striking with a centre punch at room temperature. X-ray back reflexion pictures taken before and after cold working showed that the radial breadth of the rings in the X-ray pattern did not increase. The aluminium was then brought to the temperature of liquid air, when a third photograph was taken. This showed no line broadening. With the specimen at the low temperature the aluminium was again cold-worked. The rings were now considerably broadened. On allowing the specimen to warm up to room temperature, it was found that the line broadening disappeared and large spots on the rings indicated the process of recrystallization.

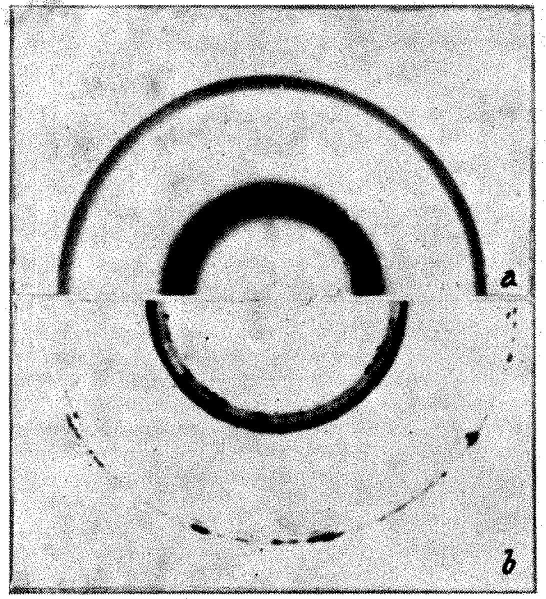

Fig. *a* shows the line broadening of the [420] and [331] rings on cold working at −180° C., while Fig. *b* shows the sharpening of the lines and the appearance of large crystals on allowing the specimen to warm up to room temperature. Cobalt *K* radiation was used in both cases.

The possible causes of general line broadening are: (1) variation of interplanar spacings in the metal due to variations in composition; (2) thermal fluctuations during the time of exposure; (3) small crystallite size; (4) variation of interplanar spacings due to mechanical strain. Causes (1) and (2) may be ignored because of the purity of the aluminium and the absence of line broadening with an unworked specimen photographed at −180° C. It is impossible on the evidence available to differentiate with any certainty between (3) and (4). The line broadening due to the fine-grain effect is given by the Scherrer formula $\Delta B = 0\cdot9\lambda/t\cos\theta$, where λ is the wave-length used, t the linear particle size and θ the Bragg reflexion angle. In the present experiment this would give an increase of just less than 1 mm. in the [420] ring with cobalt K radiation if the crystallite size decreased from about 10^{-4} cm., when the rings become continuous, to 10^{-5} cm. Now Wood[1] concludes that the lower limit of crystallite size produced in aluminium by very severe cold working is about 10^{-4} cm. On such a view the present line broadening of more than a millimetre would appear to be mostly due to mechanical strain.

There was no evidence in the present short series of experiments of the impossibility of producing complete rings after cold working, which was also noted in Wood's paper. Further work on this latter point will have to be done before a definite conclusion can be given.

T. S. Hutchison

Dept. of Physics,
University College, Dundee,
University of St. Andrews.

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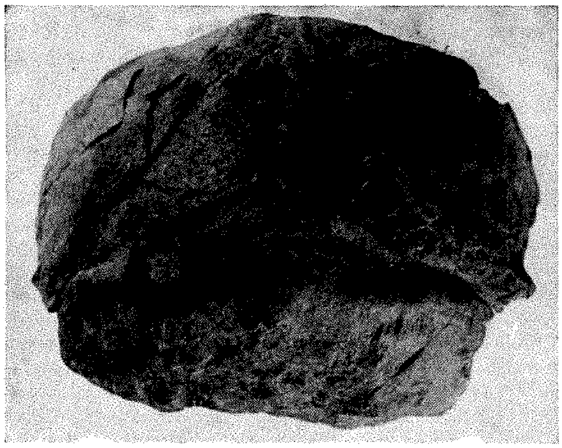
[1] Wood, W. A., *Proc. Roy. Soc.*, A, **172**, 231 (1939).

A (?) Promethean *Australopithecus* from Makapansgat Valley

During 1947 the Bernard Price Foundation for Palæontological Research in the University of the Witwatersrand maintained an archæological party in the Makapansgat Valley, twelve miles north-east of Potgietersrust. Their principal objective was to excavate the Cave of Hearths, a site of human habitation containing palæoliths of Chell-Acheul facies embedded in limestone breccia.

About a mile lower down the same valley is the Limeworks site where no implements have been found and from the dumps of which students and members of the staff of the Anatomy Department have been recovering primate and other mammalian fossils for several years past. The presence of *Parapapio broomi*, Jones, in the lowest stratum of the Limeworks cavern breccia shows that this earliest stratum belongs to the same geological horizon as that of Sterkfontein. Consequently it was a happy confirmation of our expectations when Mr. James Kitching came across an australopithecine occiput in this type of breccia during September 1947, while searching among the Limeworks dumps.

The new occiput (see photograph) exhibits an *Australopithecus* comparable in brain size to *Paranthropus robustus*, Broom, from Kromdraai. Owing to partial synostosis of the sagittal and lambdoid sutures the cranial fragment comprises the major portion of the occipital bone including most of the right margin of the foramen magnum and the posterior third of each parietal bone. It displays several significant humanoid anatomical features, namely, an expanded planum occipitale; an inferior situation of the inion relative to the opisthocranion and a consequent downward deflexion of the planum nuchale (thus proving the upright posture); the existence, but moderate development, of a torus transversus occipitalis (thus indicating the lack of a gorilloid 'bullneck' in the type) and the presence of a sutura transversa occipitalis (or sutura mendosa) with subsidiary sulci forming a complex 'Inca' bone (which has never been found hitherto in anthropoids).



Australopithecine occiput from the Makapansgat Valley

In all these features the Makapansgat *Australopithecus* distinguishes itself from its smaller-brained contemporary *Plesianthropus* at Sterkfontein. Further, if *Paranthropus* is geologically more recent (as Broom believes), the Makapansgat type probably differed considerably from *Paranthropus*. The final answer to this question must await the discovery of further remains.

But the most potent reason for separating the new fossil from its relatives is the difference between the bone breccia of Makapansgat Limeworks on one hand and the bone breccias of all the other manape sites on the other. The breccia shows first that the Makapansgat *Australopithecus* had advanced hunting habits and secondly that it was acquainted with the use of fire. Both of these inferences from the breccia were announced nine months before the discovery of the occiput in a communication to the First Pan-African Congress of Prehistory at Nairobi in January, 1947. They are briefly recapitulated here to explain why the name, *Australopithecus prometheus*, has been given to this specimen.

In addition to the Sterkfontein types of baboons such as *Parapapio broomi*, Jones, and *Parapapio jonesi*, Broom, the Makapansgat breccia has yielded fourteen species of Bovidæ, eight of which appear to be new; three carnivores (namely, lion, hyena and jackal); two extinct pigs; a rhinoceros; a hippopotamus; and two giraffes (including the extinct *Griquatherium*). Thus apart from the elephant we have concrete evidence that these creatures drew upon every family of big game found in Southern Africa for their food supply. The dentitions of the big game specimens, however, show that these Australopithecines were more frequently successful in slaying juvenile and aged representatives of these various mammalian families. But the profusion of the bone breccia shows that they were capable and successful in their hunting of very big game.

In 1925 the presence of *Australopithecus* was unsuspected because of the great size of these bones and their charred appearance—so the specimens of this Makapansgat Valley Limeworks bone breccia were submitted to two chemists (Drs. Moir and Fox) for analysis to discover whether the bones had been subjected to fire. From the great size of the beasts represented in the breccia, the intentional fracturing or splitting of the bones, and corroborative reports of the chemists relative to the presence of carbon, the deposit was claimed at that time as a primitive human kitchen midden. To-day it appears that all this 'human' activity at Makapansgat Limeworks site is the handiwork of man's australopithecine predecessors. No traces of stone implements have been found in the Makapansgat Limeworks strata nor have they been found at Taungs, Sterkfontein and Kromdraai. But we have found at Makapansgat a number of large ungulate humeri the epicondylar ridges of which were battered and broken and apparently as the result of deliberate use prior to their fossilization. Most of the bones are fresh and firm, and display clean clear lines of gross fracture before fossilization, but others crack and crumble easily. These exhibit so fine a state of macroscopic and microscopic cracking as to preclude explaining their pre-fossilization fragmentation by the crude impact of stone or bone. The most likely force to have been responsible for their crumbling and altered condition is heat. That fire was the splintering agent is corroborated by their discoloration, disintegration and the chemical reports of free carbon made more than twenty years ago, and by the vesicular character of the adjacent glassy collophanites and clays recently discovered in the breccia by Dr. V. L. Bosazza and the comparative analysis he has made of ashy deposit from the breccia with ash from local Transvaal wood.

RAYMOND A. DART

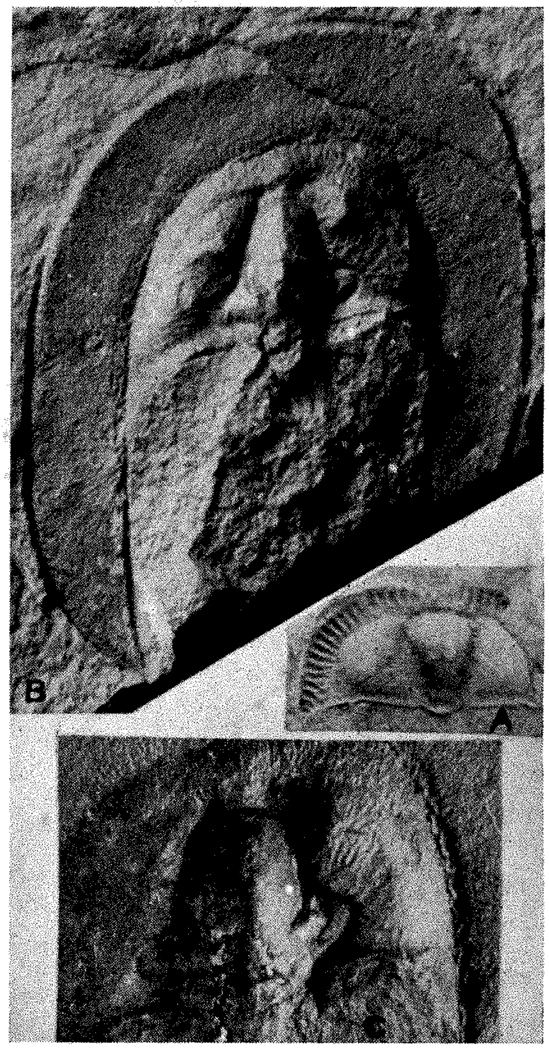
Medical School,
Hospital Street,
Johannesburg.
June 15.

Indications of Cephalic Sutures in Trinucleidæ and Harpedidæ

RUDOLF RUEDEMANN[1] in 1916 summarized the available evidence regarding traces of cephalic sutures in Trinucleidæ, Raphiophoridæ, Dionididæ, and Harpedidæ. The well-known marginal sutures in the first and last families he considered as secondary acquisitions. They are generally regarded as having facilitated ecdysis; but specimens are rarely found which have fractured along them. One might even draw a comparison between the marginal suture, which is nearer the dorsal than the marginal side of the brim, and the subcranial furrow of *Phacops* (*s.s.*). Ruedemann's reconstruction, especially of the anterior facial suture, from traces on internal moulds, is so interesting in the case of *Cryptolithus tesselatus* Green, in spite of P. E. Raymond's treatment[2] of the lateral eye-lines as genal cæca and not lateral parts of a facial suture, that for a number of years a look-out has been kept for corresponding evidence on the eastern side of the Atlantic.

In the case of *Cryptolithus* the search has not been rewarded; but in a number of internal moulds of *Trinucleus fimbriatus* Murchison, symmetrical breaks have been observed. For the most part only the remains of lateral (or posterior) facial sutures can be traced[3], but in a specimen recently obtained from Llan Fawr Quarry, near Llandrindod Wells, a semicircular anterior facial suture appears to be present and to run just outside the anterior pits and forward into the fringe so as to enclose a number of pits of the innermost concentric row. This is different from what happens in *C. tesselatus*, in which Ruedemann makes the anterior facial suture pass inside the anterior pits and not cross into the pitted part of the fringe.

It is important, as shown in Fig. *A*, that the posterior parts of the suture are continuous with the anterior suture in *T. fimbriatus*. In *C. tesselatus* the genal cæca (Raymond) or lateral sutures (Ruedemann) do not join the frontal facial suture. So far as traces of facial sutures count, *Cryptolithus* seems to be further from the Opisthoparian ancestor than *Trinucleus*, and it may be suggested that in species which ploughed through mud the tendency was for the anterior suture to migrate away from and not towards the periphery of the fringe or brim.



A. Trinucleus fimbriatus Murchison, Llan Fawr Quarry (*Nemagraptus gracilis* Zone), north of Llandrindod Wells, × 2. *B. Scotoharpes domina* gen. et. sp. nov., *Plectodonta* aff. *canastonensis* Siltstones, North Esk, Pentland Hills, × 3 (approx.). *C.* Part of the specimen shown in *B*, × 4

Good observations of posterior facial sutures have been made in *Scotoharpes domina* gen. et sp. nov., from fine Upper Gala silts of the Pentland Hills. On an external impression of the cephalon, a possible longitudinal suture was seen crossing the posterior border close to the glabella and running forward near the proximal side of an ala, where it was joined at right angles by a lateral suture bisecting the ala. This is even clearer on the internal mould (Fig. *B*, right side). Further examination suggests that the longitudinal suture cuts across the anterior extremity of the ala (Fig. *C*, right side). Perhaps its continuation is indicated by a scar which diverges outwards on the cheek towards the distal end of the genal cæcum. Possible traces of an anterior suture cannot be treated with certainty; but in Fig. *C* (left side) a fine ridge, indicating a furrow on the inside of the original cephalic shield, runs forward and then curves inwards towards the position of the first lateral furrow on the glabella. Attention may also be directed to the slight transverse angularity just in front of the glabella and even to the anterior furrow itself which separates inner and outer parts of the cheeks. Laterally this furrow is shallow, and on the left side where it approaches the distal end of the genal cæcum (Fig. *B*) a curvilinear raised ridge originates which runs back and then bends inward slightly to meet the posterior border. Can this conceivably mark the position of an early lateral or posterior suture at a stage when *Scotoharpes*, at least ancestrally, showed affinities with a genus like *Aulacopleura*? The possibility of such a relationship is supported by the recent work of Přibyl[4], in the general background of that by Stubblefield[5]. The definite suture close to the sides of the glabella suggests the condition in Olenidæ and Prœtidæ. *Prœtus loredensis* Delgado, in particular, has recently been compared with the Harpedidæ[6].

Ruedemann has suggested that the evolution of a genus like *Cryptolithus* has been marked by great lateral development of the cheeks. It is to this he attributes the length and parallelism of what he calls the "lateral facial sutures". While this may be true, one must also consider the likelihood of eyes migrating inwards and upwards on to the highest parts of the cheeks in a mud-dweller. Even if functional eyes were afterwards lost, the tendency for the migration towards the glabella appears to be supported by the course of the sutural traces in *Trinucleus fimbriatus*. Migration of eyes inward, possibly from the position of slight depressions behind the outer ends of the genal cæca in *Scotoharpes domina*, also may be arguable.

It is not easy to answer the question as to why traces of what may be facial sutures should remain on the inside of a cephalon of *Trinucleus fimbriatus*, unless they continued to serve as lines of easy splitting. In *Scotoharpes* the lateral and posterior sutures were evidently functional, and their presence on the alæ may mean that the latter had a sensory function during ecdysis and perhaps at other times.

ARCHIE LAMONT

Grant Institute of Geology,
King's Buildings,
Edinburgh 9.

[1] Ruedemann, R., Bull. New York State Mus., No. 189, 144 (1916).

[2] Raymond, P. E., *Mem. Conn. Acad.*, 7 (1920), see especially Fig. 25.

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[5] Stubblefield, C. J., *Biol. Rev.*, 11, 407 (1936).

[6] Thadeu, D., *Bol. Soc. Geol. Portugal*, 6, fasc. iii (1947).

Changes in the Incisor Teeth and Incisal Alveolar Bone of Rats in Hypervitaminosis A and Avitaminosis A

THE changes in bone in avitaminosis A have been reported by Mellanby[1], Wolbach and Bessey[2], and Wolbach[3], who consider that the vitamin is concerned with the control of bone modelling. Mellanby found excessive formation of bone in certain areas during avitaminosis and that the osteoblasts and osteoclasts could reverse their positions at the effective bony surfaces. Wolbach[3] considered that appositional bone formation continued in the normal site, but that concurrent resorption of bone ceased. Excessive doses of vitamin A have been found by many writers to cause spontaneous fractures of bones and internal hæmorrhages (see Moore and Wang[4] for a review of the literature). Wolbach[3] considered that bone remodelling was greatly accelerated and that a defective tissue was laid down.

The effects of vitamin A deficiency on the teeth are already well known[5]. A defective dentin is laid down by the odontoblasts, especially on the labial side. Pohto[5] and Wolbach[3] both reported that hypervitaminosis A has no effect upon the rat's incisor teeth.

Through the kindness of Dr. T. Moore and Mrs. S. E. Walker, of the Dunn Nutritional Laboratory, Cambridge, I obtained the heads of animals suffering from hypervitaminosis A. These were young rats and had been given 40,000 I.U. of vitamin A daily for 10–42 days. Their incisal alveolar bone and upper incisor teeth were examined microscopically. In the alveolus, the rate of bone formation was greatly reduced, many cementing lines were seen and active osteoblasts were much less prominent than usual. Osteoclasts appeared to be unaffected, so that the bone became abnormally thin and disappeared in places. In the teeth, only dentin formation was affected. This became decreased in appositional rate, the interfibrillar cementing substance was gradually reduced in amount, and the lingual odontoblasts had begun to atrophy.

The avitaminotic material studied was from rats previously investigated (Irving and Richards[5,6]). The animals had been on the vitamin-free diet used by us 28–53 days from weaning. The alveolar bones showed considerable over-production of new bone. This occurred in areas where apposition was usually seen and also in situations where resorption normally occurred. In the early stages of the deficiency, the osteoclasts endeavoured to overcome the latter abnormal apposition, while working alongside invading osteoblasts. Later they became displaced by osteoblasts and some osteoclasts were found on the opposite side of the bone. On faces where excessive apposition occurred in the usual site for apposition, osteoclasts were never found. The changes in the teeth in avitaminosis were the same as those reported by earlier workers.

It is concluded from these results that the primary action of vitamin A is upon the osteoblasts. Excessive dosage with vitamin A depresses the action of these cells, and, when the vitamin is lacking from the diet, these cells engage in disorderly overactivity. The reactions of the osteoclasts in avitaminosis are purely secondary, in an attempt to prevent excessive bone formation. In hypervitaminosis A these cells continue to act as usual. The odontoblasts, cells in the teeth comparable to the osteoblasts, react in a way similar to that of the bone-forming cells, producing less dentin in hypervitaminosis and excessive amounts in avitaminosis.

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J. T. IRVING

Department of Physiology and Pharmacology,
Medical School,
University of Cape Town.

April 27.

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Marine Fish Cultivation

IN their recent review in *Nature*[1] of the papers on an experiment in marine fish cultivation by my colleagues and me[2], Cooper and Steven express the view, "that encouragement of fish growth in arms of the open sea such as the North Sea or the English Channel by the addition of plant nutrients can never be a paying concern". This categorical statement, based on a previous paper by Cooper[3], seems to bar once and for all any large-scale application of fertilizers to suitable parts of the sea. Leaving a fuller discussion to a forthcoming paper on fertilizer application in an open sea-loch, may I point out here that Cooper's arguments and figures do not, in my opinion, bear out his conclusion. For an assessment of the economics of fertilizing the sea we require figures showing: (*a*) the return in crop and stock per ton of fertilizer added to land, (*b*) the return in fish and shell-fish per ton of fertilizer added to the sea. The latter figures unfortunately do not exist. If our experiments have shown anything, it is the desirability of keeping an open mind to a rational approach to the whole problem of increasing the amount of human food growing in the sea, and pursuing research step by step along various lines, not excluding the fertilizing of suitable larger areas. As regards the threatening scarcity of phosphate, should it become necessary to recover it from the sea it may prove possible to extract it from water taken from greater depths of unproductive areas where the concentration of phosphate is high and its availability to plants low.

F. GROSS

Department of Zoology,
University of Edinburgh.

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WE do not agree that the expression of a view is a "categorical statement" barring any door to further research. Be that as it may, we still consider that no evidence has yet been produced in support of the belief that encouragement of fish-growth by artificial fertilization of arms of the open sea, such as the English Channel or North Sea, can be made a paying concern. On the other hand, there is no little evidence in support of the opposite view. Perhaps the most convincing is the failure of Dr. Gross and his colleagues to demonstrate that marine fish cultivation could be made to pay even in a very tiny and almost completely enclosed body of water.

A large-scale fertilization of the sea is continuously in progress, for our method in the most advanced countries of disposing of the sewage of coastal towns achieves just this. The discharge from Plymouth, which must be considerable, affects the nutrient content of Plymouth Sound but is soon dissipated in the open sea beyond the breakwater. Its effect on the English Channel has rarely been notable. The problem would be most easily studied in an area already nutrient-poor, such as the Mediterranean and its adjacent seas. Such studies by Bernard[1] off Monaco and off Banyuls near the Franco-Spanish frontier, and by Ercegović[2] and Nümann[3] in the shallow northern Adriatic, do not seem to have found any appreciable enrichment by sewage. A quantitative assessment of the effect of sewage from large coastal cities discharging into seas of low natural nutrient resources should provide the readiest means of testing Ritchie's thesis which Gross again propounds.

Though there is a continuing exchange of the waters of the English Channel or the North Sea with the Atlantic Ocean, it is not easy to place a measure on it; it would seem to be large. The work of Proudman[4] suggests that the Irish Sea empties itself through the North Channel and is replaced through the St. George's Channel in a very few years, perhaps no more than two. The phosphate to be added to such arms of the sea, to do any good, would need to be measured in thousands of tons per annum. That part not quickly harvested as fish would vanish into the ocean in a year or two. Though it seems true that four-fifths of the phosphate added to arable land becomes tightly bound in the soil complex, some of it is still available to plants such as lupins which can get it out again; and given time enough, may not a saturation value be reached beyond which phosphate added to the soil remains freely available to plants? Be the answer to this what it may, there is a difference between immobilizing riches in a safe deposit and broadcasting them throughout the five oceans.

As to the last sentence of Dr. Gross's letter, it is always dangerous to try to foretell scientific development. Though the phosphate and nitrate resources of the deep ocean are enormous, the concentration rarely exceeds 90 μgm./l. of phosphate-phosphorus, or $0{\cdot}000003\ M$. In the near future, no engine devised by man is likely to harness this reserve better than the vast oceanic circulation and upwelling impelled by winds on a global scale, followed by production of plants and animals. Fisheries in the most favoured regions provide the best means yet known or foreseen of exploiting this natural asset. Our heritage of bird guano and rock phosphate, upon which we are so dependent, represents the final stages of this process of enrichment of surface ocean water by upwelling of deep water. This heritage is being replaced more slowly than it is being spent; we ought not to hasten the wastage.

We do not wish to bar any development once and for all. Economic justification of marine research can come only from the application of our increasing knowledge to problems of production from the sea. None the less, fervid advocacy of a very costly programme, followed by practical failure, could only bring the science of the sea into ill repute. Surely the right approach is through small-scale experiments to larger ones, establishing firm experience as we go. The Loch Craiglin experiment on these lines was thoroughly sound and worthy of critical appreciation. This we attempted in our review.

L. H. N. COOPER
G. A. STEVEN

The Laboratory,
Citadel Hill,
Plymouth.

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ARCTIC AEROBIOLOGY, II

PRELIMINARY REPORT ON FUNGI AND BACTERIA ISOLATED FROM THE AIR IN 1947

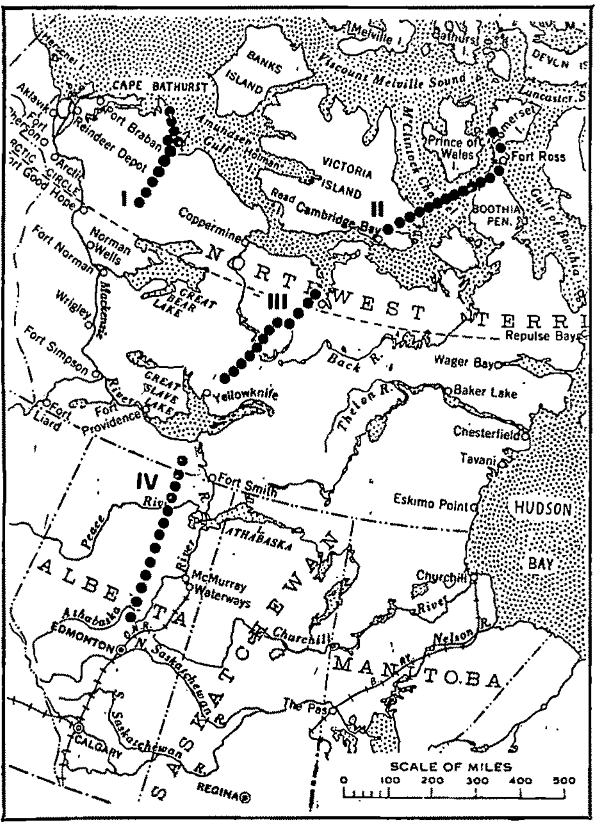
By Dr. S. M. PADY
Department of Botany

Dr. C. D. KELLY
Department of Bacteriology

AND

Prof. NICHOLAS POLUNIN
Department of Botany
McGill University, Montreal

ALTHOUGH many studies have been made of the microflora of the air over temperate regions, little such work has been done in the Arctic. Meier and Lindbergh[1] made some preliminary studies by exposing petrolatum-coated slides at various points during Lindbergh's northern flight in 1933, six of these exposures being north of the Arctic Circle over Greenland. Owing to the death of Dr. Meier, only a brief report was published[2]. The following account presents the results of a series of exposures of nutrient plates in arctic and subarctic Canada in 1947, and also preliminary studies of the subcultures of bacteria and fungi obtained from these plates. The exposures were made by Prof. Polunin with the facilities provided by the Royal Canadian Air Force, of which a general account has recently been published[3]. 'Vaselined' slides were exposed at the same time for rust spores, pollen grains, etc., and the results of this examination will be published separately.



The medium employed was designed to allow minimal growth, since it was expected that a considerable time would elapse between exposure and arrival at the laboratory. Czapek's solution agar was accordingly modified by omitting the sucrose and adding yeast extract. On June 23 the first set of plates (standard 10 cm. Petri dishes) was prepared, using 0·4 per cent yeast extract; these plates were exposed on August 12. As it was found that micro-organisms made good growth on this medium, it was deemed advisable to modify further the formula; accordingly the yeast extract was reduced to 0·1 per cent, and the agar content increased to 2·5 per cent. This second lot of medium was prepared on July 14 and was used in the remaining flights. In both cases the poured plates were left for one week at room temperatures and any that showed contamination were discarded. Details of the wrapping of the plates and the technique of exposure have already been described[3].

Following exposure, each plate was carefully rewrapped and packed, the complete stock of exposed and unexposed plates being kept together until the work was completed in early September. When the plates were returned to the laboratory on September 12 and 13 they were in excellent condition, all showing numerous small colonies of micro-organisms. Seven unexposed plates were carried throughout, and these were sterile when returned to the laboratory and remained so even after one month at room temperature.

The relatively slow air-speeds (see Table 1) made exposure by hand feasible, and the plates were held at a minimum of 20 cm. from the fuselage. Flight 1 was made in a Norseman aircraft which has a single propellor situated in front of the nose, so that these plates (1 to 11) may have been affected by the turbulence caused by the propellor. Flights II to IV were made in a twin-engined Canso flying boat in which the propellors are behind the co-pilot's seat from which the exposures were made; this permitted an unobstructed air stream to strike the plates (12 to 52).

The attempt was made to obtain exposures every 20 or 30 miles in a series of flights that would extend from temperate regions as far north as possible. Of the four flights (see accompanying map), one was near the extreme north-west of Canada and reached as far as the Arctic Ocean, while the remainder extended from Somerset Island to Edmonton, Alberta.

No attempt was made to obtain cultures from all of the colonies in any one plate, only those in which the colonies were well isolated and uncontaminated being used. Despite this precaution, many of the cultures proved to be contaminated, due possibly to several micro-organisms being present on a dust particle. In some cases, examination with a dissecting microscope revealed numerous microscopic bacterial colonies within the mycelium, and these colonies were readily transferred along with portions of the fungous hyphæ. It was believed that these tiny bacterial colonies (which were not included in the counts) either found the medium to be unfavourable or were inhibited by the fungi. Similarly, minute fungous colonies were also noted, although much less frequently: two such colonies when transferred to corn meal agar failed to grow.

The numbers of colonies of bacteria and fungi are given in Table 1 along with relevant data. It is evident that bacteria greatly outnumber fungi in most of the fifty-one plates exposed.

Table 1. Results of two-minute exposures of nutrient plates

Plate No.	Hour	Airspeed m.p.h.	Lat. N.	Long. W.	Alt. (ft.)	No. of colonies			
						Bacterial		Fungal	
						Per plate	Per cu. ft.[1]	Per plate	Per cu. ft.[1]
Flight I, from Canso Lake to Cape Bathurst (Plates 1–11), August 12.									
1 *B*	18·24	90	67° 38′	127° 8′	3200	60	0·059	8	0·0079
2 *B*	18·34	105	67° 58′	126° 52′	5100	23	0·019	7	0·0059
3 *B*	18·44	110	68° 12′	126° 28′	5100	46	0·02	7	0·0057
4 *B*	18·54	112	68° 32′	126° 05′	5100	38	0·026	4*	0·0027
5 *B*	19·04	115	68° 54′	126° 02′	5100	16	0·0093	2*	0·0012
6 *B*	19·14	110	69° 06′	125° 43′	5150	32	0·026	0	—
7 *B*	19·24	110	69° 24′	125° 30′	5350	32	0·026	1	0·0008
8 *B*	20·26	90	Circling over pt.		4000	24	0·024	4	0·0039
9 *B*	20·35	100	69° 28′	125° 48′	5100	33	0·029	11	0·0098
10 *B*	20·45	110	69° 51′	126° 34′	5100	19	0·015	4	0·0032
11 *B*	20·55	115	70° 02′	126° 54′	1500	14	0·008	15	0·0087
Flight II, from Cambridge Bay to Somerset Island (Plates 13–27), August 26.									
13 *B*	5·17	113	69° 32′	103° 33′	3500	530	0·454	12	0·01
14 *B*	5·27	109	69° 45′	102° 55′	3000	400	0·324	14	0·011
15 *B*	5·37	115	69° 57′	102° 15′	4200	290	0·224	9	0·0069
16 *B*	5·47	115	70° 09′	101° 32′	4300	180	0·139	8	0·0064
17 *B*	5·57	116	70° 20′	100° 55′	4400	95	0·07	7	0·0051
18 *B*	6·07	115	70° 33′	100° 06′	4200	38	0·029	5	0·0039
19 *B*	6·17	115	70° 44′	99° 20′	4000	60	0·046	6	0·0047
20 *B*	6·27	116	70° 57′	98° 30′	4050	43	0·033	8	0·006
21 *B*	6·37	116	71° 08′	97° 40′	4200	45	0·034	3	0·0023
22 *B*	6·47	116	71° 20′	96° 50′	4100	95	0·075	6	0·0046
23 *B*	6·57	116	71° 31′	96° 00′	4100	112	0·083	6	0·0046
24 *B*	7·07	117	71° 43′	95° 10′	4000	74	0·056	8	0·0061
25 *B*	7·17	121	71° 54′	94° 05′	4000	89	0·064	102**	0·074
26 *B*	7·42	119	72° 34′	94° 25′	5000	47	0·044	3	0·0023
27 *B*	8·01	117	72° 38′	94° 28′	4500	79	0·08	12	0·009
Flight III, from Cambridge Bay to Yellowknife (Plates 28–39), August 27.									
28 *B*	9·38	109	66° 45′	108° 20′	4600	328	0·265	24	0·02
29 *B*	9·53	104	66° 27′	108° 47′	5500	185	0·158	10	0·0086
30 *B*	10·08	117	66° 05′	109° 18′	7300	124	0·092	15	0·013
31 *B*	10·23	109	65° 45′	109° 47′	6300	78	0·063	8	0·0065
32 *B*	10·38	109	65° 25′	110° 14′	6400	54	0·048	6	0·0049
33 *B*	10·53	115	65° 06′	110° 40′	6000	92	0·071	5	0·0039
34 *B*	11·08	115	64° 44′	111° 10′	5900	59	0·046	2	0·0015
35 *B*	11·23	115	64° 24′	111° 35′	5600	33	0·039	1	0·0008
36 *B*	11·38	115	64° 04′	111° 58′	5500	67	0·052	7	0·0054
37 *B*	11·53	115	63° 45′	112° 27′	5100	61	0·047	5	0·0039
38 *B*	12·08	115	63° 27′	112° 57′	5000	46	0·036	4	0·0031
39 *B*	12·23	117	63° 06′	113° 27′	4600	81	0·063	2	0·0015
Flight IV, from Yellowknife to Edmonton (Plates 40–52), September 5.									
40 *B*	8·38	115	60° 11′	114° 00′	5000	196	0·151	19	0·015
41 *B*	8·53	115	59° 46′	113° 58′	5000	71	0·055	33	0·025
42 *B*	9·08	115	59° 20′	113° 58′	5000	75	0·058	6	0·0046
43 *B*	9·23	115	58° 54′	113° 57′	5000	41	0·032	3	0·0023
44 *B*	9·38	117	58° 28′	113° 56′	5000	40	0·031	7	0·0054
45 B	9·53	117	58° 02′	113° 55′	5000	49	0·038	11	0·0085
46 *B*	10·09	119	57° 35′	113° 54′	5000	37	0·028	18	0·014
47 *B*	10·23	119	57° 11′	113° 53′	5000	21	0·016	11	0·0083
48 *B*	10·38	119	56° 46′	113° 52′	5000	80	0·06	32	0·024
49 *B*	10·53	119	56° 18′	113° 51′	5000	105	0·075	67	0·05
50 *B*	11·08	119	55° 52′	113° 50′	5000	147	0·11	79	0·052
51 *B*	11·23	119	55° 26′	113° 49′	5000	62	0·046	111	0·083
52 *B*	11·38	120	55° 00′	113° 48′	5000	476	0·35	306	0·23

* One contaminant observed immediately following exposure.

** Mostly secondary colonies from large central one of sporulating *Penicillium*.

[1] Figures computed from time of exposure, speed of aircraft, and area of plate: it should be emphasized that they represent comparative rather than precise quantitative values.

Table 2 summarizes the subcultures that were made from representative bacterial colonies, in forty-five of the fifty-one plates. Transfers were not made from the other six plates because of bacterial spreaders, or because the colonies were covered with mould. All the subcultures were made on to nutrient agar slopes.

Wolf[4], in studies of the air over Nashville, Tenn., and Proctor and Parker[5] over Boston, found spore-forming bacteria comprising a high percentage of their colonies (37·7 and 52·2 per cent, respectively) and a low percentage of Gram-positive non-spore-forming rods. In the present investigation about 5·0 per cent were spore-formers and about 41 per cent were Gram-positive non-spore-forming rods. On the other hand, the percentages of *Micrococcus* and *Sarcina* were very close to those found by Wolf[4].

Table 2. Summary of preliminary study of bacterial cultures

Micrococcus	43
Sarcina	5
Achromobacter (probably)	8
Achromobacter or *Flavobacterium*	24
Gram-positive rods (unclassified)	20
Gram-positive rods morphologically like *Corynebacterium*	46
Spore-formers	8
No growth on transfer	21
Mixed cultures	13
Total	188

Table 3. Summary of preliminary identification of fungous cultures

Fungi Imperfecti	*Hormodendrum*	33
	Other Moniliales	20
	Phyllosticta	1
	Pestallozia	1
Ascomycetes	Yeasts	16
	Penicillium	15
	Leptosphæria	9
	Chætomium	1
Actinomycetales	*Streptomyces*	22
Other cultures	Non-sporulating	74
	Sclerotia-producing	2
	No growth on transfer	9
	Contaminated	4
	Total	207

Table 3 is a summary resulting from an examination of the fungi. Subcultures were made on corn meal agar. The lack of sporulation in many of the cultures is probably due to the presence of bacterial contaminants, and possibly to an unfavourable medium.

These cultures will be purified and grown on various media in order to induce sporulation, and a detailed report including identifications will be published later. The almost universal prevalence of *Homodendrum* in the air as indicated by many workers, including Wolf[4], Proctor and Parker[5], Meier and Lindbergh[1], is confirmed by its occurrence in 33 of the 207 cultures (15 per cent). Conspicuously absent among the sporulating cultures were *Aspergillus*, *Fusarium* and Phycomycetes.

On the basis of the colonies which developed in our plates, it would appear that bacterial cells greatly outnumber fungus spores in the arctic air. There appears to be no correlation between the number of colonies and geographical position, at least within the arctic and subarctic regions. However, in the region of Edmonton an increase of both bacterial and fungous floras was found which may possibly be related to areas of cultivation.

No explanation can be given for the high numbers of bacterial colonies encountered in the vicinity of Cambridge Bay on two successive days. The highest count was found on August 26 on plate 13 exposed some 50 miles north-east of Cambridge Bay, and high numbers were also found in plates 14, 15, 16 exposed still farther north. High counts were again obtained the following day on plates 28 to 30, plate 28 being exposed some 170 miles south-west of Cambridge Bay.

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FORMATION OF HYDROGEN PEROXIDE IN WATER IRRADIATED WITH X- AND ALPHA-RAYS

By Dr. P. BONET-MAURY and M. LEFORT
Laboratoire Curie, Institut du Radium, Paris

IN spite of numerous studies, the primary action of ionizing radiations on water is not yet fully known. Knowledge of this action is important in relation to the radio-chemistry of dilute aqueous solutions and is required for the better understanding of the mechanism of the biological effect of these radiations, since water comprises about 80 per cent of living organisms. As the formation of hydrogen peroxide is regularly demonstrable in irradiated water[1], a systematic investigation of this phenomenon has been undertaken for radiations of very different ionic density, namely, 0·9 A. X-rays and polonium or radon α-rays.

Methods. The irradiation with X-rays and the titration of hydrogen peroxide were carried out by the methods already described[2]. In order to study the effect of dissolved oxygen, gases were eliminated from the water *in vacuo* by alternate evacuation and saturation with oxygen-free argon or nitrogen. Dissolved oxygen was titrated by a special method which permitted the assay of a 30-c.c. water sample, and the estimation of 0·2 mgm. of oxygen with an accuracy of 5 per cent. A control sample was assayed in an identical manner. Dissolved radon[3] or polonium was used as a source of α-radiation. Polonium was only employed under conditions which were such that the catalytic effect of this substance[4] on the decomposition of hydrogen peroxide was negligible.

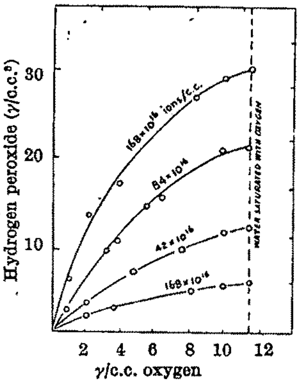

Fig. 1. Influence of dissolved oxygen. Doses of radiation: 168, 84, 42 and 16·8 × 10^{16} respectively

Effect of Dissolved Oxygen. (*a*) *X-rays.* For a given dose of radiation, the amount of hydrogen peroxide produced depends markedly upon the concentration of dissolved oxygen (Fig. 1). In water carefully freed from gas, it is no longer possible to detect any hydrogen peroxide, even after exposure to doses as high as $1{\cdot}7 \times 10^{18}$ pairs of ions/c.c., or more than 2,000,000 r. (surface dose).

(*b*) *α-rays.* The ionic yield, in the case of X-rays, suggests that the radon β-rays probably account for less than 5 per cent of the total effect of the α+β-radiation. We have verified this fact directly, using only the action of the β-radiation, α-rays being stopped by a vial of thin glass containing the radon and directly immersed in the titanium reagent. When water was exposed to the α-radiation from dissolved radon and its disintegration products, the following results were obtained. In water completely freed from gas and therefore containing no oxygen which could take part in the reaction, the ionic yield of hydrogen peroxide was found to be the same as in oxygen-saturated water. The same result was obtained when polonium α-radiation was used; but the experiments in this case were complicated by the catalytic effect of the radio-element, which tended to decompose the hydrogen peroxide produced. When initial radon concentrations of 1–3 mc./c.c. were used, the ionic yield was independent of the dose within the whole interval tested (Fig. 2). (The ionic yield is,

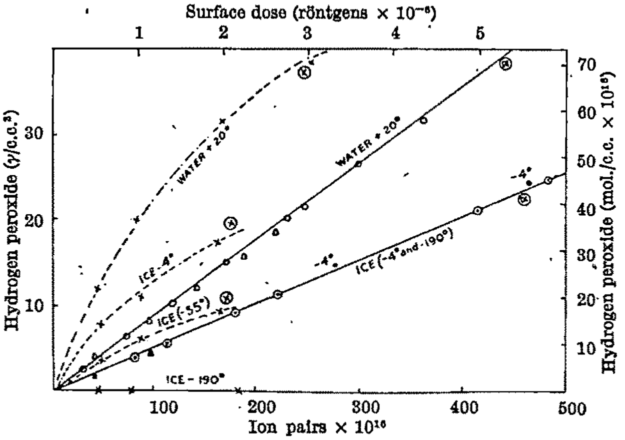

Fig. 2. The curves refer to water (+ 20°), ice (− 4°), water (+20°), ice (− 55°), ice (− 4° and − 190°) and ice (−190°)

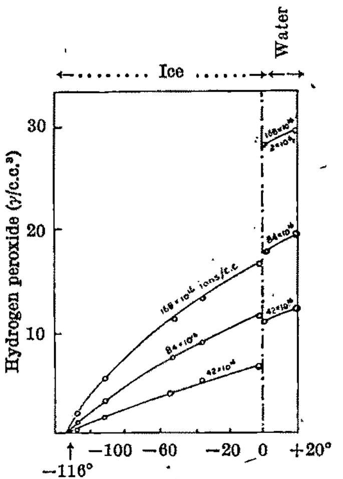

Fig. 3. Influence of temperature. The doses of radiation (reading from the top) are 1/68, 84 and 42 × 10^{16} ions/c.c. for ice; and similarly for water

of course, generally defined as the ratio of the number of molecules decomposed to that of ion pairs produced; this definition is not applicable to hydrogen peroxide formation, because the number of water molecules decomposed is not directly known.)

Temperature Effect. (*a*) *X-rays.* In oxygen-saturated water, the production of hydrogen peroxide decreases regularly with the temperature, a definite discontinuity marking the passage from water to ice (Fig. 3). Below −116°, it is no longer possible to detect any hydrogen peroxide, even when the dose is 2 × 10^6 r. (Fig. 3).

(*b*) *α-rays*. The temperature seems to be without influence on the production of hydrogen peroxide in water and ice by the α-radiation from dissolved radon. At the transition point from water to ice, a discontinuity similar to that of X-rays was observed (Fig. 1). Polonium α-rays give similar qualitative results, the catalytic effect of the radio-element being considerably decreased as the temperature is lowered.

Discussion. The experimental results show that hydrogen peroxide is formed according to different mechanisms for X- or α-rays, and that the linear ion density of the radiation affects the primary reactions concerned with the decomposition of the water.

These data are perfectly concordant with the hypothesis suggested by some British workers[5] for the interpretation of the differences between the radiobiological effects of X-rays and α-rays. According to those conceptions, the principal result of the ionization of water is the production along the track of the ionizing particle of hydrogen atoms and hydroxyl radicals (Weiss), the spatial distribution of which corresponds with that of primary ion pairs (Lea and Gray).

For X-rays, the distribution is such that the hydrogen atoms remain near the hydroxyl groups, and, in the absence of oxygen, their recombination to give water is the most likely reaction. When dissolved oxygen is present, the reaction

$$2H + O_2 = H_2O_2 \qquad (1)$$

becomes possible and produces hydrogen peroxide in amounts which increase with the oxygen concentration and the temperature.

Along the trajectory of an α-particle, the hydroxyl groups remain concentrated in the centre of the ionization column and are at first isolated from the hydrogen atoms which form a surrounding sheath. The reaction

$$OH + OH = H_2O_2 \qquad (2)$$

is the most likely, and it produces hydrogen peroxide even in the absence of dissolved oxygen; the reaction seems to be independent of the temperature. The constant ionic yield for α-rays indicates that, when oxygen is present, the amount of hydrogen peroxide produced according to reaction (1) is negligible compared with that produced according to reaction (2).

From these results, it appears that hydrogen peroxide plays an important part in the mechanism of the biological effect of radiations, since its formation seems to be one of the radiochemical primary reactions produced in aqueous media exposed to ionizing radiations.

The remarkable constancy of the ionic yield with α-rays shows that the photocolorimetric method is particularly convenient for the radiochemical dosage of dense ionizing radiations such as recoil protons or neutrons.

[1] Bonet-Maury, P., *C.R. Soc. Biol.*, **135**, 941 (1941). Latarjet, R., *C.R. Acad. Sci., Paris* (1942).

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NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY

THE annual conference of the National Institute of Industrial Psychology was held in Buxton during April 9–12, and a report has now been issued ("Psychology at Work", 1, No. 3; July 1948). Welcoming the delegates to the Conference, the chairman of the Institute, General Sir Ronald Forbes Adam, stated that everywhere in industry management is facing the fact that output must be raised if Britain is to retain its standard of life; but the re-equipping of industry is going to take a long time and some means must be found of achieving the goal more quickly. It has now been generally realized that this increase in output can be achieved if greater attention is paid to human relationships; but there has been too little research into this problem. The aim of the Conference was to discuss some of the fundamental issues of human relationships, and its purpose can be summed up in three questions: (1) How much knowledge on the subject exists? (2) Is the knowledge readily available and is it being utilized? (3) What research can be undertaken?

The first session of the Conference was grouped under the heading "The Man and the Job" and, in the first address, Mr. Robert Watson, chief personnel officer to the Philips group of electrical companies, discussed the selection and allocation of workers. In a recent attempt to check selection and placement practices in industry, Mr. Watson and his colleagues sent out a questionnaire to about two hundred firms in many industries. Replies were obtained from sixty-three firms, including a high proportion of the acknowledged better employers, employing altogether about 300,000 persons. Of the sixty-three firms, four employed full-time psychologists; fifty-two did not give special training to employment interviewers and fifty-three companies did not use job specifications. Forty-eight companies did not give dexterity tests to hourly-paid operators, and fifty-three companies did not give intelligence tests to hourly-paid operators. From this and other data supplied by Mr. Watson it seems reasonably certain that few companies are taking advantage of the latest psychological developments in the use of selection methods. If companies could be persuaded to make use of modern employment practices it would do much to reduce the heavy burden of labour turn-over costs which help to inflate the price of the finished article. While it is not easy to obtain the costs of labour turn-over in any one industry, figures obtained from a firm employing 4,500 females and 3,380 males on mass production work showed that there is a labour turn-over in 1947 of 56 per cent of the total female hourly-paid workers and 38 per cent of the male workers; of those who left the firm during the year, 67 per cent of the women and 72 per cent of the men were in their first year of service.

In a paper on training and working methods, Colonel B. Ungerson, chief psychologist, Directorate of Manpower Planning at the War Office, described the methods which give best results in providing training for unskilled and semi-skilled jobs. Instead of the existing method of placing a newcomer with an experienced operator and telling him to get on with the job, Colonel Ungerson suggested that the efficiency of a department would be considerably improved if newcomers were given definite training under competent instructors. This training should include the presentation of knowledge which would include the most suitable tools for the job, when they were satisfactory for use, what raw materials were used for which jobs and so on. This should be supplemented by as many practical aids as possible, including diagrams, models (or the real thing if possible) and a museum of faults; these should apply both to raw materials and finished products. The problem of developing skill is to ensure a repetition of good movements until they become habitual; this should be based upon movement study and is not necessarily complex. Colonel Ungerson then gave some examples of how skill could be developed in various unskilled and semi-skilled jobs.

Following the papers by Mr. Watson and Colonel Ungerson, the Conference divided into eight discussion groups which reported their findings to the Conference at the end of the first day. Summing up the findings of the groups, the chairman, Lord Piercy, said that we are faced with the problem of more production with a given labour force. We can only cut our costs by three means: education, application of what is known, and research. In the field of the education of management we are not yet getting the full benefit out of good practice and, although there will be 'sales resistance' all the way down the management chain, we must get the practice of good firms accepted by others. In the application of particular items of information he was impressed by the stress which has been laid on training as opposed to selection. Training undoubtedly is the key to prompt results, but the individual as a whole should be considered, and here selection is important. On the subject of research it is necessary to pool all our ideas. The problem of the use of individuals of low mentality might profitably be pursued further, and it is pleasing to report that over the last year the Government has come to realize the importance of this work; Panel 3 of the Committee on Industrial Productivity was specially charged with the consideration of the human factors affecting production.

The second session was grouped under the general heading, "The Firm as a Working Unit". Mr. Graham Satow, director of training, Stewarts and Lloyds, Ltd., in a paper on the supervisory grades, traced the development of a changed outlook among workpeople and into this background fitted the position of the foreman and his problems. The same difficulties seem to be encountered on both sides of the Atlantic, and he suggested that the two aims should be to strengthen the foreman's status in the firm and to develop a changed pattern of leadership in the supervisory grades. Mr. Satow then made many practical suggestions as to the methods in which these aims could be realized.

Probably the highlight of the Conference, however, was the paper by Mr. W. L. Mather, director of Mather and Platt, Ltd., on communication within the firm. Borrowing from his experience at the Army Staff College, Mr. Mather gave a practical demonstration of the way in which two-way communication could take place within the firm. Two boards were placed in front of the audience, one of which was marked "Management" and the other "Workers". Between these two there was a gap which, he said, represented the gap between management and workers about which so much was being talked at the present time. The problem is to bridge the gap. Very useful bridges across the gap are provided by personnel departments, works committees, joint production consultative and advisory committees, general committees, training, notice boards, broadsheets, magazines, suggestions schemes, lectures and verbal instructions. These bridges can easily be broken, however, and with a compelling dramatic presentation in which he was helped by a typical British workman, Mr. Mather showed how the only real way of providing communication in any firm is by personal contact.

After further discussion, the second session was summed up by Sir Godfrey Ince, permanent secretary to the Ministry of Labour and National Service, who stated that he was glad that the Conference emphasized the problem caused by the changed outlook of the worker. To find the right relationships between the man and the job involves using the right methods of selection, training and allocation, and use can be made of the Ministry of Labour's experience both with the Juvenile Employment Service and in providing supervisory training through the Training within Industry Scheme.

The final address to the Conference was given by Mr. Austin Albu, deputy director, British Institute of Management, who said that it is the variation between firms which has to be considered when approaching our industrial problems. Some British firms have employed methods which equal those of any other country, and the need is to bring all firms as near as possible to this standard. This can be done, first, by selling ideas to management; secondly, by breaking down the resistance of trade unions and abolishing restrictive practices generally; and thirdly, by training first-line supervisors. The Conference has profitably discussed ways in which these things can be done, and it is hoped that the British Institute of Management will soon be able to be of direct service to industry. T. H. HAWKINS

FORTHCOMING EVENT

Thursday, September 9

University of Manchester (in the Physical Laboratories, Manchester).—Discussion on "Meteors" (to be opened by Dr. F. L. Whipple).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (temporary), and a Demonstrator, in the Department of Botany—The Registrar, The University, Leeds 2 (September 10).

Demonstrator in Chemistry and Biochemistry with a special interest in Physical Chemistry—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (September 11).

Assistant Lecturers (3) in the Department of Civil Engineering, to assist in the subjects of Theory of Structures and Fluid Mechanics—The Professor of Civil Engineering, City and Guilds College, South Kensington, London, S.W.7 (September 13).

Lecturer (woman) in Geography, and an Assistant Librarian (man or woman)—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (September 14).

Technical Assistant (man or woman, Grade B) for experimental research work in the Zoology Department—The Registrar, University College of North Wales, Bangor (September 15).

Lecturer in Experimental Pharmacology—The Secretary, The University, Aberdeen (September 15).

Lecturer in Botany at Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 15).

Research Officers (4), Assistant Research Officers (5), and Research Assistants (3), in the Board of Trade—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 2267 (September 16).

Research Assistant (with Honours Degree in Botany and, if possible, some practical experience in Horticulture) to work on Strawberry Breeding—The Secretary, School of Agriculture, Cambridge (September 25).

Assistant Lecturers (2) in Anatomy—The Secretary, University College, Gower Street, London, W.C.1 (September 25).

Deputy Curator at the Horniman Museum, London Road, London, S.E.23—The Education Officer (Estab/2), County Hall, Westminster Bridge, London, S.E.1 (September 30).

Controller of Telecommunications, Civil Aviation Branch, Air Department, Wellington—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 30).

Lecturer in Electrical Engineering at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (October 1).

Technician to take charge of Medical Unit Laboratory—The Secretary, St. Mary's Hospital Medical School, Praed Street, London W.2 (October 1).

Lecturer in General Bacteriology, and a Research Assistant and Demonstrator (temporary) in Botany—The Registrar, University College of South Wales, Cathays Park, Cardiff (October 2).

Chair of Experimental Physics, and an Assistant Professor of Experimental Physics, in the University of Geneva—Le Conseiller d'Etat charge du Departement de l'Instruction Publique, 6 rue de l'Hotel-de-Ville, Geneva, Switzerland (October 15).

Readership in Physiology at St. Bartholomew's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 18).

Studentships (4) at a British (or, exceptionally, foreign) research institute in preparation for Fisheries Research in the Colonial Empire—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (October 31).

Senior Lecturer or Lecturer in Chemistry at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (November 1).

Readership in Physics (in the field of Metal Physics) at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 4).

Lecturers in Physics, a Lecturer in the Department of Mathematics, and a Senior Assistant in the School of Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Inspector of Mines (to act also as Inspector of Quarries and Explosives and Technical Adviser to the Mining Board) in the Department of Lands, Mines and Surveys, Fiji—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Botanists (to undertake the improvement of economic plants by selection and breeding, and to investigate and control plant disease) in Nigeria—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Senior Technicians (2) in the National Blood Transfusion Laboratory, Cardiff—The Regional Blood Transfusion Officer, 19 Newport Road, Cardiff.

Senior Laboratory Steward (Chemistry and Biology)—The Bursar, Merchant Taylor's School, Sandy Lodge, Northwood, Middx.

Laboratory Assistant—The Headmistress, Godolphin and Latymer School, Hammersmith, London, W.6.

Laboratory Assistant in the Chemical Laboratories—The Principal, County Technical College, Stoke Park, Guildford.

Laboratory Technician—The House Governor, Skin Hospital, John Bright Street, Birmingham 1.

Lecturer in Chemistry to Intermediate B.Sc. stage—The Principal, Medway Technical College, Gardiner Street, Gillingham, Kent.

Lecturer in the Natural Philosophy Department—The Secretary, Royal Technical College, Glasgow.

Assistant Lecturer in Agriculture, and a Demonstrator in Chemistry—The Registrar, The University, Nottingham.

Principal Medical Officer/Research (bacteriologist with good experience of original research), a Principal Scientific Officer (bacteriologist with good experience of original research), a Principal Scientific Officer (biochemist with first- or second-class honours degree and good experience in original research), and Medical Officers/Research (bacteriologists or experimental pathologists with experience of original research), in the Microbiological Research Department of the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2274.

Biochemist to undertake establishment and direction of biochemistry research and development laboratory in Serum Institute, Naples—The Secretary, Wright-Fleming Institute of Microbiology, St. Mary's Hospital, Paddington, London, W.2.

Engineer specializing in drilling and blasting operations (Ref. TT.76), an Engineer specializing in shaft sinking and tunnelling operations (Ref. TT.77), and an Engineer specializing in mechanical stowage (Ref. TT.78), in the Production Department in London—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting the relevant Ref. No.

Agricultural Chemist in the Agricultural Department of the Government of Kenya—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Senior Meteorological Officer for the Government of Falkland Islands Dependencies Survey for service in the Antarctic—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21628/3E.

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BALANCE BETWEEN THE PURSUIT AND APPLICATION OF SCIENCE

IN title, and, to some extent, in content, Sir Henry Tizard's presidential address to the British Association (see p. 392) recalls that of General Smuts to the centenary meeting in London, though in form the outlook of the present chief scientific adviser of the Government resembles rather that of the engineer, as it was put by Sir Alfred Ewing. All three addresses glance at that Victorian era, the ideas and beliefs of which must have been made more familiar to many of Sir Henry's audience by the series of talks broadcast in the B.B.C. 'third programme' this spring. Already, however, the scientific world picture which General Smuts outlined has changed considerably, as indeed he indicated it would do ; and although Sir Henry Tizard did not pursue the philosophical theme of the centenary address to the British Association, it is clear that one or two of its points were in his own mind.

Science now, as he pointed out, stands higher in the public esteem than it has ever done in Britain. The public controversy between science and religion has died down, and the recent report of the Lambeth Conference provides evidence of a changed attitude and outlook on the part of the churches assembled there that would have seemed startling indeed to the Victorians, even to those with scientific interests who gathered in Brighton for the meeting of the British Association in 1872. Indeed, the frankness, clarity and logic of that report may well astonish many men of science who have not yet realized how truly science and religion stand on the same side in the defence of freedom and the moral, spiritual and cultural values of civilization.

At these values Sir Henry, however, gave no more than a passing glance. Instead, we have been given a world picture in which the central and dominating figure is man and his activities. The world, he suggests, is passing from one state of unstable equilibrium to another, and will be unstable for many years to come. We can at least strive to balance it so that the chance of a major catastrophe is made as small as possible, and Sir Henry holds that science has much to contribute towards this aim. We should ask ourselves whether we are not claiming too much for science in some directions, and doing too little in others ; and, in words that recall those of General Smuts and also those of Sir Alfred Ewing, he suggests that we should consider in fact whether the great forces of science, on the proper exercise of which all social progress depends, are in balance.

The balance to which Sir Henry addresses himself more particularly is not that between ethical and material values, between science, art and religion, but between the pursuit and the application of science. To read his presidential address is to realize the extent to which his master mind is influencing the work of the Advisory Council on Scientific Policy as revealed in its first annual report. Some of his remarks may fail to reach all the industrialists or professors or directors of research for whom they are plainly intended ; but Sir Henry's position justifies the confidence that he will not fail to make those views known in any quarter that may be desired.

This part of the address is essentially a sermon on economic recovery. Sir Henry suggests that one of the lessons of the last two generations is that the decline in the prosperity of some branches of industry is due to their tendency to go on doing what manufacturers know they can do successfully rather than to launch out in new directions. Sir James Morton, for example, used to contend strongly that this was the real reason for the depression in the cotton industry in the nineteen-twenties; Sir Henry himself suggests that this rather than the neglect of science was the real reason for the development of synthetic dyes and fine chemicals in Germany rather than in Great Britain.

But after a tribute to the quality of the reserve of scientific ability in Britain as revealed in both the world wars, and a warning as to the importance of maintaining the quality of academic research, Sir Henry puts in a timely protest against excessive drift of scientific man-power to the universities. He wonders whether we are not already over-populating the research departments of universities. Industrialists, who are looking patiently to the universities to provide the recruits to their research and production departments which they are at present unable to find may share that wonder. They may equally believe that university research departments are not the only over-populated departments, and the subsequent reports of the Advisory Council on Scientific Policy will certainly be scanned for evidence that the chairman is making his own views on the distribution of scientific man-power effectively prevail.

There need be no fear that whatever action the Advisory Council may inspire will impair the high standard of teaching in the universities or the schools of Britain, or impede the expansion of education in the higher branches of technology. We have become a scientific nation, but there is still too slight an understanding of the nature and the limitations of research; and a main theme of Sir Henry's address is that which recurred in the annual reports of the Department of Scientific and Industrial Research before the War. Sir Henry contends that industrial prosperity will depend more and more on the continuous application of science to industrial practice. Without disparaging new knowledge or research, he points out that the first requirement at the present time is the application of existing knowledge.

The prime object of industrial research is to do something that has never been done before, or to do things better than they have ever been done before. Furthermore, all social progress, such as the spread of education, promotion of health, and opportunities for leisure and healthy recreation, must depend on the power of science and technology to increase the productivity of industry. The productivity of labour in Britain is far lower than it could be if the results of past research were more resolutely and continuously applied. Sir Henry instances building, the coal industry and textiles, and suggests that the real reason for the higher productivity of such countries as Sweden and Switzerland is not in superiority of natural resources or in the quality or quantity of scientific and industrial research, but in their higher average standard of technology and in the greater proportion of men of high scientific education in executive control of industry.

It is not the general expansion of research in Great Britain that is of the first importance for the restoration of its industrial health, and certainly not the expansion of Government research remote from the everyday problems of industry. In Sir Henry's view the immediate task should be to apply what is already known. That view will be welcomed by many for its implications in regard to the distribution of man-power; but before considering two of these implications in particular, it is interesting to note that without using the stock term 'operational research', Sir Henry commends as one practical means of assisting the application of existing knowledge the technique used in progressive industry in technical service long before the War and developed with such remarkable success by the fighting services in the attack on problems of war.

The concluding observation in this connexion brings out the really vital factor in the utilization of science to-day. In the technique to which Sir Henry refers, far more attention is given to the study of man in relation to the machine he has to operate than in any branch of industry. Those industries which have gone furthest in that direction are precisely those in which human troubles, if not entirely absent, are most inconspicuous. In them, therefore, under such conditions, is there the best prospect of achieving that special object which all industrial research should have, namely, of reducing the labour required to supply the material needs and wants of men.

The central problem in the utilization of scientific knowledge in our economic recovery is thus that of man: of the wise use of man-power, of distribution or redistribution, and of securing the willing and intelligent co-operation essential for the full use of the new powers which applied science has given us. The importance of the work of the committee on human factors concerned in industrial productivity, of which Sir George Schuster is chairman, could scarcely have been better emphasized. Although Sir Henry's direct responsibilities in that field have now ceased, it seems certain that the work initiated by the Committee on Research and Productivity will continue to be watched by him with interest and firm support.

On the material plane, subject to the qualifications already indicated, Sir Henry takes a hopeful view of the future. He is reassuring on the question of food supply, but points out that it is on the development of the biological sciences that the peace and prosperity of the world depend. He considers that, so far as Great Britain is concerned, we must plan our economy on the assumption that food will be both scarce and dear for many years to come; and the answer to the question how long depends less on the ability than on the will of man.

"Science", said General Smuts at the centenary meeting of the British Association, "has come to represent the growing point of the human advance. It stands for the new forces which are re-shaping this world of ours. It faces the future with a bold and confident spirit. It has an invincible faith in truth at all costs ; and in that faith it is embarked on the endless adventure which carries the future of the human race."

In seventeen years we have lost something of that confidence in science, and in spite of the respect to which Sir Henry Tizard rightly referred, there have been new doubts as to the sufficiency of science. Science alone, it is widely held, is not enough ; and in the world of science there are many who believe with the Lambeth Conference that technical discovery must be brought into line with ethical direction. Sir Henry Tizard recognizes that we live in difficult times, but it is from Whitehead rather than Smuts that he draws his inspiration when he urges that it is a time for adventure, for taking calculated risks.

Sir Henry's contacts with the universities and with industry have convinced him that the spirit of adventure in science is as lively as ever it was. He looks forward to the future in the belief that by finding the right way to combine originality in science with enterprise and speed in its application, the nation can climb from the depths of bankruptcy to new and unsurpassed heights of prosperity and influence. Some successor in the presidential chair may or may not have occasion to refer to the great influence of the work of a few young men, who are now unknown to the public. Sir Henry's audience will look forward to that future with the greater confidence, because one whose foresight did so much to prepare our scientific resources for war is in the position to influence as potently their ordering for the tasks of economic recovery and of peace.

PLANT COMMUNITIES

The Study of Plant Communities

An Introduction to Plant Ecology. By Prof. Henry J. Oosting. Pp. 389. (San Francisco : W. H. Freeman and Co., 1948.) 4.50 dollars.

SINCE plant ecology first started, as a distinct division of study within the major science of botany, with the publication of Warming's "Plantesamfund" in 1895 (first German edition in 1896 and an English edition, "Oecology of Plants", Oxford, 1909), it has owed much of its rapid growth to American workers. In particular, the concept of succession was clarified and systematized, if not conceived, in the United States, and its development has been stimulated and largely directed by the researches, terminology and theories of American ecologists. It is therefore to be expected that text-books of ecology intended primarily for American students should record progress periodically. Such works naturally have both peculiar value and particular limitations for students in other countries. They direct attention to points of view and literature which might otherwise be overlooked and to examples which might remain unknown. On the other hand, it is not always easy to evaluate the conclusions reached because of unfamiliarity with both the flora involved and the field conditions.

The book under notice covers fairly adequately the subject of plant communities or synecology as an introduction to a part of plant ecology. After a preliminary discussion on the subject-matter of ecology there are five parts, with a total of eleven chapters, dealing with the plant community, factors controlling the community (the environment), community dynamics and practical considerations. A useful distinction is made early on, and emphasized several times later, between a concrete or specific example of a community and the abstract community as a synthetic idea derived from a study of several or many concrete examples or stands. Terminology is introduced gradually in the text and nowhere overwhelms the reader. Divergent points of view are judiciously treated. For example, the description and classification of communities, as developed especially by European writers, is contrasted with the view of vegetation as changing by development from origin to climax. Yet "each method has its place and usefulness. In fact each has profited from the other, but since the dynamic point of view has the broadest usefulness in both pure and applied ecology, it will be emphasized here." Importance is rightly given to the need for quantitative data in vegetational analysis. Refinements of the quadrat method, density, frequency, cover and space are considered. Qualitative characters, including sociability, dispersion, vitality, stratification, and periodicity, and "synthetic characteristics", such as presence, constancy, and fidelity, are discussed.

Considerable space is devoted to describing the factors controlling the community and the methods of measuring them and their influence on vegetation. Climatic, physiographic (mainly soil), and biological factors are dealt with in four chapters. The treatment accorded is on the whole adequate and up to date so far as American research is concerned, but would have been improved by the inclusion of European research, especially on 'biological' (or better, 'biotic') factors. The account of plant competition, for example, could have been much improved by reference to published researches on British vegetation.

A concise account of plant succession is followed by a very useful chapter on the distribution of climax communities in North America. This summary of the principal vegetational features of the continent is likely to be welcomed by many students of plant geography. The chapter on shifts of climaxes with time suffers from having only very brief references to work done outside North America, and from over-condensation, especially of the subject of pollen analysis.

The final chapter, on applied ecology, is to be commended as linking up scientific investigations with the satisfaction of human needs in the practices of forestry, agriculture, conservation, water supply, and what is termed 'landscaping'. The extent of this chapter could have been enlarged with advantage.

The book is illustrated with 190 figures. These are mostly well-chosen and fairly well-reproduced photographs, but include some outline drawings. There are also a number of tabulations. Besides "General References" at the ends of chapters there is a list of 276 "References Listed". The vast majority of the references are to American publications. It is, for example, surprising to find only two or three references to papers in the *Journal of Ecology*, which was not only the pioneer of ecological periodical literature but has always been and is still in the first rank. There is an adequate index.

A general criticism, which has already been indicated, is the relative neglect of non-American investigations. One would naturally expect emphasis to be given to American work and examples to be chosen largely from North American vegetation; but more consideration of various methods of study, both of vegetation itself and of the factors of the environment, which have been developed in Europe and elsewhere would have added greatly to the value of the first half of the book. It is also unfortunate that, in common with many other text-books of ecology, the dependence of good ecological work on the correct determination of the organisms composing the communities studied is not stressed.

W. B. TURRILL

LOCAL GENII OF BRITISH FOLK-BELIEF

The Minor Traditions of British Mythology

By Lewis Spence. Pp. 176. (London: Rider and Co., 1948.) 16*s*. net.

THIS volume is an attempt to present in concise and summarized form some of the lesser facts and circumstances of British mythology which, although dealt with in some detail by writers in the more specialized journals devoted to folk-lore, have not yet received adequate attention in more popular books. It has been Mr. Spence's object to collect together many of the more local British traditions as they are expressed in legend and folk-tale, and show how the rivers, mountains, lakes and wells are peopled by a motley collection of goblins and demons, giants and monsters, vegetation spirits and supernatural birds. To the stories concerning these monsters the author has added the legendary material which has collected in such quantity around the standing stones of Britain and the dolmens and menhirs which can be treated with them.

It follows from the plan designed by the author that a good deal of the material with which he deals is concerned with those local genii and solitary spirits who rarely seem to have attained more than a local distinction, but who, in many cases, can be linked up with more prominent mythological figures.

Having discussed the spirits which are connected with British rivers, lakes and wells, Mr. Spence proceeds to give an interesting account of mermaids and seal-folk, and then goes on to discuss the giants and ogres of England. He is of the opinion that many of these gigantic divinities were the original deities of this island; and from the passages he quotes it would seem that at one time Britain must have been the home of many giants, some of whom were guilty of exceedingly unpleasant habits. Passing in review the giants of Scotland, Ireland and Wales, Mr. Spence then continues his narrative by an account of British goblins and demons, a chapter which could, I think, have been considerably enlarged with great advantage to the reader. The author points out that what he calls the demonology of Britain is the equal of any to be found in Europe, and although it does not present the number of fantastic varieties to be found in Germany, the type is broader, owing perhaps to the great admixture of stocks which makes up the British population. How far this is true it would be difficult to determine without a much more detailed examination of the legendary figures and their possible sources than has been attempted here. What is clear is that British goblins have appeared in numberless forms, many of which were described by Scot in his famous sixteenth-century book on witchcraft. Here will be found a catalogue of sprites listed under such names as bull-beggers, sylens, pans, kit with the cansticke, calcars, the hell-waine, the puckle "and such other bugs". Mr. Spence rightly points out that few of the types listed by Scot are actually of British provenance, while others are of the fairy class to which, in the present volume, the author has not turned his attention.

In the discussion of these curious demonic figures some of them are compared with so-called poltergeists, inasmuch as a few were noted for their tricks and troublesome antics. Thus the Hedley kow seems to have been of this type, for it would disguise itself as a truss of straw, and when someone tried to pick it up it would become so heavy that it would have to be laid down to let the bearer have a few minutes rest. Thereupon it would suddenly come to life and shuffle away with a peal of laughter.

It would be of interest to discover whether legends of this sort can be in any way linked up with the many accounts of poltergeist activity to be found in Great Britain. In the present volume, however, Mr. Spence has confined himself to a bald statement of the facts, and the reader is often left with a desire to know more just when his attention is directed to a fresh case. Indeed, the author might have been wiser had he not attempted to deal with so much material in so small a space. In its present form the book is little more than a very convenient and useful summary of the subject; but it would have been much improved if the dates of publication had been added to the material listed under the references, and the index much enlarged so as to include more of the proper names, and not only a certain number of them based on a method of selection the principle of which does not seem to be at all clear.

E. J. DINGWALL

THE GRADUATE IN INDUSTRY

The Graduate in Industry

By Dr. Percy Dunsheath. Pp. x + 276. (London: Hutchinson's Scientific and Technical Publications, n.d.) 10*s*. 6*d*. net.

THIS book is a thoroughly competent piece of workmanship which to some extent breaks new ground in that, unlike most 'careers' books, it indicates the trend of numerous occupations for university-trained men and women in industry and attempts to demonstrate the opportunities for service to the community which lie therein. In this his first objective, Dr. Dunsheath sets out deliberately to overcome some of the prejudices against entering industry which, according to Sir Lawrence Bragg and others, are sometimes manifest among students. While thus endeavouring to satisfy the ideals which often influence such students, Dr. Dunsheath remains essentially factual and has assembled a considerable amount of information not otherwise accessible in one volume, which should make his book of real value to the university appointments boards and to the higher appointments officers of the Ministry of Labour and National Service.

In his preface, however, Dr. Dunsheath indicates a second objective. He attempts to show both the need for a change of approach in university teaching for students destined for a life in industry, and that the new conditions of the present day may be adequately matched to the tradition of the university as a place where young people find a philosophy of life which remains with them to guide and strengthen them throughout the conflicts of life which lie ahead. Here Dr. Dunsheath has much to say that is stimulating and sometimes provocative, but he writes with insight as well as with a deep sympathy with the social aspirations that so often colour the ideals of students which will commend his book to them, no less than to those responsible for determining the trend and content of university teaching.

Dr. Dunsheath's book from the first point of view gives a fair indication of the structure on which the attempt to obtain quantitative estimates of the future demand for graduates should be based. Here his book is as important to the industrialist as to the appointments boards which attempt to prepare those estimates. Some chapters, indeed, are almost specifically addressed to the industrialist: if there are graduates prejudiced against entering industry there are also industrialists prejudiced against employing graduates in some at least of the fields which Dr. Dunsheath indicates. He gives some attention to the question of the man of science as administrator, and not only here but also in other places he emphasizes the importance of the student taking full advantage of the opportunities which a university offers to broaden his mind and outlook and enlarge his contacts with men and women. All the weight of his experience is thrown against the narrow bookish conception of education, as it is against premature or excessive specialization.

As might be expected in a book of this size, some parts of the wide field are surveyed rather sketchily, and Dr. Dunsheath would be the first to admit that he initiates rather than exhausts either discussion or description. Nevertheless, he has given a fairly clear statement of what is involved in the present discussion on the expansion of the universities, and his book should not be without value to those also who are endeavouring to see that a reasonable balance is achieved between the numbers of university-trained men and women who enter industry and those entering the universities and the public services. For its price, the printing and production might well have been better; its usefulness would be increased if it could be issued in another edition at half the price.

R. BRIGHTMAN

SEA WAVES AND SURF

Wind Waves at Sea, Breakers and Surf

By Henry B. Bigelow and W. T. Edmondson. (United States Navy Department: Hydrographic Office: H.O. Pub. No. 602.) Pp. xii + 177 + 24 plates. (Washington, D.C.: Hydrographic Office and Government Printing Office, 1947.) 2.80 dollars.

SEA WAVES are as unruly as ever; but their characteristics are becoming more predictable as knowledge accumulates. The pioneer work of Arago and Stevenson was energetically extended by the American army engineer Gaillard, whose book on "Wave Action" published in 1904 has recently been reprinted. The aim of theory has always been to extract from the reality simpler ideas that are comprehensible; that real sea waves are complicated is sufficiently evident from the stereophotographs and contour diagrams prepared in 1939 by Schumacher. The first mathematical guess at the nature of a sea wave was made by Gerstner in 1802, and the later theories, most notably those of Stokes and Rayleigh, have provided a sound basis for the work of the physicist and engineer.

The appearance, therefore, of a book by Henry B. Bigelow and W. T. Edmondson is particularly welcome because of the extensive work on waves that has been done since 1940. It is described in the preface as a popular book; but the reader may take notice that it contains too many facts to be easy reading for the landsman. It aims at being a simple comprehensive account of wind waves written for the seafaring man. For this reason it is not a text-book, and the authors present only the general findings of theory supported by numerous practical illustrations taken mainly from the seaboards of North America. This practical bias is very desirable in a science which has such practical applications. The European reader may find difficulty in appreciating the practical examples and applying them to his home waters, unless he is provided with a good atlas of the American lakes and seaboards. The book is illustrated by 57 photographs and diagrams and contains 37 numerical tables with a sufficient number of selected references.

A notable feature of the book is an atlas of the frequency of occurrence of high seas and low seas and of high swells and low swells in all the major oceans during summer and winter. This atlas is one result of the military demands of the Second World War; it may prove to be of value to commerce, since such information is needed in the construction of new harbours and other engineering ventures that are exposed to the sea, as, for example, certain new oilfields. This atlas is the only one available as yet to the public.

The first four chapters describe the character of waves at sea, their growth under wind and their propagation away from the storm as swell. The last three chapters describe how waves change their behaviour when approaching the coast, due to shoaling water, to refraction around islands or headlands or to the effect of tidal streams, and describe the different types of surf which form on various beaches. The complicated effects are rationalized in a pleasing way, and these chapters deserve the attention of all maritime engineers. Though the discussion of theory is avoided, the numerous practical observations will suggest useful lines of work to the specialist. Is the grouping of waves, for example, as fortuitous as it might seem, for if fifty or more successive waves are observed by a ship, could not the next one be predicted with fair certainty? When a moderate swell is partly beaten down by an opposing wind, in what form does it emerge? Is its wavelength increased or diminished or does it merely show a reduced height?

As a correction of fact it may be pointed out that in 1911 Rayleigh deduced that waves would show a small decrease in height as they first approached shallow water, so this is not a recent discovery.

The authors give no space to the description of modern wave-measuring instruments or to techniques such as frequency analysis which are advancing the science. These subjects would find a place in a specialist's text-book, and it is to be hoped that the authors will compile one, since the present book meets its own purpose so well.

N. F. BARBER

FREE RADICALS IN CHEMISTRY

The Chemistry of Free Radicals

By Dr. W. A. Waters. Second edition. Pp. viii + 296. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 20*s.* net.

DURING recent years it has become increasingly evident that free atoms and radicals, chemically very reactive but physically quite stable, play an important part as intermediates in chemical reactions. Thus the equation of a chemical reaction, as usually formulated, is very often merely the sum of many separate equations involving their short-lived substances, and a knowledge of their properties and reactivity is necessary if we are to understand the mechanism of the reaction as a whole. Consequently there has arisen in the last two decades a new kind of chemistry, no longer bound by the usual valency rules—the chemistry of free radicals. Dr. Waters' book surveys in a general way the whole of this rapidly growing subject.

The second edition, which has just been published, is identical in subject-matter with the first, published two years ago, but several minor alterations have been made and references to work published in 1947 are included. The approach to the subject is that of an organic chemist interested in understanding better the well-known reactions of organic synthesis. Physical methods of investigation, such as spectroscopy and mass spectroscopy and the results of theoretical chemists on free radical structure, are therefore omitted, although there is a fairly detailed chapter on the use of magnetic properties of free radicals as a means of diagnosis. After a general and historical introduction on the methods of production and detection, there are chapters on resonance-stabilized radicals of the triphenylmethyl type, the gas reactions of free atoms and the reactions of alkyl and aryl radicals and radicals containing other elements than carbon and hydrogen. These labile molecules are seen to be of common occurrence in a wide variety of chemical reactions. There follows an account of photochemical decompositions and the free radical mechanism of polymerization and oxidation. Finally, the subject is carried into the field of biochemistry, and the free radical mechanisms of biological oxidation are critically discussed.

The book is complementary in many ways to Dr. E. W. R. Steacie's "Atomic and Free Radical Reactions", first published at about the same time. Dr. Steacie is particularly concerned with the kinetics of the reactions of the simple free radicals mostly in the gas phase, and gives a very detailed and comprehensive account of these reactions and their associated activation energies in so far as they are known. Dr. Waters, on the other hand, presents a more general and very readable account of a wider field and devotes more attention to reactions in solution. Each author is therefore writing particularly about that part of the subject to which his own research has contributed much.

Apart from the value to research workers in this relatively new branch of chemistry, Dr. Waters' book will be read with interest by a much wider public who want a general and lucid account of a subject which has applications in so many other branches of chemistry and biochemistry. In particular it will be of great interest to organic chemists in presenting a means of understanding better what are now almost classical methods of organic synthesis and preparation.

The Oxford University Press is to be congratulated on the production of this volume at the sort of price which is becoming rare in scientific literature. It is unfortunate that there is no term in the publishers' vocabulary with a meaning between 'new edition' and 'reprint' or 'new impression', for volumes of this kind which, though technically second editions, are not sufficiently changed to make their purchase necessary by owners of the first. In the absence of such a distinction a second preface or publishers' cover note indicating what changes have been made would be of value.

George Porter

STELLAR ASTRONOMY

An Outline of Stellar Astronomy

By Peter Doig. Second edition, completely revised. Pp. vii+168. (London: Hutchinson's Scientific and Technical Publications, 1947.) 10*s.* 6*d.* net.

THIS little book is designed, as the author unassumingly states, for readers who have "slightly more knowledge than that necessary for perusal of 'popular' astronomical literature". It is, in fact, a useful summary, remarkably complete for its size, of the present state of knowledge, and there will be many genuine astronomers, both amateur and professional, who will find it worth reading for the facts and opinions which it reports.

It is not, however, a text-book, and although it does not claim to be one it must be said that it would have been even more useful if it had approached the text-book ideal more closely in some respects. In particular, although the facts, and the conclusions from arguments, are clearly stated, the arguments themselves are frequently so much compressed that they lack clarity; no one, for example, who is not already familiar with Trumpler's work on open clusters and interstellar absorption will be likely to grasp the argument summarized on p. 28. In some places compression has resulted in actual errors; thus it is stated that the υ-component of proper motion is caused by the sun's motion, and in the formulæ for mean parallaxes based on the υ and τ components no mention is made of the fact that with the former the means are algebraical while with the latter they are arithmetical; also the sign of υ is not defined, but appears to be opposite to the usual convention. These two are almost the only formulæ presented in the body of the book, and they are not actually usable as presented.

There are a number of good appendixes, mostly devoted to formulæ; one on indirect methods of parallax determination omits all notice of the three methods dealt with in the book proper, which may mislead some readers. There is a short bibliography at the end of each chapter, but it is quite clear that much more extensive and detailed references could easily have been given; they obviously were used by the author, especially in the appendixes (where scarcely any are quoted), and they would also have been valuable for elucidating the arguments in the text. There are a fair number of printer's errors, but most of these are minor. In spite of such criticisms the book well deserves a place on the shelves of working astronomers, in addition to having obvious value for the readers to whom it is more specifically addressed.

R. d'E. Atkinson

Atomic Energy Levels as derived from the Analyses of Optical Spectra

Vol. 1, Section 1: The Spectra of Hydrogen, Deuterium, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen and Fluorine. By Charlotte E. Moore. (Circular of the National Bureau of Standards, 467.) Pp. iii+75. (Washington, D.C.: Government Printing Office, 1948.) 50 cents.

THIS is apparently the first of a series of reports from the National Bureau of Standards, Washington, and covers the elements of the first row of the Periodic Table. That very valuable book, "Atomic Energy States", by Bacher and Goudsmit, is now sixteen years out of date, and as it is not being revised this new series will eventually replace it.

The general arrangement follows closely that of Bacher and Goudsmit; but it is an improvement to have all spectra treated similarly with the ground-state of the atom taken as zero energy. This part is right up to date, including work up to late in 1947. The recent work of Edlén is fully treated, and many of his hitherto unpublished results are included. It is interesting to see the inclusion of the ^5S level of C I at 33735 cm.$^{-1}$; this has been the subject of much discussion in connexion with the energies of carbon bonds. The introduction to the series has not yet been published, and that is quite understandable; but it is a pity that a brief key is not given to the mysterious symbols (T., G.D., etc.) which appear after the references. The present circular does not contain any diagrams of term schemes; but charts of predicted terms in the spectra of some isoelectronic sequences are promised later. This work of compiling atomic energy-levels is an extremely valuable contribution to science, and these volumes will be indispensable to anyone who uses spectroscopic data. A. G. G.

Finite Differences and Difference Equations in the Real Domain

By Prof. Tomlinson Fort. Pp. viii + 251. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 25s. net.

IN his preface, the author states that this volume includes material for a course in finite differences as well as a treatment of a number of special topics. A selection of material was necessary in order to bring the work within reasonable compass, and also to follow somewhat the special interests of the author. The very large theory of difference equations in the field of analytic functions of a complex variable has been completely omitted. This has carried with it the omission of a variety of related subjects, particularly in infinite series.

The first six chapters constitute a readable account of the applications of the finite calculus to differencing, summation, the polynomials of Bernoulli and Euler, numerical differentiation and integration, and interpolation. The remaining eleven chapters are mainly devoted to a study of the linear recurrence relation, that is to say, the linear difference equation in which the independent variable assumes integral values. It is in this topic that the author's main interest clearly lies, but the powerful and elegant operational methods which are available in this field are barely touched. On the other hand, there are interesting and useful accounts of the linear recurrence relations of the first and second orders with periodic coefficients. L. M. M.-T.

A Bibliography of Chemical Research in South Africa, 1910–1939

Compiled by Dr. Herbert Coblans. (Published for the Natal University College.) Pp. ix + 25. (Cape Town: *African Bookman*, 1947.) 7s. 6d.

THE author of this slender volume explains that the lack of bibliographical tools is a real handicap to research workers in South Africa, since the proceedings of the learned societies there have no cumulative indexes. Many of the papers listed, however, have been published in European or American journals, and chemical research is perhaps one of the best abstracted fields of work. The information given can, therefore, be of special interest only to those chemists who wish to know which publications were by South African authors. Full titles of the papers are given and the references to the publications. The classification is according to subjects in decimal order based on the general principle of increasing specialization. In each section, the order is according to year of publication. Dr. Coblans is himself a chemist, and the accuracy of the book may, therefore, be taken for granted. His position as librarian of Natal University College vouches for his bibliographical ability. It is clear from the contents of the book that chemists in South Africa are making notable contributions to research in their subject, as was, in fact, generally realized before its publication.

Studies and Essays presented to R. Courant on his 60th Birthday, January 8, 1948

Pp. viii + 470. (New York and London: Interscience Publishers, Inc., 1948.) 33s.

PROF. R. COURANT, formerly of Göttingen and now of New York, who is known to all mathematicians by Courant and Hilbert's "Methoden der Mathematischen Physik", attained his sixtieth birthday on January 8, 1948. To commemorate the occasion a number of his friends and colleagues were invited to contribute articles for a volume to be presented to him. Among the thirty-eight mathematicians who responded to this invitation are included such well-known authorities as Harald Bohr, Carathéodory, Franck, Hadamard, Kramers, Neugebauer, Pólya, and Van der Waerden. The papers cover a wide field, corresponding to the wide range of Courant's own work, and some of them are direct developments from this work. Although most of the authors are foreign, all but six of the papers are in English.

The Cathode Ray Oscillograph in Industry

By Dr. W. Wilson. Third edition, revised. Pp. xii+252. (London: Chapman and Hall, Ltd., 1948.) 18s. net.

BECAUSE of demand the present text has been off the market for some time, so the author has taken the opportunity of bringing some of the matter up to date and also of incorporating applications of cathode-ray tubes which have been recently released. Not only would radar have been impossible but also many of the measurements and controls of industry would have been impracticable without the cathode-ray tube. It has become a tool of precision and a means of display. The types available and applicable to special tasks in industry are so well treated by the author that this edition will also soon be disposed of. L. E. C. H.

THE PASSING WORLD*

By Sir HENRY TIZARD, K.C.B., F.R.S.

President of the British Association

SEVENTY-SIX years have passed since the British Association met in Brighton. Great changes have taken place in the world since then. Nothing illustrates the lapse of time more strikingly than one passage in the address of the president, Dr. William Carpenter. After referring to the expedition sent for the relief of Livingstone he added :

"While we give a cordial welcome to Mr. Stanley, let us glory in the prospect now opening, that England and America will co-operate in that noble object which—far more than the discovery of the Sources of the Nile—our great Traveller has set before himself as his true mission, the Extinction of the Slave Trade."

And nothing better illustrates the truth of the old saying that the more things change the more they remain the same than the address of the president of the Section of Engineering, Mr. Bramwell. He discussed the coal problem. He directed attention to the alarming increase in the cost of coal, which had doubled in a year. "I am aware", he said, "that the subject of coal is a hackneyed one", but the startling facts to which he referred "force us seriously to reflect upon the use and also the abuse of coal." He discussed the inefficiency of domestic fires; but said he would rather put up with the whole of our present domestic discomforts, and even with the loss of heat than resort to the stove as a remedy. "But let not users of coal remain indifferent to savings on their present consumption until those improvements are discovered by scientific men ; on the contrary, let them forthwith do everything in their power to reduce the consumption to the extent to which present science and, in some instances, present practice show the consumption can be reduced."

At the same meeting the famous physiologist, Prof. Burdon Sanderson, referred to the backwardness of physiological research in Britain as compared with Germany. "If a man wants to be a physiologist", he said, "he must, as things at present stand, study medicine. There is no logical reason for this : for although medicine ought to be built on physiology, there is no reason why a physiologist should know anything about the art of curing diseases." However, it was a most encouraging sign of the times that Trinity College, Cambridge, had "condescended to provide a place for physiologists to study and labour in, from which . . . one or two valuable researches have already sprung." We shall all agree that the condescension of Trinity College has been amply rewarded. There is perhaps still room for similar acts of condescension on the part of wealthy corporations.

There is, finally, another passage in Dr. Carpenter's address which is of special interest to me. He describes how he urged on his friends in the Admiralty the importance of organising a new expedition to circumnavigate the world, and how the Royal Society followed up his preliminary inquiries with a formal request. The Admiralty agreed, and the good ship *Challenger* was then fitting out at Sheerness, and being equipped with the most modern scientific apparatus. Captain Nares had been chosen to command the expedition, and Prof. Wyville Thomson to lead the scientific staff. The reason of my special interest is that my father was the navigating officer of that famous ship.

All that the British Association set out to achieve over a hundred years ago has been accomplished. Long past are the days when the public estimation of science had fallen so low that, to use the words of David Brewster in 1830, no scientist enjoyed "the favour of his sovereign, or the friendship of his ministers ;" and when an alarmed Dean of York was moved to publish a pamphlet entitled, "The Bible defended against the British Association", which attained such a popularity with Victorian churchgoers that it ran through five editions in one year. We men of science have little to complain of now. The public estimation of science stands higher than it has ever done in Great Britain. The Royal Society enjoys a prestige unequalled since the early part of the eighteenth century. The Great War, which has been succeeded by an uneasy peace, grimly demonstrated that the country whose rulers neglect science is lost ; and public men in England now display a touching but alarming faith in the power of science to solve any national problem, however serious. The time is near when, as Huxley warned us over sixty years ago, science, like Tarpeia, may be crushed with the weight of rewards bestowed on her. Let us then beware, when all men speak well of us, and be critical of ourselves. Let us ask whether we are claiming too much in some directions, and doing too little in others ; let us consider in fact whether the great forces of science, on the proper exercise of which all social progress depends, are in balance.

The Progress of Sixty Years

It was with some such thoughts as these that I chose the title of my address. It is taken from Dr. Johnson's well-known advice to the poor scholar in the "Vanity of Human Wishes."

> "Deign on the passing world to turn thine eyes,
> And pause awhile from letters to be wise."

I propose to pause awhile from the fashionable discussions of Science and the Community, Science and Education, and the like, and to invite you to turn your eyes on the passing world. For it is passing —from one state of unstable equilibrium to another. I say unstable, for many many years will pass before the dreams of those who look forward to a world Government which will bring not only peace but also happiness to all, will come true. But if it must be in unstable equilibrium for many years to come, let us at least strive to balance it so that the chance of a major catastrophe is made as small as possible. Science has much to contribute to this aim ; but just as no man can aim a rifle accurately without a backsight as well as a foresight, so must we provide ourselves with both, if our contribution is to be worth while. The backsight is history; it can be fashioned accurately by study. The foresight can only be fashioned from our knowledge of the state of science as it exists to-day, and from what we know is possible. It cannot be so accurate as we could wish, because we cannot foretell the effect of discoveries of which we have no inkling at present.

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* From the Presidential Address, delivered at Brighton, on September 8.

My backsight shall not be too far back. In considering the future we shall not gain more by studying remote history than we gain perceptibly in accuracy by lengthening the barrel of a rifle. I shall sight, somewhat arbitrarily, from the year 1885; not 1685. It happens to be a convenient year for me, as it was the year of my birth. It happens, too, that it marks almost the close of the stagnant period of nineteenth century science, when many men thought that "our power to discover new experimental facts was practically exhausted." But new men were coming on, and new ideas were hatching. J. J. Thomson had just been elected to the Cavendish chair of physics at the scandalously young age of twenty-eight —a thing which would not be tolerated nowadays. Charles Parsons had patented the steam turbine in 1884, and demonstrated a model at the Inventions Exhibition in 1885. Gowland Hopkins had been appointed assistant to Sir T. Stevenson, the Home Office analyst, and was studying, in his spare time, the pigments of the wings of butterflies. Three years were to pass before he was able to begin his formal education in science as a medical student at Guy's Hospital. Charles Sherrington was fighting cholera in Spain and investigating its causes, and Rutherford was carrying off all the prizes at school in New Zealand. Of these great men, whom many of us had the privilege of knowing, only one is alive to-day. Sir Charles Sherrington is the oldest living president of the British Association. We send him our respectful and affectionate greetings.

It is understandable that none of these events, which in their different ways were to have a more profound effect on history and society than any legislation, or rise or fall of governments, created any public interest, except perhaps the exhibition of the turbine which was considered ingenious but wholly unpractical. In other respects the events of the year 1885 followed a normal course, judged by modern standards. There was fighting in what we now call the Middle East, which ended in the massacre of British troops, and of their leader, General Gordon. Our Russian friends were told that anxious though we were to preserve our friendship, there was a limit to patience. But the British public soon recovered from the shock of Gordon's death, and refused, so far as I can judge, to be seriously disturbed by the prospect of war. It must be remembered that they were denied the blessings of broadcasting, and other modern equipment for the ready circulation of bad news. They were far more exercised by the prospect of cholera spreading from Spain. They had reason for their anxiety, for the great majority remembered the epidemic of 1866 when 14,000 deaths from cholera were recorded. On the whole, the people of England jogged along in a deplorable state of confidence, which was, however, justified by events, for nearly thirty years of peace followed, broken only by minor wars which had no perceptible effect on the growth of material prosperity.

In 1885, after a few years of depression, during which nearly 700,000 men and women left the country to seek better opportunities overseas, the United Kingdom was still the greatest manufacturing nation of the world. An enthusiastic commentator wrote at the time that "the material greatness of the country is amazing—it exceeds that of any other Empire, Ancient or Modern. But the moral greatness is even grander . . ." Unemployment was sometimes high in particular trades, such as shipbuilding, but between 1885 and 1914 it was never alarming, and was often as low as 2½ per cent of the gainfully employed. The United States were not then serious competitors; imports of iron and steel manufactures from the United States only reached an annual value of £500,000 in 1890, but from then on steadily increased. Germany was considered a more serious competitor. In the pursuit of science she stood first among the nations, and she was applying the methods and results of scientific research to industry on a scale and with a determination that far surpassed her rivals. At the meeting of the British Association in 1885 the president, Playfair, sadly recorded that in science "Oxford and Cambridge are still far behind a second-class German University", and that "in Great Britain we have nothing comparable to the great technical college of Zurich". Germany kept her pre-eminence in applied science until 1914; but it is perhaps worth noting that she never equalled the industrial prosperity of England, judged by the test of real national income. She might have done so, had not her rulers believed that by war they could find a short cut to the happiness and wealth that could have come in the natural course of events to a hard-working and highly educated people anxious to live in peace with the world. The terrible fate of Germany is a tragedy that affects us all, the last act of which perhaps we have not yet witnessed.

Many of the numerous comforts and luxuries which are now within the reach of every diligent working man in England are the result of invention or scientific discovery in or about the year 1885. I have already mentioned the steam turbine, which by making possible the generation of electricity on a large scale provided in the most convenient form the power on which industrial productivity so largely depends. Kelvin lit his house with electricity in 1881, and the telephone was invented in 1876; but they were both scientific curiosities in 1885. The modern 'safety' bicycle first appeared upon the roads in 1885; it was the manufacture of a reliable chain that made it practical. The first Dunlop pneumatic tyre appeared in 1888; but the idea was not then wholly new. Like many other things before and since, it had been invented before its time, that is to say, before manufacturing technique was sufficiently advanced to make it practical. Edison, in 1885, was in the full tide of his inventive genius. The first talking machine had been demonstrated in 1877, and in 1885 he was busy experimenting with motion pictures. Swan, whose share in the production of the carbon lamp is well known, invented a practical process for the manufacture of artificial silk in 1883. The typewriter in its early form was then quite old; but difficulties in manufacture prevented it from becoming available in quantity until towards the end of the century. The internal combustion engine which, in peace and war, has had a greater influence on society than any invention since that of printing, was developed from Otto's experiments in 1877. The intrepid Daimler drove a bicycle powered by an internal combustion engine of his own design in 1885; and the first motor-cars were sold to the public. In the field of applied chemistry one far-reaching development to recall is the electrolytic production of aluminium in 1885. Aluminium was then a rare metal costing £18 a pound. It now costs 10d. a pound.

Thus, although the science of physics was languishing until the discovery of the electron, X-rays and radioactivity in the closing years of the century, it was a time of enterprise and progress in engineering practice. Britain prospered. In 1897, the year of the spectacular triumph of the *Turbinia* at Spithead, we exported goods to the value of one quarter of everything we produced. Ten years later we shipped overseas nearly one third of the whole national output of goods of all sorts—on farms, in mines, or in factories. If we were doing so to-day we should have little cause for anxiety. Perhaps it was this very prosperity that caused us to fall behind in some branches of industry, for when there is little unemployment and when the standard of living is obviously rising in all sections of the community, there is an excusable tendency for manufacturers to go on doing what they know they can do successfully, rather than to launch out in new directions. Is not this, rather than the neglect of science, the chief reason for the fact that synthetic dyes and fine chemicals were manufactured in Germany, rather than in their original home England ? Whatever the answer to this question, the fact remains that when war started in 1914 we were caught off our balance. We found ourselves dependent on our enemies for many essential products and instruments on which our power to make war, and to maintain health, depended. But, to everyone's surprise, we also found that the reserve of scientific ability in the country, though not large, was high enough in quality to overcome the immediate dangers with remarkable speed. Young men from the universities who had spent their time on researches of no practical importance applied themselves with success to problems often completely outside the range of their previous studies. We had the same experience in the Second World War, although fortunately we also had the foresight to prepare for some of the worst dangers beforehand. There is a clear lesson, I feel, to be drawn from this experience. Whatever may be done, in a burst of public enthusiasm, to support and promote schools of research at universities, nothing should be allowed to lower the quality; and size, beyond a certain point, undeniably does. A research laboratory, of whatever nature, is like a living cell. Once it reaches a certain size, which may differ with the nature of the subject, it must divide or die. When a young graduate tells me, as one did recently, that he was going to do research because it got him off military training, it makes me wonder whether we are not already overpopulating the research departments of universities.

The shock caused by the exposure in 1914 of our industrial shortcomings, which had been concealed by the apparent prosperity of previous years, led to a great increase of research by industry and by Government. The National Physical Laboratory, which had been of inestimable value during the War, extended the scope of its work. The Department of Scientific and Industrial Research, which was founded in 1915, established other Government research laboratories, and encouraged the formation of research associations to serve the needs of the older scattered industries. University schools of science were greatly enlarged, and under the influence of the great men of the inter-war period there was a surge of discovery which put Great Britain in the van of progress in nearly all branches of science. We became a scientific nation. The newer industries, such as the viscose and radio industries, which had been founded on science, rapidly developed. The chemical industries took on a new and active lease of life. Germany, badly disorganised by defeat, ceased for many years to be a serious competitor in the world market.

Many of us must have felt confident that when leadership in scientific and industrial research was allied to experience in commerce and manufacture, and to skill in craftsmanship, our country would have little difficulty in maintaining its position among the nations of the world. We have been disappointed. I am referring now not to the acute difficulties of the present day, but to the general trend of events before and after the First World War, when in spite of a nearly continuous advance in national income and standard of living, Great Britain gradually lost her pre-eminent position. We cannot attribute this relative decline to the 1914 War. That War had curiously little effect on our economy. Nor can we attribute it to the world depression in the 1930's. The depression affected us much less than many other nations, for owing to the great fall of prices of food and raw material the terms of trade moved sharply in our favour. During 1930–38 the volume of exports necessary to purchase a given volume of imports was only two thirds of what it had been during 1885–1914. To what then shall we attribute the relative decline ? Shall we argue that a main cause was that research was on too small a scale, or shall we seek for other reasons ?

Research and Industry

Let us first be clear about what results we expect to come from the application of science to industry. The primary object of industrial research is severely practical. It is not to enlarge the boundaries of knowledge, or to publish scientific papers, although that may be a prerequisite or a consequence. The object is to do something that has never been done before, or to do things better than they have been done before. And it has, or should have, the special object of reducing the labour required to supply the material needs and wants of men. All social progress such as spread of education, promotion of health, opportunities for leisure and healthy recreation, must depend on the power of science and technology to increase the productivity of industry. The rate of social reform is set by the rate at which productivity increases; and social unrest is inevitable if reform lags too far behind the advance of technology, or is pressed too thoughtlessly before it. So we must judge the effect of industrial research not merely by the new comforts and luxuries that it produces, but also by the rate of improvement of existing processes.

In Britain, which depends more than any other country on international trade, and which can continue to maintain its present population only by exchanging manufactured articles for food and raw materials, the productivity of labour is of primary importance, for unless it is as high as, or higher than, in other manufacturing countries, we shall not be able to compete in the markets of the world. And the productivity of labour in Britain is far lower than it could be if the results of past research were more resolutely and continuously applied. We find this particularly in certain industries of great importance. In the coal industry the results are painfully obvious—

the coal raised per man employed is now lower than it was thirty years ago, when nearly all coal was hewed by hand. Research on building has been intensively pursued since the Department of Scientific and Industrial Research was founded. Those responsible for its direction have not been content with the publication of papers giving the results of their investigations but have built demonstration houses for other builders to inspect and study. But are better houses now being built with less labour than twenty years ago? I doubt it; if not, the research has had as yet little influence on practice. The Shirley Research Institute for the cotton industry is well known for the range and excellence of its work; but productivity in the cotton textile trades is lower than it was fifteen years ago and much lower than in some other countries. Taking British industry as a whole, productivity is far lower than in the United States. In both countries about 40 per cent of the population is gainfully employed. In the United Kingdom the proportion engaged in manufacturing, building and civil engineering, which covers the production of all capital and consumer goods (other than minerals or food) is now a little less than 18 per cent of the population. In the United States the corresponding figure is 12 per cent; and yet in proportion to the population the volume of production is far higher than in the United Kingdom.

The causes of the relative productivity and wealth of nations are, of course, many and complex. We gained our supremacy in the nineteenth century because we excelled in engineering genius and were the first to use mechanical power on the large scale for manufacture and transport. Our population grew rapidly because we were prosperous, and it paid us to become a food importing nation because the productivity of labour in the secondary industries was so much higher than in agriculture. But conditions have changed in the course of time. We no longer have any outstanding natural advantages, and we must expect that given approximately equal skill in technology other nations with greater natural advantages will surpass us. Only by maintaining leadership in the application of science can we hope to keep our position among the great nations. So it is not surprising that the United States, and Canada, for example, with their great natural resources, and abundant supply of cheap power, should have passed us in wealth and productivity before the War. It would have been surprising if they had not. But it is by no means so easy to explain why Switzerland, which in 1885 possessed a national income per head about two thirds of that of the United Kingdom, should have equalled us in prosperity by 1939; or why the industrial productivity of Sweden, a country that has no coal, should have been rising so much more rapidly than ours in the years between the wars. These two countries cannot be said to possess natural resources superior to ours; nor can it be argued that in the quality or quantity of scientific and industrial research they excel us. But I suggest that they, in common with the United States, possess a higher average standard of technology than we do, and have a much greater proportion of men of high scientific education in executive control of industry. I quote them in support of my view that it is not the general expansion of research in Britain that is of first importance for the restoration of its industrial health, and certainly not the expansion of Government research remote from the everyday problems of industry. What is of first importance is to apply what is already known.

The fact is that all really new developments of industry are the product of the work of very few men. In general, knowledge in the physical sciences now accumulates at a rate much faster than it is, or possibly than it can be, applied in industry. There is a vast amount of knowledge waiting to be used. No new discovery, in any field, is likely to have so quick and beneficial an effect on British industry as the application of what is already known. We hear, for example, of the possibility of the production of power from atomic sources of energy. I do not think that anyone will be rash enough to prophesy what discoveries of real industrial importance will result from the researches now in progress; but I shall certainly assert that the production of power from uranium cannot bring such economic benefits to Britain within twenty years as would the practical application of known methods of economizing coal. Mr. Bramwell's advice in 1872 is still sound, and is always likely to be. Even in those fields of industy where science and development have been most in step, we find scientific knowledge far ahead of practice. In aeronautics, for example, research has shown, without any shadow of doubt, that it should be possible to design aircraft far more economical in fuel consumption than present aircraft. For the next step we need bold and highly skilled engineering rather than more fundamental knowledge: if it is successful, air transport, instead of existing precariously on subsidies, will compete on level terms with the train and ship for long-distance passenger travel. Indeed, a revolution in transport is in sight. Shall we leave it to be encompassed by other nations, or shall we show the way? The answer depends on whether we shall encourage enterprise and adventure in engineering.

War as Applied Science

Although I have been interested in the problems of industry for many years, I have never been closely concerned with its conduct. But for much of my working life I have been intimately concerned with that peculiar business called war, which is as old as agriculture, which is subject to the most violent booms and slumps, the cause of which we do not understand, and in which the incentive to succeed is greater than any profit or ideological incentive in civilian life. There is a healthy human rivalry between the various units and companies into which the business is divided. Sometimes it may be thought that this rivalry is carried too far; but all are working for the same cause. In my own life-time I have seen this business change from one in which the practical man considered he had little to learn from scientists, into one in which scientists are concerned with its every aspect, from policy making to the actual conduct of operations. We shall all hope that this business is moribund, and shall do our best to kill it: but in the meanwhile it is possible that other old industries have much to learn by studying the principles of its successful conduct.

In the first place, let us note that the managing directors, the chiefs of staff and commanders, are all carefully selected highly trained professional men, who have gained their experience in a hard school, and who, at intervals in their career, have had the opportunity to study, at staff colleges and elsewhere, the fundamentals of their trade. The managing directors do not have the final responsibility for policy, but have a great influence on the decisions. Secondly, the technical efficiency of the business is entrusted to a body of engineers and technologists, who have had an advanced specialized education and experience, and who are in personal contact at all levels with scientists who are concerned with research and development. This secures that in all research, however recondite, there is a practical objective, and that there is also a continuous urge to improve in detail. The scientist is primarily responsible for research, but experienced engineers take part in it. The engineer and the scientist are jointly responsible for development. But there is no part in the whole process from research to production and use that is neglected, and none in which scientific thought and influence are wholly absent. One point of special interest is that far more attention—but perhaps still not enough—is given to the study of man in relation to the machines he has to operate than in any branch in industry.

It does not need any profound research to show that the British industries that are now best standing up to the strain of adverse circumstances are those that most nearly approach the system I have described. The chemical industries, for example, have gradually developed a similar organisation over the last thirty years. Neither research nor development has been neglected, and management is in the hands of men highly educated in pure and applied science. The result is that our chemical industries are a source of great and growing strength in peace and war. Forty years ago they were far inferior to the German industries; now they have little to fear from any competitors. In the steel industry, the efforts of which now merit our admiration, it is not uncommon to find management and direction entrusted to men of the highest reputation in science and technology. Turn your eyes on any industry in the world that is similarly organised, on the steel industry of Australia, for example, or the photographic industry of the United States, or the machine-tool industry of Switzerland, and you will find that they are the best able to weather the storms and take advantage of the fair winds of trade. Further, I shall ask you to note that in such industries human troubles, if not entirely absent, are inconspicuous. This, I think, is to be expected, for most men are happiest and do their best work when new things are being attempted, and when adventure of some kind relieves the monotony of a daily routine.

It is a mistake to suppose that science advances rapidly in a war. Certain branches of science may receive a special stimulus; but on the whole the advance of knowledge is slowed. What is striking in a war is the rapid solution of practical problems by the use of previously acquired scientific knowledge and technique. It is a mistake also to attribute this success to the fact that cost does not matter. Cost matters a great deal; indeed the purpose is always to achieve the end in view with the minimum cost of lives, labour and material. Finally, all depends on good design and production. Our weakness in the War was not to be found in the judgment of what was best to do, nor in the scientific work necessary to do it. It was when the stage of design and production was reached that we fell short of the best standards. The magnetron, which contributed more to the success of the Allies than any other single invention, was a product of British science; but it had to be redesigned in the United States for economical manufacture. Penicillin, the greatest practical achievement of medical research during the War, also originated in Britain, but unless American skill in large-scale manufacture had been available, many thousands of men, who now enjoy a healthy life, would have died.

We now see history repeating itself. After the Second World War, as after the First, there is a cry for more research, in industry, and by Government, and a strong demand on the universities to expand their schools of science. Temporarily this enthusiasm is having an unfortunate effect, for the schools are getting starved of teachers; and unless a high standard of teaching is maintained in our schools, the next generation of scientists will suffer. In the long run, too, the expansion of research will fail to produce the hoped-for result unless we promote at the same time education in the higher branches of technology, and unless the technologist takes his rightful place in industry. Throughout the nineteenth century, the advances in engineering that made so great a difference to our prosperity, were the product of inventive rather than of scientific genius. Even the steam turbine, though its conception was founded on long-established physical principles, was brought to a high pitch of practical efficiency with very little assistance from scientists. But we live in a different age. Pure invention still has its place; but industrial prosperity will depend more and more on the continuous application of science to industrial practice. Unless we can raise our standard of technology, unless there are many more men in executive positions in industry whose practical experience has been preceded by a scientific eduction, we shall inevitably fail to keep our place among the great manufacturing nations. President Playfair's remark about Oxford and Cambridge is no longer true. Cambridge has long been recognized throughout the world as a great home of science; and it is not merely devotion to my *Alma Mater* that prompts me to say that Oxford is now not far behind. But I fear that it is still true that in Britain we have nothing comparable to the great technical college in Zurich.

Advances in Public Health

I turn now to another branch of applied science, less spectacular in its results to the ordinary citizen, but far greater in the benefits that it has brought to mankind during the last sixty years. The physical sciences have given men comforts and luxuries that are obvious to all. The aeroplane, the cinema, the broadcasting and television receiver, the domestic refrigerator, and many other familiar things which were unknown even at the end of the nineteenth century, are positive results of scientific research. Health, on the other hand, is in a different category. The ordinary citizen sees little connexion between the advance of science and the fact that he is healthy; it is, he feels, a quality that other people may lack, but is his by right of a superior heredity or habit. Ill health, on the other hand, while a fault in other people, is a misfortune in himself, and a serious reflexion on the state of medical science. How many men now living in Britain have any real conception, I wonder, of the astonishing advances in the prevention and cure of disease that have taken place in the last sixty years, and of how they have come about? Where is the cholera with which I was threatened as a child if I drank unboiled water? Its last appearance in England was in 1893; it was soon stamped out, and there has been no epidemic since. We are puzzled and alarmed by its appearance even in a country like Egypt, with its low standard of sanitation. Many other diseases which were common in 1885 have practically disappeared or are under control. Those that remain, will, without doubt, be conquered in the end by the advance of knowledge.

In 1885 the crude death-rate was twenty per thousand; now it is twelve. In 1885 one in every seven children died during the first year of life; now the figure is one in twenty-five. In 1885 a young man of twenty could expect on the average to live for forty-one years; now his expectation of life is forty-eight years. And it is not merely that he will have a longer existence, but that he can look forward to a far healthier life. Where can one now find the stunted children with distorted limbs, who were a common sight in the industrial towns of England when I was young? If it were possible to compare a random sample of young men and women from the poorer districts of London with their grandparents at the same age, it could scarcely be believed that they came from the same stock. Only those few medical men who had the duty of examining recruits for the Army in the First and the Second World Wars can have any vivid appreciation at first hand of the changes that have come about in a single generation through the study of nutrition and preventive medicine.

These great advances have been mainly due to the fundamental researches of very few men, and to the vigour and good judgment with which their work has been extended and applied in practice. Never has public money been better spent than on this branch of applied science; and never has such a small investment yielded such a rich return to the nation. The recently published report of the Medical Research Council, covering the war years 1939–45, is a document of the highest scientific and historic importance which can be read with interest and profit even by laymen who are unfamiliar with the jargon of medical men. In 1939 the Medical Research Council confidently stated that:

> "The destructive power of arms will indeed have increased immensely since 1918 if it overshadows the advances in knowledge for the saving of life which modern discovery has placed at the disposal of medical men. If a strict comparison were made between what science has done to increase war mortality and what medical science has done to lessen these lethal effects, there is good reason to believe that the latter would be an easy winner."

Omit the word 'medical' in the last sentence, and I think it will be agreed that no prediction has been more amply justified. Nor should we too quickly assume that new destructive weapons evolved by physical science will in the future reverse the decision. In spite of all the hazards of bombing, the average civilian death-rate during the years of war was lower than it was during the immediately preceding years of peace. The deaths in the fighting services were less than one third of the deaths in the 1914–18 War; and more than 80 per cent of the wounded have been restored to normal life. In spite of all the difficulties caused by the submarine blockade, and the shortage of food, which still persists, we are a healthier nation than we were in 1939. Whether we are as energetic is another question.

Our American allies have the same tale to tell. Four years of hard fighting in Europe and the Pacific caused fewer deaths than in the American Civil War, when the population of the United States was only one fourth of what it is now. It was only in Germany, East Europe and the U.S.S.R. that war counted its victims by millions, and then not through the destructive forces of science, but because of the brutality of human nature at its worst.

Nevertheless, the progress of preventive medicine is giving rise to social changes of great complexity, which will seriously affect the peace and prosperity of the world unless their consequences are studied with care, and their possible evils counteracted by wise and far-sighted action. In all countries which have a high standard of education, such as our own, the rise in population which follows a rapidly decreasing death-rate has been kept in check by a voluntary control of births. As a result the average age of the population has considerably increased, and is increasing; the proportion of the population of England and Wales that is more than sixty-five years of age is now nearly four times as high as it was in 1885. This in itself does not yet present any serious problem, for, as the proportion of children is much less than it was, the proportion capable of productive work, between the ages of fifteen and sixty-five, is actually somewhat higher than in 1885. No fundamental difficulty, from this cause, is likely to arise for many years to come. But the population of the world as a whole is now increasing by 1 per cent a year, and its distribution is such as to make it extremely doubtful whether the supply of food can keep pace, even with the present low standard of nutrition. It is the advance of science that has made this possible. War, pestilence, and famine have kept the population within bounds since the dawn of history. War has ceased to be effective; pestilence is rapidly losing its power; only famine is left as a brake until education takes its place. Is famine inevitable, or will science again come to the rescue, as it has done before? I do not think that the danger of the present position is yet fully realized, in spite of all the work and publications of the United Nations Organisation, and in our country the well-informed debates and warnings of the House of Lords. People remember only too well the apparent over-production of food in the 1930's, and forget, or do not know, that since then the population of the world has increased by some 300 million people.

A single example of what is now happening, and will probably happen on an ever-increasing scale, may help to illustrate the problem. Malaria has always been one of the most potent instruments of population control. It is endemic in most tropical countries. In the Far East it has hitherto been an antagonist more to be feared than the armed forces of an enemy. In the Second World War it was defeated by the controlled use of 'Mepacrine', a German drug, which is being replaced by an even better product of British research. In addition, the potential importance of the insecticide D.D.T. for the elimination of malaria-carrying mosquitoes began to be recognized toward the end of the War.

In 1944, Sir Robert Robinson, Prof. J. L. Simonsen, and Dr. Harold King visited British Guiana on a special mission. British Guiana has a population of roughly 400,000. Accurate statistics of the fluctuation of population do not exist; but it is probable that it has remained stationary for the last twenty years. Two thirds of the population used to live under conditions of severe endemic malaria. The birth-rate was low, and the infantile and adult mortality high.

The particular type of mosquito which is the carrier of malaria, and also of yellow fever and filariasis in the Colony, lives and breeds in the wooden houses, and not in swamps. It is thus peculiarly susceptible to attack by insecticides. The British mission advised a comprehensive trial. They were fortunate in finding a most experienced and progressive officer in Dr. Giglioli, honorary Government malariologist. Their advice was taken; operations were started in 1945, and at the time of speaking it is probable that the whole population of the Colony has been protected. The annual cost of keeping the whole district under continuous control is of the order of five shillings a head.

Malaria is now rapidly disappearing from the Colony. I cannot quote valid statistics covering the whole population; but I have been supplied with exact information about a suburb of Georgetown with a population of about 3,000, and there is no reason to suppose that the results will not apply generally. In this village the death-rate was equal to the birth-rate during the years 1938–44 inclusive. The average infantile mortality during this period was about 250 in a thousand. It rose to more than 350 in 1944. D.D.T. control was introduced in July 1945. By the end of 1947 the birth-rate had doubled, and the infantile mortality had dropped to 67 in a thousand. The population is increasing by 10 per cent annually.

Population and Food Supplies

As the new methods of preventive medicine spread—and that there will be many more to come no one can doubt—we must expect the world population to grow at an even faster rate than it has done in our life-time, unless famine intervenes. Moreover, it will grow particularly in parts of the world that already have a high density of population, such as India, where the population is now increasing by five million people a year; and Egypt, where there are already 2,000 people to every square mile of cultivated land, and where it pays to have children as they are a source of labour and of profit to their parents at a very early age.

Exactly fifty years have passed since a president of the British Association last warned his audience of the danger of famine. Sir William Crookes was then alarmed at the prospective shortage of wheat. He produced evidence to support his conviction that England and all civilized nations stood "in deadly peril of not having enough to eat". But he qualified his gloomy forebodings by the statement that the chemist must come to the rescue of the threatened communities, and went on to discuss the possibility of the fixation of atmospheric nitrogen. If that were achieved, the future, said Crookes, could take care of itself, and "in days to come when the demand may again overtake supply, we may safely leave our successors to grapple with the stupendous food problem". The chemist did come to the rescue, and the plant breeder too, though not quite in the way that Crookes imagined; and now the day has came when we must grapple again with the problem. We must not encourage the easy thought that some entirely new development in science will solve it quickly; there is nothing in sight comparable with the importance of synthetic fertilizers. There are certainly some interesting investigations in progress, for example, the production of food yeasts from molasses, and of fats by the action of micro-organisms on carbohydrates. All that can reasonably be said about these new developments at present is that they show the need for fundamental research in an almost untouched field. They are very unlikely to lead to a new and substantial source of supply of food within the next thirty years. So far as Great Britain is concerned, we must plan our economy on the assumption that food will be both scarce and dear for many years to come. Its scarcity is obvious to us; its dearness is concealed by a policy of subsidies. I do not criticize the policy. I refer to it only because it tends to hide a state of affairs that should be realized by every thinking man.

One or two years of good harvests in the wheat-producing countries may go far to relieve the present troubles of Europe, and will be of great benefit to us. But the supply of wheat is only part of a larger problem. World food supply will only keep up with demand if the productivity of land is increased, and more land is brought into cultivation. The productivity of land in the United Kingdom is already high; much higher, for example, than in most European countries and in North America. The productivity of labour on the land has increased in recent years much more than the productivity of labour in any other old industry. One man working on the land now produces enough food for twenty-five of the population. New Zealand surpasses all other countries in both respects. It is a land blessed by Nature and improved by science. But few people realize that in our small country we now grow enough food for twice the population of Canada. There is still room for a great advance. There is a consensus of opinion among experts whom I have consulted that the production of food in the United Kingdom could be raised by 20 per cent within five years by a combination of measures, such as the improvement of grasslands, the conservation of grass for winter feeding, the control of pests and weeds, the extended use of fertilizers, and the development of large tracts of marginal land such as exist in the Highlands of Scotland. It is argued that, though this would need considerable capital expenditure, there is no direction in which capital expenditure would yield more certain dividends to the nation, or make a more substantial contribution to the balance of trade.

I find these views convincing. But even if all this were to come to pass, we shall still need to import food for twenty to twenty-five million people unless there is to be a large outward movement of population; and we must not lose sight of the fact that at least twenty million people are added to the population of the world every year, and that it is conceivable that in another seventy years, or even less, the world population will have doubled. Whatever other countries may do, it is our bounden duty, and the only certain way of safeguarding our future so long as we remain a large food-importing country, to develop our colonial territories, particularly the underpopulated African colonies, where the increase in population that would follow the control of disease and the increase of food supply would open fresh markets for international trade. This great task will call for the intensive application of science, in collaboration with other countries. The tale of plant disease in our Colonies, for example, is a sorry one. I shall predict that unless the prevention of disease among plants and animals, and all other scientific problems of the supply of food, are studied on the same kind of scale, by men of similar calibre, as are the problems of human health, chaos and misery will result. Whatever new comforts and luxuries may be provided in future by the advance of physical science, it is on the development of the biological sciences that the peace and prosperity of the world will largely depend. Until recently there have been far too few careers open to young biologists outside the field of the medical sciences. There has been nothing corresponding to the Colonial Service, which has offered to young administrators a life of adventure nicely seasoned with economic security. All members of the British Association will therefore welcome the intention of the Government to inaugurate a Colonial Scientific Service, and will hope that the conditions of service will be such as to attract young men of the highest quality.

Challenge of the Times

We live, indeed, in difficult times. But they are very interesting times; and difficulties are bracing to a nation which has not lost the resilience of youth. We must not get into the way of thinking of our great country as an elderly man who is told by his doctor that if he is very careful of his diet, and avoids all exertion and worry, he may look forward to some years of placid life before he dies. This is a time for adventure; for taking risks. Calculated risks, of course; but not so nicely or so lengthily calculated that they are taken too late. My contacts with universities and with industry are not now so frequent or so close as I should like them to be; but they are enough to convince me that the spirit of adventure in science is as lively as it ever was. It is that spirit which will largely determine the future. Many years hence, when a president of the British Association reviews the progress of the nation from the depths of bankruptcy to new and unsurpassed heights of prosperity and influence, he may well have occasion to refer, as I did at the beginning of this address, to the great influence of the work of a few young men who are now unknown to the public; and he may justly claim that the chief cause of the change was that we had found the right way to combine originality in science with enterprise and speed in its application.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

RECENT ADVANCES IN THE STUDY OF THE CRYSTALLINE STATE

In his presidential address to Section A (Mathematics and Physics), Sir Lawrence Bragg points out that X-ray analysis of crystals may be said to have attained its majority this year. Its importance has been recognized by the formation of an International Union of Crystallography, and it takes its place with the other branches of science which have unions of their own. Laue discovered the diffraction of X-rays by crystals in 1911; now most universities have an active centre devoted to the investigation of the arrangement of atoms in matter by means of X-ray diffraction. Sir Lawrence has worked in this field from the beginning, and takes the opportunity which this address affords to review what has been accomplished in little more than a generation. X-ray analysis is a typical border-line subject. Its successes are interesting to the chemist, mineralogist, metallurgist and biologist as well as to the physicist, and this is perhaps its most attractive feature.

In X-ray analysis in general, we are seeking to interpret the manner in which a substance diffracts X-rays owing to the spatial arrangement of its atoms. Two main lines of work may be distinguished. On one hand, there is the analysis of the pattern of the perfect crystal, where the atoms have taken up positions of equilibrium under the influence of the interatomic forces; from the conformation of the structure we can gain a deep insight into the nature of these forces. This study is principally of interest to the chemist, because it presents him with a scale plan of the chemical molecule and of the way molecules or ions are held together by the intermolecular forces to form a solid structure. The results of X-ray analysis have had a profound influence on chemistry and mineralogy and solved many problems. A steady advance has been made in tackling more and more complex molecules, and a stage has already been reached where such compounds as the sugars, strychnine, sterols and penicillin can be analysed, to take a few examples. We would like to pass on to the study of such high complexes as the molecules which form part of living matter—nucleic acids, proteins and others.

The other side of X-ray analysis is concerned with what we might call the 'geography' of atomic arrangement in matter. The perfect crystal is an ideal which is rarely attained. Even if the substance is pure it is composed of a mass of crystals, and we are interested in the size and shape of the crystallites and their growth, in allotropic change, and in their preferred orientation and state of strain after mechanical treatment; if complex, we are interested in the fitting together of the crystallites of different kinds. Metastable structures often exist in which there is partial separation into regions of different composition, while a continuous crystal lattice is preserved though in a distorted form, as in the permanent magnet alloys, in martensite, or in age-hardening alloys. We can study the distortion of the lattice by the thermal waves at high temperatures. Amorphous and semi-crystalline matter can be examined. All these aspects of structure are of prime interest to the physicist and metallurgist. They are vitally interesting to the technologist, because the geography of the structure has a profound influence upon its mechanical, electrical and magnetic properties.

In this address, Sir Lawrence reviews the active centres carrying out X-ray investigations in Great Britain; examples are given of recent work, presenting a picture of what has already been achieved, and indicating the lines of exploration which are now being pursued.

SPECIALIZATION AND CULTURE IN CHEMISTRY

PROF. JOHN READ, president of Section B (Chemistry), deals with some of the problems of increasing specialization in chemistry. The growing burden of new knowledge in chemistry, as in science generally, has created many new problems for the student, teacher and research worker. These problems are largely bound up with the growth of specialization. A fundamental problem confronting the chemist is that of acquiring a proper education leading to a cultured outlook and fitting him to take his place in the world of men and affairs. What steps can be taken to combat the narrowing outlook which threatens to affect science students at all levels, and to provide for their social, cultural and spiritual needs ?

Formerly a chemistry student was trained to become an all-round practitioner of his art ; but latterly the vision of the student and research worker has narrowed. We have entered into an age of team-work. Chemical science has been aided nobly by such work ; but the individual worker is liable to sacrifice a great deal in the process.

The mental effect of an unrelieved absorption in a specialized field of science has been vividly described by Charles Darwin, and the growth of such specialization in later times has led to many criticisms of its effect upon the human subject.

It is in the schools that we view the education of the incipient scientific worker in its broadest aspect ; and it is here, helped in the ideal case by home influences, that the foundations of the necessary wider interests must be firmly laid. There ought to be no sense of antagonism between arts and science, and any form of modern education should be made up of a proper blend of each. A lively interest in literature, history, art, music or the drama, gained in early life and nurtured thereafter, would do much to solve some of the problems of specialization in science. Highly specialized teaching in science ought to be avoided in the schools.

In the universities, the way of teaching chemistry is of the first importance. Although his chemical studies must deepen rather than broaden as the student passes onwards towards research, he should always be encouraged to realize that there are a chemical geography and a chemical history, and that these offer him avenues leading to a wider horizon. Chemistry itself may become a cultural and humanistic instrument of high value. Historical chemistry is linked in turn with philosophy, literature, art, and even with music. During the student's undergraduate days a great deal could be done to arm him against the dangers of specialization, and more importance should be attached to the technique of teaching from this point of view.

During postgraduate research work the student should be encouraged to undertake a certain amount of teaching work in the junior laboratories. He should also use opportunities to migrate to new research centres either at home or abroad. A research theme of a suitable kind ought to help the student to become resourceful and to develop originality of thought, besides stimulating his imaginative and critical powers ; unfortunately, research themes often fail to fulfil these requirements. Finally, the proper education and training of the young scientific worker, with the application of the various influences that have been mentioned, including personal contact with his teachers, call for the provision of adequate staff and accommodation.

GEOLOGY TO-DAY AND TO-MORROW

THE theme of Dr. A. E. Trueman's presidential address to Section C (Geology) is the future of geology. At the present time, he points out, geology is passing through a period of very active growth. It is doubtful if at any time since the 'heroic age' of the science, a hundred and fifty years ago, there has been so rapid an increase in our knowledge of earth history. More geologists are professionally employed in all parts of the world ; many more fields of human activity are dependent on the success of their operations than ever before. They search for ores, coal, oil and water. If in the future we are to depend on atomic energy for some of our power, it will need geologists to locate the new materials. Inevitably, we shall be driven to exploit mineral resources occurring at greater depths, or of poorer quality ; while we continue to use materials from the earth's crust the geologist will have an increasing part to play in their discovery. In the course of these explorations much new information is being gathered, but many major problems still await solution.

Although geology is in this phase of active development, its results and methods are probably less familiar to the educated public in Britain than those of any of the other fundamental sciences. This widespread unawareness of geology, which is not found in most other countries, is in marked contrast with the position of fifty to a hundred years ago and calls for serious attention, for it cannot be held that any science is in a healthy condition if its work is insufficiently understood by laymen. The absence of almost any geology teaching in schools and the scarcity of teachers with any acquaintance with the subject are partly responsible for present conditions. It is claimed that geology should form part of a wide cultural education ; it can serve as a link between science and more humane studies or as a basis for a new type of synthesis.

Fortunately, the comparative lack of public interest in geology has not in recent years limited the recognition of its value by Government. Much has happened to stimulate the demand for geological advice for a variety of economic purposes, both in Britain and overseas. In the limited area of Great Britain, the Geological Survey, founded more than a hundred years ago, not only meets new demands for more detailed maps but also is required to undertake great new responsibilities. The record of its work in war years, recently published, exemplifies the wide range of activities in which geological information is necessary ; in view of the growing importance of the work of the Survey, the need for an expansion of its numbers has been recognized. The Colonial surveys, even more in need of increased support, are accepted as having a vital part in the economic development of the Colonial territories. The present Secretary of State for the Colonies has himself on several occasions appealed to young men to take up the work of geologists in these areas. The small surveys of the past have been sparsely staffed, one geologist being responsible for thirty times the area for which a member of the home survey was responsible. In the past, several Colonial geological surveys have paid for their own cost many times over by discoveries of diamonds and ores, but future results must not be judged only in terms of exportable minerals ; more bulky materials, such as limestones, clays, road materials and especially water, may contribute even more to the development of the territories. Alongside these developments of geological survey activity throughout the Commonwealth, the promotion of researches by unofficial geologists is equally essential.

In the immediate future we must expect an increasing tendency to specialization in limited fields and particularly on the fringes of the subject, as on the borderlines between geology and physics, or geology and chemistry. Advances in such fields as geophysics call for workers with more extensive training in the two subjects. The co-operation of geophysicist and geologist makes possible the interpretation of concealed structures: England south from the Wash requires special study in view of the possibilities of new coalfields. But on a wider front we may expect to learn more of submarine areas, of the structure and origin of mountains and of the larger features of the earth. Work in geochemistry, in the distribution of minerals, the origin of rocks and the nature of clays, promises rapid development. In the fields of geomorphology the problems are barely touched; in palæontology the existing data only serve to illustrate the extent of the problems to be solved. But in all these extensions of knowledge it may be hoped that it will be possible to avoid the isolation of the fields of study, relating them all to stratigraphy and the study of the structure of the earth's crust which form the 'heart of geology'.

TEACHING ZOOLOGY IN THE UNIVERSITY

PROF. H. GRAHAM CANNON discusses "Undergraduate Zoology" in his presidential address to Section D (Zoology). After the First World War, he says, the interest in zoology became almost exclusively experimental. The more orthodox attitude of comparative anatomy became the one to be avoided. This was due to a variety of reasons, but largely because, for generations, zoologists had been teaching the comparative anatomy of dead animals without worrying about how these animals lived. As a result of this changed outlook between the two World Wars, a generation of teachers has grown up who are predominantly experimentalists, and our present undergraduates run the risk of becoming very knowledgeable about the latest developments of experimental technique while knowing very little indeed about the anatomy of the animals on which they work. Recently, but somewhat tardily, it has become recognized that there is such an aspect of zoology as functional morphology, that is, a method of treatment where structures are dealt with not merely in the way in which they are built, but also, and at the same time, from the way in which they function. It is this attitude which should form the basis of undergraduate zoology.

Two main difficulties present themselves in considering the teaching of zoology to undergraduates. First, there is the modern tendency to scorn any elementary teaching and to thrust the first year's university work back on to the schools. This misguided attitude may be excusable in the more basic physical sciences and mathematics; but in the biological sciences, which, after all, utilize the physical sciences as their tools, it is completely illogical. Moreover, it is essential that the more experienced teachers, preferably the professor, should always deal with this fundamental first year's introduction to university study.

Secondly, there is the tendency almost everywhere to introduce specialist courses into the undergraduate years: a tendency which is being encouraged by the efforts of the University Grants Committee to foster the establishment of readerships or even chairs in the most abstruse specialist aspects of biology. At the undergraduate stage the students are quite unable to assimilate such courses. The sort of courses which are being established are those admirably suited for the second part of the Cambridge Tripos. But what is almost invariably overlooked is that the second part is entirely a postgraduate course. The honours degree is given on the first part of the Tripos, and this corresponds to the degrees in the 'Redbrick Universities' of honours general science. It is suggested that it would be a great advantage in all 'Redbrick Universities' to abolish the specialist honours degree altogether and insist on a first degree being taken in general science as at Cambridge. The more specialist attitude to the subject could then be left to a postgraduate year, leading preferably to a master's degree.

SOCIAL GEOGRAPHY

IN his presidential address to Section E (Geography), Lord Rennell of Rodd deals with the geographical environment of man as a social animal, and consequently does not attempt to consider the geographical circumstances of the origin of human species or prehistoric man. But the spiritual as well as the material consequences of geography on human society are considered rather by posing a series of questions, and stating a number of problems, especially in connexion with Africa, than by proposing conclusions or solutions.

Starting from the influence of geography on the spiritual as well as on the material development of society, Lord Rennell makes a strong plea, which he takes up again at the end of the address, for the teaching of geography in medium and higher education as a means of creating a bridge between the humanities and the natural sciences, which "except among the leaders of the latter group" have more and more tended to develop on independent lines divorced from each other. This tendency he dates from the decline in classical education; but he sees in geography, and especially in social geography, a new link which could be made between the two, in view of the manifold contacts which geography has with both the exact and the abstract realms of human thought.

From this point he goes on to discuss a number of problems arising in Africa. What are the reasons why Islam spread as far as the southern rim of the North African deserts but never affected the population south of the northern fringe of the forest belt? Why was the negro and negroid population of Africa antagonistic to outside civilization in spite of many opportunities of contact with more civilized people from Greek and Carthaginian times through all the period of Arab and Portuguese navigation until the European conquest? Why then, and only then, did a ferment of Western civilization begin, within say the last seventy years? Yet the civilizing influence of the Mediterranean found no difficulty in crossing the Sahara and following up the Niles until they came to a dead end against the unwillingness of the negro to adopt or adapt. Why is there no trace of writing or even ideography in Dark Africa? Why was there no true architecture, the wheel or the plough in Africa south of the deserts until the conquering European started the modern phase?

Lord Rennell goes on to discuss the anomalous and absurd consequences of the European conquest, the purpose of which, in spite of Lord Hailey's investigations, remains very obscure. He refers to the ribbon development of colonies along the coastal routes, and the strange efforts of our Colonial Office to keep separate, contiguous British territories in eastern Africa, in spite of departing substantially in recent years from the dual mandate principle in favour of "colonies d'exploitation". He concludes with the suggestion that only the geographer with a foot in each of the camps tenanted by the humanist and the natural scientist, is fitted to seek answers to the problems he raises, and is unbiased enough to propose solutions which it is incumbent on European nations generally, and ourselves in particular, to find, in order "for the sake of our own good name" to remedy the administrative and social chaos which is Africa.

THE PRICE SYSTEM

IN his presidential address to Section F (Economics), Sir Hubert Henderson remarks that the idea of a return to the price system which is widely advocated to-day is marked by the same defects that marred the idea of economic planning which was so popular a year or two ago, namely, incoherence and wishful thinking.

In its most general sense, the price system is an inevitable outcome of the use of money. So long as goods and services are bought and sold for money, there must be prices; and these prices must always exert a powerful and pervasive influence. It is important, therefore, that this influence should be a healthy one, that the configuration of prices should be such as to pull in directions which accord with the public interest. We want price relations that are right, so far as that object is attainable. But we must be careful not to beg a major question. In the matter of price relations, as in many others, it is easier to be sure that certain things are wrong than to know at all precisely what is right.

According to current price system ideology, the right price is the theoretical equilibrium price. In times of large-scale economic maladjustments, however, this concept is ambiguous. The theory of value comprises two parts, short-term and long-term, each with its appropriate equilibrium price. These prices are seldom far apart in ordinary times, when the economic system has not been subjected to any recent large disturbance. But they are apt to diverge widely when the maladjustments to be corrected are very large. It is a mistake to suppose that in such conditions the theoretical short-term equilibrium price is either what we want, or what we normally get in a free economy. There are apt to be serious and injurious anomalies in price relations when shortages are widespread.

Shortages, or surpluses, are, of course, most widespread, and the consequential anomalies most serious, when there is a large maladjustment between aggregate demand and aggregate supply. It is therefore especially important to avoid disequilibrium here. In Great Britain at the present time it is rightly a main object of policy to remove the inflationary trend in our economy. Success in this might enable us to dispense with many of the controls that irk us to-day, and to simplify others. But it would not enable us to remove them all. The regulation of long-term capital expenditure would still be desirable for a fairly considerable time, and the regulation of imports indispensable for a much longer time.

If the consuming public were free to choose, there is no reason for supposing that imported goods would represent a smaller fraction of their total purchases than before the War. Since our total rate of consumption is at about the pre-war level, this would imply imports at about the pre-war level; or an increase of more than one quarter in our present import-bill. The removal of every vestige of inflation in our internal economy, though helpful, could not radically alter this result. With a huge deficit in our current balance of payments, we are in no position to contemplate a largely increased expenditure on imports.

Price system ideologues believe that disequilibria in the balance of payments can always be corrected by variations in foreign exchange-rates. This belief is attributable to the pivotal role which they assign to the concept of equilibrium price. When, however, our import–export balance is so far from adjustment, there is a huge divergence between the short-term equilibrium rates of exchange and the long-term norm represented by purchasing-power parity. It might be disastrous to try to make our actual exchange-rates approximate to the former. It is better to keep them in the neighbourhood of purchasing-power parity; and to recognize that it will remain essential to regulate the volume of our import purchases as effectively as we now do by means of import restrictions.

More generally, the time-honoured theory of value endorses, and indeed enjoins, the humdrum practical proposition that, when large adjustments have to be made, regulation and deliberate direction may be useful or even indispensable.

THE YOUNG ENGINEER

IN the presidential address to Section G (Engineering), Wing-Commander T. R. Cave-Browne-Cave deals with the qualifications and personal qualities necessary in 'the young engineer', and treats the problem of engineering education from an unusual point of view because his experience has been in the application of engineering science to a wide variety of new developments, mainly in connexion with airships and aircraft engines. Since going to University College, Southampton, he has been dealing not only with students preparing for the external degree of the University of London, but also with apprentices following part-time courses for national certificates and still more practical qualifications. The review is based upon the knowledge and personal qualities which a young engineer should have acquired shortly after the end of his formal training, say at the age of twenty-eight to thirty, and may serve as a guide to those who are considering engineering as a career. It may also be taken as a background against which the various stages of engineering education are examined.

Mathematics is a limiting factor in the progress of a student along the main road of engineering science. It must, therefore, be of a really appropriate type and no harder than is necessary for each corresponding stage.

The general structure of engineering education should be revised so that it is possible for candidates to enter at any appropriate stage. Changes from one course to a more suitable one should be simpler than at present, and there must be fewer 'casualties' who fall out and go no further. Courses of instruction should be aimed, not at a final examination, but at the future useful application of the knowledge acquired.

The student must develop the art of learning by himself from books, because he will have to acquire in this way a great deal more science and technology than can be included in his formal training. If this is achieved, the present overcrowded syllabuses can be shortened by leaving certain parts for subsequent study when required.

Attention is directed to the importance of developing skill in clear explanation of technical matters, both in verbal discussion and in writing. The effective value of a proposal depends not only upon its technical merit but also upon the clarity with which it is communicated.

It is suggested that national service for students who are to read for a degree should be taken between the intermediate examination and Part I of the final degree examination, and that the fighting services should arrange this year to give, in addition to military training, a good practical groundwork similar to that given in the first year of service technical training. The year of national service would then be a valuable addition to the degree course as well as a foundation for future war service, if required.

Personal qualities, judgment, effectiveness, enterprise and determination are so important that they must be considered in the selection of a candidate and must be developed throughout his training.

The address is intended to open a general discussion on engineering education, relating it definitely to the knowledge and qualities which experience shows to be desirable in later engineering work. It contains much new and possibly contentious matter, which, with the discussion on it, should form a useful contribution to the developments which now have to be made in engineering education at all levels.

INVESTIGATION OF FOLK-LIFE IN BRITAIN AND ABROAD

MR. R. U. SAYCE discusses folk-life in his presidential address to Section H (Anthropology). Until about 1914, Britain occupied a well-recognized place in the front rank of folk studies; but since that time it has been falling further and further behind, and appears to a great extent to have lost touch with the developments that have taken place in European countries. A few scholars continue to produce work of distinction; but they lack a common meeting ground, where adequate discussion can stimulate thought and help them to see their special problems in relation to the whole. There are even societies devoted to dialects and place-names, beliefs and customs, dance and song, which have scarcely any contact with one another, although they are all concerned with the culture of the folk. In spite of this fragmentation, we are realizing, as general ethnologists have already done, that a culture must be studied as a whole. This, of course, makes our studies more complex, but also far more interesting. It also needs special training; the student of folk-life must know something of the methods of, and the results achieved by, archæology, history, psychology, anthropology, to say nothing about architecture, agriculture, technology, etc. There can be little doubt that the present unsatisfactory state of British studies in this field is due largely to the failure of the universities to provide the necessary training.

Folk-culture is very closely related to ethnology and to history, and could only neglect one of these indispensable allies at great loss to itself. For many years it has enjoyed close contact with ethnology, to which it is greatly indebted; but it has neglected its second essential partner, so much so that it has been in danger of becoming an unimportant appendage of the former. Nevertheless, a very slight knowledge of our problems is sufficient to make it clear that their solution depends on a historical approach. The subject does not consist of an inert mass of survivals from a vague and generalized past. The contents and their vitality change. Sometimes customs and beliefs appear to survive only in remote circles or among the least educated, and these periods may be succeeded by others when irrational ideas spread rapidly and become widely current. We can see fluctuations of this kind in western European civilization as well as in that of ancient Greece.

The impression must not be given that folk-culture deals only with 'primitive thought' and superstition; it includes the whole way of life of the people—their houses, clothes, food, work, and recreations. All these change, sometimes abruptly, at other times almost imperceptibly; old elements drop out, and new ones come in. For a knowledge of the changes we have to turn to a much closer co-operation with historians and archæologists.

At the present time, certain long-established interpretations of European folk customs are being challenged. A new school of folklorists questions whether the old harvest customs, for example, had any connexion with beliefs in vegetation spirits, and suggests that scholars like Maunhardt and Frazer made insufficient allowance for the spirit of jollity and of competition that would be quite natural where young men and women are for the time working together in the fields. The new school recommends a more modern, functional approach to the problems. There is very much of interest in their arguments, but the question is essentially a historical one. What did the medieval peasant think about the powers that influenced growth and fertility? Did he hold animistic beliefs, or was the hare that dashed out of the last standing corn nothing more than a hare? Until we can answer such questions, it would be as dangerous to apply ideas derived from studies of harvesters during the last century or two to their forerunners of a thousand or two thousand years ago as it would be to accept a modern educated African as a guide to the conceptions and emotions that underlie the age-old tribal customs.

In conclusion, Mr. Sayce makes a strong appeal for properly trained workers in Britain, and for the fullest possible intercourse with scholars in those countries where studies of folk-life have made so much more progress in recent years than they have done in Great Britain.

RECENT ADVANCES IN COLOUR VISION

IN his presidential address to Section I (Physiology), Prof. H. Hartridge discusses recent views on the mechanism of colour vision. Colour vision to-day, he says, is in a situation not very different from that of nutrition half a century ago. The solid constituents of the diet—the proteins, the fats and the carbohydrates—were well known and understood. All major problems concerning them had been solved and there was really little more to be found out about them. Then suddenly the importance of the accessory food factors, the vitamins, began to be disclosed. Substances, small in amount, became of prime importance in dietetics, and we know to-day how much our health and well-being depend on these accessory food substances.

Atomic physics might be taken as a second example of a branch of science where not many years ago all problems appeared to have been solved and everything to be known. We have only to look back at the last thirty years to realize how very limited our outlook really was in those days.

Human colour perception to-day is in a similar situation, because, until quite recently, most—if not all—known visual phenomena were adequately accounted for either on the three-colour theory of Thomas Young or on the four-colour theory of Ewald Hering. But we are beginning to suspect that things are not quite so simple as they seemed and that there may be present in the human retina certain accessory receptor mechanisms, not embraced by either of these theories, which, however, play an important part in man's colour sense. The questions which now confront us are similar to those which claimed the attention of the early workers on the vitamins.

So far as present evidence goes, there appear to be four additional types of receptor, three of which have a single maximum of activity in the spectrum, which is situated in the yellow, in the blue-green or in the blue. The fourth has two regions of activity: in the extreme red and in the extreme violet; and for this reason may be referred to as 'the crimson receptor' mechanism. These four accessory mechanisms, which play a relatively unimportant part in foveal vision at medium visual angles and at medium light intensities, hold a very different position when these conditions are departed from. Thus in the dichromatic zone of the retinal periphery, at medium light intensities and at the fovea at very high intensities, two of these subsidiary receptor systems, the yellow and the blue, hold a predominant position. On the other hand, at very low light intensities and at very small visual angles, the two receptor types which are most strongly represented are the crimson and the blue-green.

While nearly every phase of human colour perception, when closely examined, discloses evidence of the presence of these supplementary receptors, the idea that there are four of them, or that they have the properties preliminarily assigned to them, may have to be modified in important respects as additional knowledge is acquired.

Lessons of a valuable kind are to be learned from a study of the history of the vitamins; because, whereas only a few years ago a few appeared to suffice, we now have overwhelming evidence that there are many. So it may be with the visual receptors. At this juncture the important point is for us to recognize that accessory receptors are present in the human retina, and then to concentrate attention on the wider problems which their presence involves.

PRESENT-DAY TRENDS IN BRITISH PSYCHOLOGY

PROF. REX KNIGHT, in his presidential address to Section J, remarks that more than sixty years have now passed since the "Encyclopædia Britannica" first published in 1886 Ward's famous article on "Psychology", which William James at once described as "marking the transition of British psychology from one epoch to another". Ward's article showed that psychology was no longer to be regarded as a branch of analytic or speculative philosophy, but as a positive science concerned with the systematic investigation of matters of fact. Since it appeared, striking changes have occurred in the scope, methods and practical usefulness of psychology in Great Britain.

In scope, there have been five major developments. First, physiological psychology, which everyone except Bain neglected in the 'eighties, has come into its own. This has been due to the advocacy of Sully and James, the general acceptance of the evolutionary theory, the researches of neurologists like Lashley and Sherrington, and the influence of the behaviourists.

Secondly, psychology is no longer preoccupied with cognition. The work of James, McDougall and Freud has developed an intense interest in dynamic psychology, and at least as much attention is now given to the conscious and unconscious motives that underlie thought and behaviour as to the processes which are involved in the acquisition of knowledge itself.

Thirdly, sixty years ago psychologists concerned themselves mainly with human beings, and with human beings who were adult, civilized and normal. Now animal psychology, child psychology, anthropological psychology and abnormal psychology are all prominent features of the psychological landscape, and are receiving much attention.

Fourthly, psychology was generally regarded in 1886 as the study of man as an isolated individual, whereas present-day psychology is much concerned with man as a member of society.

Fifthly, the last sixty years have seen the development of mental tests, which, though originated by Galton before Ward's article appeared in the "Encyclopædia Britannica", have been developed during the present century in Britain chiefly by Spearman, Thomson and Burt.

In method, there have also been five notable changes. First, introspection, which dominated the field in 1886, has been supplemented by observation of behaviour and exploration of the unconscious. Secondly, experimental psychology, which was disparaged by most nineteenth-century British psychologists, has established itself. Thirdly, the anecdotal method, once so common in psychology as well as biology, is under sentence of banishment. Fourthly, field-studies have become as important as laboratory investigations. Fifthly, the statistical principles and techniques appropriate to psychological data have received great attention.

In practical usefulness, psychology in Britain has moved during the period under review from a stage where applied psychology was almost unknown to one where psychology is constantly being applied to the practical problems of public and private life. Educational psychology is now an important ingredient in the training of teachers, and educational psychologists are becoming established members of the staffs of education authorities. Psychiatry is a recognized branch of medicine, and clinical psychologists are employed in many fields. Occupational or industrial psychology, the development of which in Great Britain owed so much to Charles Myers, was used on a large scale in the Second World War, and is now being used in the drive for greater productivity.

STUDY OF THE BRITISH FLORA

IN his presidential address to Section K, Prof. J. R. Matthews begins by referring to some of the more noteworthy landmarks in the history of British botany. The exact recording of native plants, an essential preliminary to the formulation of any scientific account of them, dates from the time of William Turner. Although new records have continued to be made down to the present time, the discovery and discrimination of more than a thousand species of vascular plants before the death of John Ray in 1705 remains an outstanding tribute to the work of the early explorers. Much of the subsequent floristic work was carried out by botanists who made no claim to be called professional, and it often found expression in the publication of local or county floras. The value of these surveys could not be seriously doubted, and there is a growing need for their encouragement and support by all responsible authorities, public or private, who have the desire to see a revival of interest in the scientific study of local natural history.

The edifice of British botany raised by the early naturalists gradually became expanded and enlarged, and by the end of the nineteenth century, knowledge of the composition of the native flora was relatively complete. The distribution of plants had also attracted considerable attention, and Great Britain had become one of the best botanically explored countries in the world. But along with other subjects, botany shared in the general scientific renaissance which occurred in the early years of the twentieth century. Although the systematic study and recording of plants continued, greater emphasis began to be laid on the ecological approach to field studies. The investigation of heredity and the study of variation by the experimental method and the advance of cytology were at once recognized as sources of valuable data contributing towards an understanding of the species problem, which had followed the enunciation of the Darwinian theory of evolution. Detailed ecological studies of individual species throughout the range of distribution were necessary, if the responses to changing environmental conditions were to be correctly interpreted. Such investigations were closely connected with problems of taxonomy, since it was evident that much intraspecific variation was related to environmental gradients. It should therefore become the purpose of experimental taxonomy to examine and analyse the heterogeneous nature of the species complex and correlate the results of such analysis with those derived from physiological and ecological studies. Investigations along these lines would prove of immense value in the application of scientific botany to the practice of horticulture, agriculture and forestry.

THE SCHOOL IN A PROGRESSIVE SOCIETY

IN his presidential address to Section L (Education), Mr. W. O. Lester Smith points out that school business has increased rapidly in recent years, affecting each of the leading partners in educational administration—the Ministry of Education, the local authority, the head teacher and his colleagues. It is worth considering how this has come about, and there would seem to be three main causes: social change, the widening scope of education, and the modern emphasis on management. The administrative pressure on the head teacher is more serious in its consequences than that on the other two partners, because hitherto in Great Britain we have regarded the school as the natural growing point of educational thought and technique, and we owe much to the creative wisdom of some of our great head teachers.

It is usual to attribute the increase of administration to the growing demands of Government departments; but this is a partial diagnosis, for the preoccupation of the head teacher with managerial detail began not in the schools associated with the State but in the independent public schools from the days of Thring onwards. It was due largely to the emphasis in these schools on an active corporate life and on giving each pupil a full or 'total' education. In a sense, therefore, the criticized Rugby appointment of an administrator as head master was but a logical recognition of a process that has been unfolding itself for a century.

The head teachers of the primary and secondary schools associated with the State in Britain are now being diverted from their educational task by a growing administrative pressure, and this is particularly unfortunate because the abolition of the elementary school by the Butler Act was a historic opportunity; and the heads of the schools emerging from the elementary tradition ought to be free to concentrate on the difficult task of making education a living force in the social democracy now taking shape. Just when imaginative leadership is urgently necessary, the head teacher's function is becoming increasingly managerial as a result of the growth of corporate activities, the demands of society, and the aftermath of Government schemes and schemes launched by well-meaning importunate organisations.

Some of the new demands are necessary and desirable, but others are hard to justify. There is also an increasing use of schools for extraneous purposes, involving the necessity of putting away daily all equipment and appurtenances of educational or æsthetic value. We cannot hope to achieve quality unless we are prepared to put education first; and it is regrettable that, owing to shortages of staff and buildings, we make a habit of measuring progress in quantitative terms. The schools of the people were for centuries retarded by what Defoe called the law of subordination, and to-day Demos is apt to treat his schools like the old feudalism writ large.

One of the most difficult issues is to determine the extent to which schools should respond to the many claims which society makes upon them. There is general agreement that they cannot to-day thrive in isolation, or, as the McNair Report puts it, teachers cannot be "a race apart". On the other hand, there is a limit to sociability, a plimsoll line at which service to the community becomes a danger to education. If a service rendered by a school fits naturally into the curriculum or the corporate life, it may provide useful educative experience; but if there is a marriage of convenience designed primarily to further an extraneous scheme, there can be serious waste of teacher- and pupil-time without compensating advantage. We ought, as a nation, to recognize before it is too late that the essential function of each school is to educate, and that of each head teacher to give expert guidance to his team in the conduct of an extremely difficult operation, requiring human sympathy and a sure grasp of the intricate problems of childhood and adolescence.

AGRICULTURE AND THE WORLD FOOD PROBLEM

IN his presidential address to Section M (Agriculture), Dr. G. Scott Robertson compares the present world food problem with that in 1798 when Malthus put forward his theory that populations tend to outrun their means of subsistence. The invention of machinery, the discovery of artificial fertilizers, the development of transport and colonization for a time made his views seem unduly pessimistic and out of date, but two world wars have brought up afresh the problem of attempting to provide adequate food for the peoples of the world.

The two chief factors responsible for the present situation are the rapid increase in the world's population (estimated at 20 million per annum) and the improved standard of living of that population. Fortunately, the prospects of finding a solution are more hopeful to-day than they were a hundred and fifty years ago, when hand labour and primitive tools set a limit to agricultural production, for by merely applying existing knowledge and making a fuller use of available resources, the world output could be doubled or trebled in a relatively short time. The Food and Agriculture Organisation is doing valuable work in pointing the way by which this can be done, and the only permanent solution seems to be in increasing production in each country. The requirements of India and China, for example, are so vast that outside help would be inadequate even if it could be provided and the immense transport difficulties overcome.

Aid from the more advanced countries can best be given by helping the less developed ones to modernize their agriculture so that they can feed their own peoples. To do this, very large quantities of fertilizers will be required, and fertilizer manufacture must form a part of their industrialization. Even in Europe and America, much could be done to improve output. More attention to the growing and conservation of grass, for example, would increase milk and meat production and at the same time reduce the competition with the human population for cereals. Enormous economies in grain crops could also be achieved if the ravages of pests during storage were prevented; the knowledge exists and only the practical application of it is needed. The Council of the Food and Agriculture Organisation has already taken this matter up and recommended member countries to take immediate and concerted action in such matters.

Losses in the animal world from disease are estimated as even more serious than in the case of crops, and the necessity for preventing this wastage becomes the more vital as the standard of living rises not only in advanced countries but also in the more primitive.

Improved nutritional standards will inevitably mean changes, for agricultural produce will have to play a more important part in world trade than in the past, and the old conception of exchanging agricultural for industrial products gradually give place to an interchange of agricultural products. Restrictions, such as tariffs and quotas, will have to disappear, for no country should be forced into a form of agriculture unsuited to its soil and climatic conditions. The peoples of the world, in fact, will not be properly fed or any real prosperity achieved until there is both a greatly increased output and the fullest interchange of the products of agriculture on a world-wide scale.

THE CORRESPONDING SOCIETIES AND THE COMMUNITY

THE president of the Conference of Delegates of Corresponding Societies, Prof. H. J. Fleure, deals in his address with the relationship between the corresponding societies and the community. Many such societies belong to and have opportunities to serve our cities and counties in the important and necessary effort to re-emphasize social life, which has been submerged by the crowds that have taken the place of traditional groups, crowds made up of atomized individuals. Rousseau, Hobbes and others have too often spoken as though human society were made by the coming-together of individuals, whereas it is in society, itself basically a heritage from pre-human phases, that human individuality has struggled towards expression. The group again and again has sought order through imposed uniformity; the individual has, increasingly, rebelled and has immensely extended men's vision. We need only read anything written about man and the universe before Copernicus, Bruno, Galileo, Newton and Darwin to realize the importance of the newer ideal "We seek the truth"; imposed uniformity may prevail for a short time, but it must fade; it closes the mind.

In the late eighteenth century steam-power and mass-production set society sailing on an uncharted sea and found it philosophers to justify or excuse exploitation under the theory of *laisser-faire*. The atomization of the individual, the submergence of society in the crowd, have been widespread with unfortunate consequences. The corresponding societies and the British Association, both pledged to the search for truth, can help one another and our communities towards rehabilitation. The local society can help and advise planners in their work of adjusting the environment and can bring wisdom from the past without, one hopes, imposing that as a dead weight on the future.

The Education Act, 1944, assigns 'secondary' status to many schools hitherto primary, and in these the education, for the less bookish, must be to a considerable extent visual. Members of local societies can help in the schools to spread knowledge of the locality, can guide school parties, promote local museums of folklife, publish books and booklets that will help teachers and pupils to understand their locality; and the British Association can help with advice on such work; it could also organise short conferences in many towns and cities which cannot quite manage the full annual conference, sending delegates specially chosen because of the help they can give. Contacts spread over a few days and extending into the field as well as the lecture room can be more vitalizing and have a more enduring effect than visits of a lecturer for one evening's meeting.

Co-operative research on land utilization, on interpretation of Domesday and other historical surveys, on local names and implements, land tenures and field systems can all be made to help rehabilitate social life. Much of this work can find expression not only in the transactions of local societies, but also in local museums made intelligible to the public, in improved education with partnership between the societies and the teachers and pupils, as well as in scientific contributions to a National Atlas of Britain, a new survey of land utilization and many other efforts of both planners and historical and scientific searchers.

NEWS and VIEWS

Death of President Beneš

By the passing of Dr. Eduard Beneš on September 3 at the age of sixty-four, Czechoslovakia loses its former president, and the world loses a cultured and learned man who had striven for the welfare of all mankind during the past forty years. Born in the Bohemian village of Kožlany on May 28, 1884, Beneš studied philosophy, philology and sociology at Prague and later at Dijon, where his thesis was "Le problème autrichien et la question tchèque". Beneš then spent a short time in London and Berlin before returning to Prague, where he attracted T. G. Masaryk's attention. In 1915 Beneš escaped to Geneva, and with Masaryk and Štefánik (a Slovak astronomer who became an air force general and Czechoslovak War Minister) organised Czech resistance to the Central Powers. Beneš became Czechoslovak Foreign Minister of the first provisional Government, and after the republic was established in October 1918, he retained that post in successive administrations until he succeeded Masaryk as president in 1935. His work became more arduous with the rise of Nazism in Germany, and Beneš had soon to face another exile. Returning in 1945 as president of liberated Czechoslovakia, he was confronted with greater problems than before, since war and occupation had brought more distress than the First World War.. The strain of post-war anxieties, the events of February last and Jan Masaryk's suicide, deeply affected him. President Beneš, who had always maintained an interest in learning and culture (especially in the social sciences) made his last public speech on April 7, at the sexcentenary celebrations of the University of Prague (see *Nature*, May 1, p. 670). Among the exhibits in connexion with these celebrations were several items associated with Benes' academic life, including the original Dijon thesis. Since February, President and Mme. Beneš had lived in their country house at Ústí Sezimovo in south Bohemia and had taken no part in public affairs, although he did not resign from the presidency until June 7. Like the Masaryks, Beneš was a 'great European' with wide vision, and though his work for greater understanding among peoples seems recently to have been in vain, he has shown mankind the way.

Presentation to Sir John Parsons, C.B.E., F.R.S.

At a ceremony held in the Royal College of Surgeons on September 3, Sir John Parsons was presented with his portrait in oils, painted by Mr. John Gilroy. The presentation was made by Sir Stewart Duke-Elder, in the name of the members of the Faculty of Ophthalmologists and the Ophthalmological Society, and to mark the celebration of Sir John's eightieth birthday. It is good that Sir John's long and strenuous career has met with such a fitting and happy culmination, for he has long been the acknowledged leader in all aspects of British ophthalmology—clinical work, basic research and public activities. For more than a generation he has been the recognized leader in the clinical practice of this specialty, and opthalmologists of a much wider circle than Great Britain to-day treat their patients better because of his precepts and his writings. So long as ophthalmology is a science, his name will be remembered for the work he did fifty years ago as a pioneer in ophthalmic pathology. To-day he is still the foremost authority in the fundamental sciences concerning vision—biological, physiological and psychological. In guiding, stimulating and encouraging ophthalmic research he has in his time stood out almost alone. In all problems concerning vision successive Governments and industry have asked and received his help; he served in the two World Wars, in the First as consultant to the Army, in the Second as adviser to the Royal Air Force; in international ophthalmology he has consistently been an acceptable and gracious British ambassador; and for years he was the dominant figure in the social and political life of the ophthalmologists of Britain.

Probably, however, the greatest contribution which Sir John Parsons has made is the historical continuity he has succeeded in maintaining between the past and the future. In his youth, ophthalmology in Britain was great among the nations; but later—largely because with the evolution of science, individual effort had to give place to organised effort for which we were not prepared or equipped—ophthalmology undoubtedly lost its place in Britain. He was largely responsible for reinvigorating it to what may be a future as great as or greater than its past. To-day those who have eyes to see may discern the beginnings of the fruits of his labours. Thirty years ago he was responsible for interesting the Medical Research Council in ophthalmological problems, and to-day these are fully consolidated. Twenty years ago he endeavoured to bring about an amalgamation of London hospitals and inaugurate a research institute; to-day, that is an accomplished fact. He was primarily responsible for the inauguration of the Faculty of Ophthalmologists, and to-day it is growing lustily. To him and to all of us these promising developments of his ambitions ought to be a source of satisfaction.

Physiology at the London Hospital

Prof. D. T. Harris

Prof. D. T. Harris, on whom the title of professor emeritus has been conferred by the University of London, is to retire at the end of the present session from the chair of physiology which he has held at the London Hospital for the past sixteen years. Prof. Harris studied physics as a special subject at Cardiff, where he took his B.Sc. in 1904. He graduated in medicine at Manchester in 1914 and after holding various hospital appointments and experiencing general practice served as a temporary captain in the R.A.M.C. After a short period as lecturer in physiology at Manchester under Prof. William Stirling, he joined the Institute of Physiology at University College, London, where he held a Beit Memorial Research Fellowship and as Sharpey Research Scholar came under the influence of Sir William Baylis and Prof. E. H. Starling. He obtained the D.Sc. London in 1926 and held the post of assistant professor of physiology in University College, London, when he was appointed to the chair at the London Hospital in 1932. Throughout his academic career Prof. Harris has maintained his interest in physics, his scientific work being mainly concerned with problems arising in the territory bridging physics and physiology, and in particular with the biological action of ultra-violet radiations and ultra-short waves. His contributions to knowledge of these subjects have been published in a series of papers in the *Journals of Physiology, Biochemistry* and *Scientific Instruments*, and his textbook on "Ultra-Violet Radiation" is widely used by operators of ultra-violet lamps who wish to study underlying principles and methods of measurement. In another direction he applied his knowledge of physics to his hobby—photography—and this brought him in contact with the scientific research workers in the cinematograph industry, to whom he gave a series of lectures on stereoscopy.

In the immediate post-war period of intensified university education of 1919–22, Prof. Harris found full scope for his exceptional and natural aptitude for teaching. Large numbers of medical students, and in particular the ex-Service group who came back to complete their medical studies under a sense of urgency to make up for lost time, have cause to be grateful to him for the personal interest he took in their problems and for the systematic clarity of exposition which characterized his lectures and the practical courses he gave for the examinations of the University of London and the Royal Colleges. His book on experimental physiology is used by students in many parts of the world. As a teacher and examiner, Prof. Harris has played a notable part in medical education during the past thirty years, and his many friends will be gratified to learn that, even after his retirement from the London Hospital, he will actively participate in the developments in the teaching of physiology sponsored by the Royal College of Surgeons.

Agricultural Research Council: Lord Rothschild

THE Committee of the Privy Council for Agricultural Research has appointed Lord Rothschild to be chairman of the Agricultural Research Council in succession to Lord De La Warr. Lord Rothschild was born in 1910 and was educated at Harrow and Trinity College, Cambridge, of which he was a fellow during 1935–39. He served in the Army Intelligence Corps during the War and was awarded the George Medal in 1944; was mentioned in dispatches and received the American Bronze Star and Legion of Merit. Lord Rothschild is a biologist, who has carried out research work in the Department of Zoology at Cambridge and has published a number of scientific papers; he has also agricultural interests. He is a member of the boards of the British Overseas Airways Corporation and the Overseas Food Corporation.

Central African Scientific Liaison Office: Mr. R. McChlery

ON September 1, the Central African Council established, on behalf of the Governments of Southern Rhodesia, Northern Rhodesia and Nyasaland, a Central African Scientific Liaison Office in the British Commonwealth of Nations Scientific Offices, Kingsway, London. This arrangement whereby three Colonies, acting jointly, follow the lead of the Dominions by appointing a scientific liaison officer to London provides an interesting new phase in the developing pattern of Commonwealth scientific relations. Mr. R. McChlery, who becomes the first Central African scientific liaison officer in London, went from school at Salisbury, Southern Rhodesia, to take a science degree at Rhodes University College, Grahamstown. He was then awarded a Rhodes Scholarship and proceeded to Exeter College, Oxford, where he obtained the B.A. degree in chemistry in 1925 and the B.Sc. degree in 1926. Following a short course of study at Rothamsted Agricultural Research Station he returned to Southern Rhodesia to join the Chemistry Branch of the Department of Agriculture, where he has since been employed, mainly on problems connected with soil fertility and crop production.

Oxford Science

Oxford Science makes a welcome reappearance after an absence of nearly nine years. Under the general editorship of F. A. Holland, it gives a survey of scientific development in the University of Oxford and is particularly designed to keep the person with a scientific education informed of the progress made in fields of science other than his own. Articles in the present issue (2, No. 1, June 1948) are by A. J. Birch and D. K. C. MacDonald on metal-ammonia solutions; C. J. Dickenson on functional organisation within the cell; J. D. Dunitz and S. C. Wallwork on some developments in structural chemistry; A. H. Cooke on magnetism at low temperatures, and H. M. Sinclair on nutritional science. In the editorial, reference is made to the part played by Oxford men of science in the nation's war effort, to the new laboratories under construction or about to be constructed, and to the closing down of the last of the college laboratories, so that laboratory teaching is now entirely in the hands of the University staffs. Only brief mention is made of the important physical work done in the new Clarendon Laboratory; but a fuller report can be found in *Oxford*, **9**, No. 2, p. 54 (1946–47). Those interested in the progress of chemistry at Oxford may like to refer to the article by F. M. Brewer in *Oxford*, **9**, No. 3, p. 98 (1948), which is very informative.

United States Book Exchange

A BUREAU for the international exchange of books and periodicals between libraries, scientific and educational institutions of the United States and other countries has been opened in the Library of Congress, Washington, D.C. The organisation, known as the United States Book Exchange, is a successor to the American Book Centre for War Devastated Libraries, Inc., and the executive director is Miss Alice D. Ball, formerly acting director of the Book Centre. While the new organisation will continue the rehabilitation programme of the Book Centre, libraries of foreign countries are expected to become members of the new Book Exchange and contribute material to the programme as well as draw from it. During the past two and a half years, more than 1,250,000 volumes have been sent out by the Book Centre, to war-devastated libraries in thirty-one countries. At first the activities of the Book Exchange are being limited to printed matter of scientific or literary character; this will include books, pamphlets, periodicals, government documents, music, printed leaflets, and occasional papers. At present no microfilm and microprint will be dealt with, and no motion pictures, art reproductions and newspapers; but it is hoped eventually to handle all types of printed and filmed material.

Mitigation of Spray Injury

IT is an essential prerequisite of a fungicidal spray that it should not itself cause damage on the plants to which it is applied. This is, unfortunately, not always the case, for lime-sulphur sometimes causes early leaf-drop on the apples Cox's Orange Pippin and Worcester Pearmain. M. H. Moore has shown (*J. Pom. and Hort. Sci.*, **23**, 3 and 4, Dec. 1947) that this damage can be greatly reduced by adding 4 lb. of ferrous sulphate crystals to every gallon of lime-sulphur concentrate before dilution. Sprays against apple scab were made according to the usual schedule. The relative effects of calcium arsenate and lead arsenate separately mixed with lime sulphur as post-blossom sprays were also estimated. Calcium arsenate powder proved more toxic to the apple leaves than lead arsenate paste of much less arsenic oxide equivalent. The inclusion of ferrous sulphate in the mixtures, however, reduced the leaf-drop; but did not markedly prevent fruit-drop. Zinc sulphate provided no suitable alternative to ferrous sulphate; it was highly phytotoxic.

Parallelism between Atomic and Planetary Properties

A SHORT article with the above title in *Nature* of May 15, p. 780, directed attention to the formulation by M. F. Prunier of a wave equation for astronomical planetary systems similar to Schrödinger's equation for atomic systems. It has just been brought to our notice that a somewhat similar hypothesis had been put forward earlier by Mr. B. Liebowitz, of New York (*Phys. Rev.*, **66**, 343; 1944). His equation is satisfied by a variable which he calls the "probability of presence". The subsequent development, very surprisingly, seems to show that for a purely classical problem concerning the planets, akin to Bode's law, using purely classical arguments, an equation can be obtained which has the same form and meaning as Schrödinger's essential non-classical equation. But, in sharp opposition to the conclusion of M. Prunier, Mr. Liebowitz says that there is no implication of a magnetic moment associated with the angular momentum. It will be recalled that the possibility of such a relation, particularly for the earth's magnetism, has been much discussed since Prof. Blackett's article in *Nature* (**159**, 658; 1947) was published.

The Coco-nut Research Scheme

THE annual report for 1944 of the Coco-nut Research Scheme (Government Record Office, Colombo, Ceylon, 40 cents, 20 pp., Jan., 1948) shows that in addition to many routine analyses of copra and coco-nut products, a more detailed examination of the dry distillation of coco-nut shells has been made. The yield of pyroligneous acid was 38·2 per cent and of settled tar, 5·6 per cent. Total acid (as acetic) accounted for 11·6 per cent of the pyroligneous acid, which also contained about 3 per cent of wood spirit. An attempt to use coco-nut shells as a starting material for the preparation of furfurol gave rather poor yields. Manurial experiments with nitrogen, phosphorus and potash indicate that only the potash increased the yield of copra, beginning at the fourth year from commencement of applications. On poor soils, complete manuring with all three major nutrients gave a marked increase in the number of female flowers. Various other experiments on cultivation are also described in the report.

The Royal Anthropological Institute

THE report of the Council of the Royal Anthropological Institute for July, 1947–June, 1948 has appeared. It is pleasing to gather that real progress has been made in all directions. The Institute has always been handicapped through lack of means and in other ways. Though these disabilities have by no means all been overcome, improvement can be clearly noted. The membership is rising, and the library is now in better order. Much activity has been shown in many directions. The Institute fulfils an important function in a country like Great Britain which lies at the centre of a great Empire, and every effort should be made to help it to do what it alone can accomplish for the study and understanding of the many primitive peoples it is still our lot to sustain.

Erdoel und Kohle

THE former German oil journal, *Oel und Kohle*, has now appeared under the title *Erdoel und Kohle* (von Hernhaussen, Hamburg; annual subscription, 60 marks). The first issue of 56 pages was brought out by Dr. Karl Zerbe in June. Its contents cover the future problems of petroleum geology and geophysics and the possibilities of applying secondary recovery methods. In the refining section there are articles on the progress of hydrocarbon synthesis and dewaxing. Scientific abstracts and short commercial notices are included. This journal is the official organ of several technical associations.

Seventh Pacific Science Congress

THE Seventh Pacific Science Congress will be held in Auckland and Christchurch, New Zealand, under the auspices of the Royal Society of New Zealand, and with the assistance of the Government of New Zealand, during February 2–22, 1949. As in previous Congresses, members will be classified as official members (delegates representing the constituent countries of the Pacific Science Association and specially invited guests), members (accredited by scientific bodies) and participants. The Congress will be organised in ten divisions, and within divisions there will be a varying number of sections. The programme is arranged in the form of symposia for the discussion of topics of wider interest for the Pacific peoples; within divisions, subjects of specialist or technical interest will be presented at section meetings. Among the subjects for symposia are: structure of the Pacific basin; Antarctic and Pacific meteorology; oceanography and fisheries of the Pacific; biogeographical provinces; soil resources; ethnographic studies in Micronesia; medical and nutritional problems of the Pacific area. The president of the Congress is Mr. R. A. Falla, president of the Royal Society of New Zealand and director of the Dominion Museum, Wellington; the secretary-general is Mr. Gilbert Archey, director of the Auckland Institute and Museum, Auckland, S.E.1, to whom all communications should be addressed.

Announcements

THE Queen has been graciously pleased to accord her patronage to the Royal Society of Edinburgh, of which H.M. the King is patron.

AT the National Gallery, London, Mr. Martin Davies, who is chiefly in charge of the library, and Mr. Ian Rawlins, scientific adviser, have been appointed deputy keepers.

MR. J. V. CONNOLLY, who has served since 1937 at the Air Ministry, Ministry of Aircraft Production and Ministry of Supply, recently as assistant director of aircraft production, has been appointed professor of aircraft economics and production at the College of Aeronautics.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Creep of Metals and Recrystallization

THERE has been a certain amount of dispute as to the fundamental laws of creep of polycrystalline metals[1]. I have advanced the view that the normal creep of a rod extending longitudinally under constant stress can always be represented fairly closely by the formula

$$l = l_0(1 + \beta t^{1/3})e^{kt},$$

where l is the length at time t, l_0 is approximately the initial length and β and k are constants. This gives a final rate of extension per unit length which tends to become approximately constant. On the other hand, it has been contended that there is a final state of accelerated creep, called[2] by some metallurgists Stage 4. When the total extension is of some per cent, this stage is often obtained in tests at constant load and can then, on my view, be attributed to increasing stress, consequent upon the thinning of the specimen. As argument against this, it has been pointed out that the increasing rate of creep has been obtained with extensions of less than 1 per cent in the case of certain steels at high temperature (see Fig. 1)[3]. This I have, however, attributed to recrystallization during the process of creep, recrystallization having been shown to produce increased rate of flow in certain cases[4].

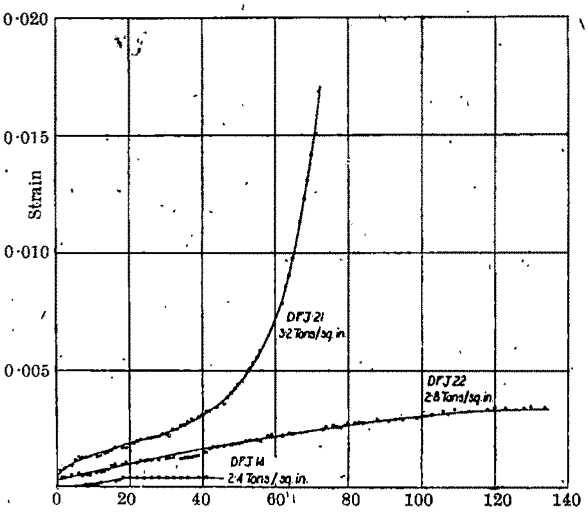

Fig. 1. Creep of a high-nickel–high-chromium steel at 800° C.

Certain experiments which Miss Charmian Sinclair has been carrying out with me on the flow of metals under constant stress throw light on this point. The metal in question is a pure lead (Tadanac virgin lead, of purity approximately 99·99 per cent) which was prepared by extrusion at 100° C. and kindly supplied to me by Mr. G. L. Bailey, director of the British Non-Ferrous Metals Research Association. It turns out that this metal, although normally stable at atmospheric temperature, recrystallizes under stress, the crystals increasing in size from about 0·05 mm. up to about 0·3 mm. linear dimensions.

Fig. 2 shows length against time for a range of stresses, each stress being maintained constant during flow by an Andrade–Chalmers constant stress bar[5]. It will be seen that the form differs markedly from that obtained with normal metals, which is represented by the broken line, obtained with normal lead extended at about the same temperature at constant stress. For the recrystallizing lead there is a stage of accelerated creep during the first ten minutes which is followed by a final creep at an approximately constant rate. The form of creep curve during the first ten minutes resembles closely that for the steels at high temperature. Whether the steels would, at like extension, ultimately creep at constant rate, cannot be said, but the 2·8 tons/sq. in. curve suggests that it may be possible.

It is clear, in any case, that recrystallization during creep has a fundamental effect on the form of creep curves. So far we have examined the wires microscopically only before and after creep, and noted the very marked recrystallization that has taken place. We are about to examine the state of crystallization at different stages of creep, with the object of connecting the rate of creep with the process of recrystallization.

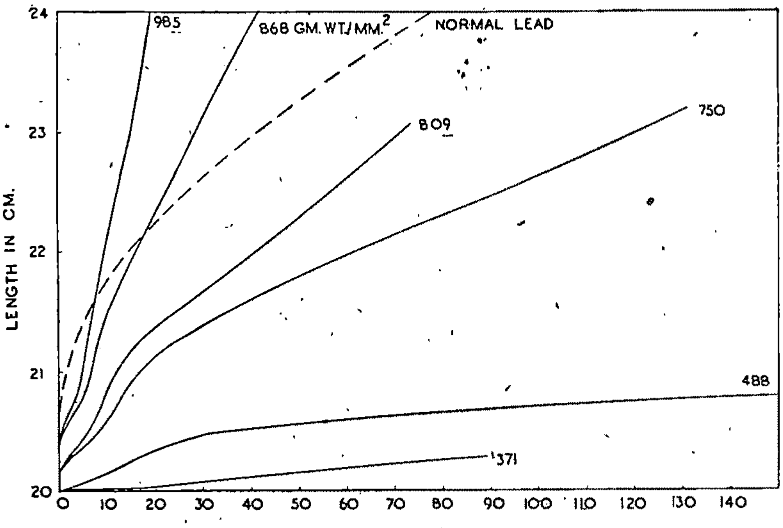

Fig. 2. Creep of a very pure lead which recrystallizes under stress

E. N. DA C. ANDRADE

University College,
London, W.C.1.
June 29.

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[1] For example, *Nature*, 157, 469 (1946).

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[3] Tapsell, H. J., and Remfry, J., D.S.I.R. Engineering Research Special Report No. 15 (1929).

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Creep of Metals Subjected to Compression Stress

THE progress of creep in metals in the case of applied tensile stress is usually divided into three stages: (1) an initial decelerating rate of creep (primary creep); (2) a stage of approximately constant creep-rate (secondary or steady state creep); (3) a final accelerating state of creep, leading to fracture (tertiary creep often ascribed in materials undergoing large deformations to increase in stress due to decreasing cross-sectional area as creep proceeds).

We have conducted creep tests in compression at a constant load on some typical creep-resistant nickel–chromium alloys, which in tensile creep tests at the same initial stress and temperature show the three stages of creep referred to above. During the course of these tests, we have made the following observations:

(*a*) The creep-rate in the secondary or constant state stage of creep is approximately the same in tensile and in compressive tests.

(*b*) Tertiary creep occurs in compression as well as in tension, and its onset in compressive tests occurs at approximately the same time as in tensile tests.

(*c*) Whereas in tensile tests, creep in the tertiary stage proceeds at an accelerating rate until fracture ensues, in corresponding compressive tests creep proceeds in a series of accelerating and decelerating rates.

Fig. 1 illustrates a typical compressive creep test showing primary and secondary creep, the onset of tertiary creep, and a stage of decelerating and accelerating creep in the tertiary stage. Fig. 2 is a comparison of the tensile and compressive creep of samples of identical alloy under the same conditions of stress and temperature. The accelerating rate of tertiary creep in the tensile specimen and the stages of acceleration and deceleration in the tertiary creep stage of the compressive creep specimen should be noted.

We believe that this is the first observation of tertiary creep in compression tests. The fact that it occurs after the same time has elapsed in both tension and compression tests suggests that its onset in tension tests in these materials is in no way connected with the increase in stress resulting from a reduction in effective cross-sectional area due to creep. Increase in stress due to decrease in cross-sectional area is, of course, a factor accelerating creep in materials such as pure metals tested at stresses that cause relatively large deformations to occur during the creep test.

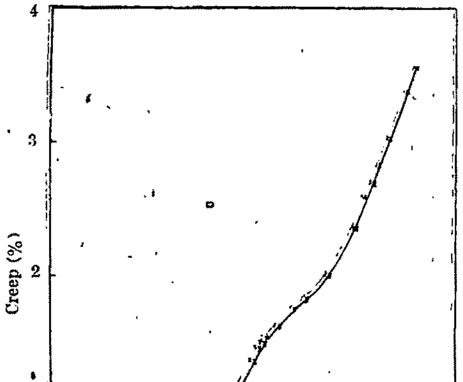

Fig. 1. Creep test in compression on a complex nickel-chromium alloy under a stress of 3·5 tons/sq. in. at a temperature of 900° C.

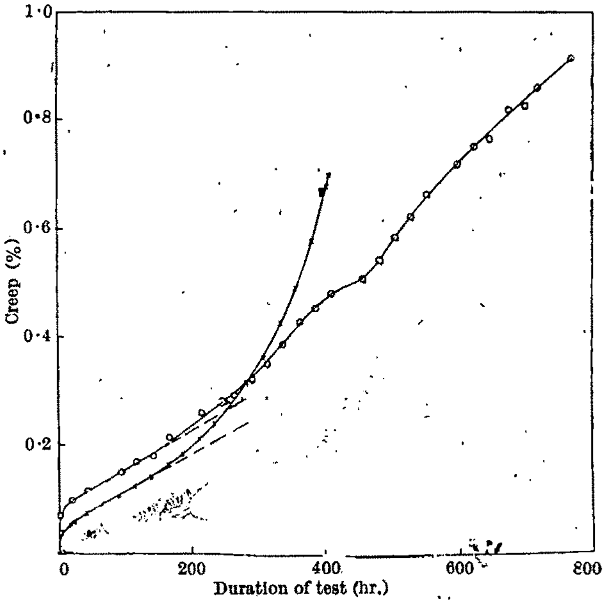

Fig. 2. Comparison of tensile and compressive creep under a stress of 9 tons/sq. in. at a temperature of 815° C. x, tension creep test; o, compression creep test

It is suggested that a study of the differences between tensile and compressive creep in the tertiary stage may enable certain deductions to be made about the mechanism by which this stage of creep occurs. We tentatively suggest that, in both tension and in compression, tertiary creep is initiated by atomic rearrangement in the most heavily strained zones adjacent to the crystal boundaries, the onset of which may be determined by the amount of strain which the specimen has undergone. This rearrangement may represent the initial stages of a recrystallization process similar to that which has been stated by Greenwood and Worner[1] to be responsible for successive stages of accelerating and decelerating creep in tensile creep tests on lead and lead alloys. If this acceleration of creep-rate occurs by slip processes in the zones adjacent to the boundaries, it will lead to misfit at grain boundaries and, in the case of applied tension, to the formation of fissures at the grain boundaries at large angles to the applied stress, causing a further acceleration of creep-rate and rapid fracture. The formation in tension of such fissures at or near the grain boundaries and an accompanying decrease in density have been demonstrated by Hanson and Wheeler[2].

In compressive creep, we suggest that such fissures in boundaries making large angles to the direction of the applied stress cannot form as readily as in the case of tensile creep, so that creep may proceed by a series of hardening processes, due perhaps to the blocking of dislocations, and to recovery processes akin to the onset of recrystallization. These hardening and recovery processes may be localized in material adjacent to the grain boundaries, due to the stress concentrations in these regions brought about by flow in the boundaries.

We intend to make further correlation of compressive and tensile creep in materials free from the metallurgical complexities of commercial creep-resistant alloys, in order to obtain further data.

We are indebted to the Ministry of Supply, under the sponsorship of which the work was conducted, for permission to publish these results, and to Mr. W. H. Mayes, who was responsible for the construction of the apparatus, which was similar in principle to a machine in use at the National Physical Laboratory.

A. H. SULLY
G. N. CALE
G. WILLOUGHBY

Fulmer Research Institute, Ltd.,
Stoke Poges, Buckinghamshire.
July 6.

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Isotopic Assignment of the α-Activity of Samarium

THE recent report by Dempster[1] that the earlier conclusion of Wilkins and Dempster[2] regarding the α-active isotope of samarium is unreliable makes necessary the revision of a great deal of past speculation. Previously the α-activity was assigned to ^{148}Sm ; now it appears that ^{152}Sm is almost certainly the isotope responsible.

It is the object of this note to point out that (once the shock of this radical re-assignment is forgotten) the new result is more easily reconcilable with other evidence than is the old. Earlier arguments attempting to explain why the range of elements neodymium (60) to samarium (62) is particularly liable to α-disintegration, and seeking to compare this range of elements with that neighbouring upon polonium (84), the most α-unstable of the classical radioelements, are not affected; but the details of the picture are filled in with much greater consistency than before.

The outside evidence of most direct relevance is that regarding isotopic hyperfine structure in the spectra of neodymium and samarium. With samarium, Schüler and Schmidt[3] found an anomaly in the relative separations of the isotopic hyperfine structure components ; later a closely similar anomaly was found by Klinkenberg[4] with neodymium. For all other even-numbered elements so far examined the isotopic hyperfine structure consists of components which to a good approximation are linearly spaced in respect of mass number on a frequency scale (at least so far as the components of even mass number are concerned). With samarium this linear spacing is interrupted by an abnormally large interval between the components of mass numbers 150 and 152, and with neodymium there is similarly an unusually large interval between components of mass 148 and 150. Basically these anomalies are interpreted as evidence for an abnormal increase of nuclear radius (more exactly of the proton-occupied volume of the nucleus) between ^{150}Sm and ^{152}Sm, as also between ^{148}Nd and ^{150}Nd ; scarcely less directly they may be regarded as evidence for a 'discontinuous' decrease in nuclear binding energy as between these pairs of even isotopes. Classifying on this basis the samarium isotopes of mass numbers 144, 148, 150 and the neodymium isotopes 142, 144, 146 and 148 as 'tightly bound' and the samarium isotopes 152, 154 and the neodymium isotope 150 as 'loosely bound', it is clear that the only possibility for α-disintegration from a loosely bound samarium to a tightly bound neodymium is, in fact, the possibility $^{152}\text{Sm} \xrightarrow{\alpha} {}^{148}\text{Nd}$. There is every reason to expect, therefore, that ^{152}Sm is the predominantly α-active samarium isotope. A tentative suggestion to this effect was, in fact, made by Schüler and Schmidt[3] in 1934.

Returning to the comparison of the α-activity of samarium with that of the classical radioelements—and with the α-activities of the polonium isotopes in particular—we may note how recent results serve to correct previous misconceptions. Previously it has been too readily assumed that α-activity becomes more pronounced as the mass number (A) decreases ; for polonium (84), at least, the work of Howland, Templeton and Perlman[5] shows that this is not the case. The annexed table gives the total energy of α-disintegration (E) of the isotopes from $A = 206$ to $A = 218$. The pattern of variation is obvious from the figures quoted. The 'pure α-active' species for this element ($Z = 84$) are the isotopes of mass numbers 208, 210, 211, 212, 213 (?), 214 and 216 ; these are the species which correspond to the stable isotopes of the elements[6] of atomic number $Z \leqslant 83$. It is clear that the maximum α-disintegration energy in this case ($Z = 84$) belongs to the even-numbered isotope, which occupies the mid-place in the sequence of β-stable species $A = 208, 210, 212, 214, 216$. The case of samarium is seen in comparison to be not so different as might previously have been supposed.

A	206	207	208	209	210	211	212	213	214	215	216	217	218
E (MeV.)	5·3	5·2	5·24	?	5·40	7·58	8·95	8·45	7·83	7·51	6·90	(6·45)	6·11

N. FEATHER

Department of Natural Philosophy,
University of Edinburgh.
July 26.

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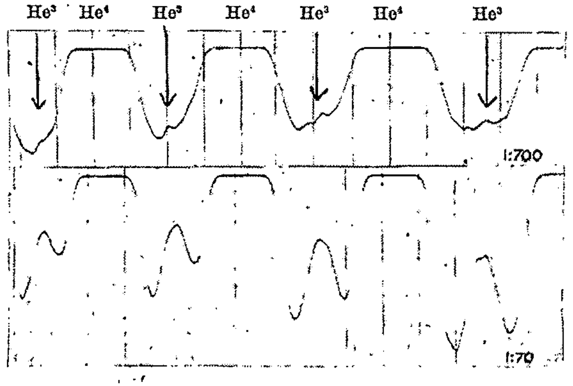
Spectrum of Helium-3

THE possibility of obtaining samples of helium in which the isotope of mass 3 has been enriched allows the isotope shifts in the arc spectrum of this element to be investigated. The first samples, which had kindly been made available to us by Dr. Rollin and Mr. Hatton[1], had been prepared by means of thermal diffusion, and contained helium-3 in a concentration of 1 : 700. With an ordinary Fabry Pérot étalon, the detection of satellites several hundred times weaker than the main line is impossible, owing to the finite background intensity of this instrument. This difficulty was overcome by the use of two étalons, of equal spacings, in series. By suitable choice of apertures, distances and orientations of the wedge-shaped étalon plates, it was found comparatively easy to avoid secondary reflexions. The method appears to be very useful for the investigation of faint satellites very close to strong lines.

The upper part of the figure shows a photometer tracing of the line 2^1S–3^1P, 5015 A., photographed with two étalons in series, each of spacing 0·318 cm. The peaks due to helium-3 are small, but clearly visible between the large peaks of helium-4, which appear flattened at the top as the result of over-exposure. A sample in which the helium-3 had been



further enriched to a concentration of 1 : 70 by the method of evaporation at very low temperature[1] became available later, and its spectrum is shown in the lower part of the figure. Comparison of the two tracings demonstrates the enrichment achieved by this method. Rough photometric estimates of the intensities agree with the concentration of the samples measured in the mass spectroscope.

The background which appears in the tracings is largely due to the finite width of the helium lines, not to instrumental effects. The intensity ratio 1 : 700 does not, therefore, represent the limit of sensitivity of the method.

In the highly enriched sample, the satellite could also be photographed and measured with a single étalon. The helium-3 line was found to have a separation of $-0\cdot83 \pm 0\cdot03$ cm.$^{-1}$ from the helium-4 line.

A theory of isotope shifts in two-electron spectra due to mass effects has been developed by Hughes and Eckart[2,3]. It is based on the assumption of hydrogen-like wave functions with effective nuclear charges. On the basis of their calculations for the $2P$ states, the value of the effective charge Z_s for the $1s$ electron in the $3P$ states can be assumed to be 2·00, giving a value of $Z_p = 0\cdot996$ for the $3p$ electron in the 3^1P state. This gives an isotope shift of the line 2^1S–3^1P of $-0\cdot77$ cm.$^{-1}$, which is outside the limits of error of the experimental value. The difference may be due to the approximations contained in the theory, or to the influence of factors other than the pure mass effect.

Details of the spectroscopic method will be published elsewhere.

L. C. BRADLEY*
H. KUHN

Clarendon Laboratory,
Oxford. July 22.

* Rhodes scholar.

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Vibrating Electrodes in Polarography

THE constant diffusion conditions necessary for polarographic work have hitherto been attained by use of the dropping-mercury electrode, the streaming mercury electrode[1], the rotating platinum micro-electrode[2], or even by a fixed micro-electrode and a constant electrolyte streaming-rate[3].

We have found that a platinum micro-electrode vibrating at a constant frequency (100 cycles per second) with an amplitude considerably greater than its linear dimensions gives constant diffusion conditions, and with such an electrode we have obtained reproducible polarograms. The electrode is free from irregularities due to external vibration and gives smoother curves than those obtained with the dropping-mercury cathode.

E. D. HARRIS
A. J. LINDSEY

Sir John Cass Technical Institute,
Jewry Street, London, E.C.3.

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Evidence of Geological Age against Decay of Tin-115 to Indium-115 by Electron Capture

ACCORDING to a rule of nuclear stability, it is improbable that two neighbouring elements (neighbouring Z) have stable isotopes of the same nominal mass, that is, stable neighbouring isobaric pairs should not exist. A few apparent exceptions to this rule are known, one of which is the pair, $_{49}In^{115}$ and $_{50}Sn^{115}$.

In indium, the relative abundance of In^{115} is 95·5 per cent, and in tin, the relative abundance of Sn^{115} is 0·4 per cent: In^{115} is thus an abundant indium isotope, whereas Sn^{115} is a minor tin isotope; this has caused some nuclear physicists, for example, Fluegge[1], to suggest that Sn^{115} has probably decayed by orbital electron capture to In^{115} during the life-period of the earth.

Recently Kohman[2] has discussed β-stability of all nuclei, and by means of his β-stability diagram has been able to predict that for the pair, Sn^{115} and In^{115}, Sn^{115} should be unstable, which accords with the above suggestion by Fluegge[1]. Kohman[2] refers to an earlier paper by Eastman[3], which, on the basis of atomic mass calculations, would also favour decay of Sn^{115} to In^{115}. A later paper by Eastman[4] invokes geochemical evidence, namely, the association of traces of indium with tin in tin minerals, as indicative of electron capture decay to indium-115. Since this publication appeared, many more tin minerals have been analysed, notably cassiterite; in some, traces of indium have been found, whereas in others no indium could be detected. Of considerable interest is a paper by Itsikson and Rusanov[5] which reports analyses of many specimens of cassiterite from the U.S.S.R.: the useful conclusion is made that although specimens of cassiterite associated with sulphide veins usually contain traces of indium, specimens from pegmatite are likely to be free from detectable quantities.

Direct observations on the production of characteristic X-radiation which would result from electron capture decay by tin-115 have been made by Zingg[6]. His results are inconclusive, as, in three specimens of tin he examined, very feeble activity could be detected, whereas in a fourth specimen no activity was observed. Later, similar observations by Rusinov and Igelnitzky[7] failed to reveal the presence of any X-radiation, and these authors set the minimum value for the period of half-life (T) for Sn^{115} as greater than $1\cdot0 \times 10^{13}$ years.

As a result of the considerable diversity of opinion and experimental evidence mentioned above, I have attempted to utilize geochemical evidence of the type referred to before, for establishing whether significant decay of tin-115 by electron capture decay has taken place or not. For this purpose, three requirements have to be fulfilled: the absolute age of the mineral has to be known; this age must be extremely great—

if possible, of the same magnitude as the age of the earth—and, finally, contamination by non-radiogenic indium has to be reduced to an absolute minimum.

The age of the earth appears very likely to be of the magnitude of 3,000 × 10^6 years, according to Holmes,[8] Houtermanns[9] and some astronomical data, and minerals of the greatest geological age yet reported are, according to Ahrens[10], from pegmatites in south-eastern Manitoba, Canada: the age of these pegmatites from this area is given as 2,100 × 10^6 years and is based on strontium and lead age measurements. These pegmatites are thus of extreme age, the magnitude of which is comparable with the age of the earth. In greisenized portions of some of these pegmatites, cassiterite occurs, and according to Itsikson and Rusanov[5], pegmatitic cassiterite is likely to be freest from the presence of even traces of indium. Consequently, a spectrochemical analysis was made of a specimen of cassiterite from pegmatite (south-east Manitoba), which had been kindly supplied by the Department of Mines and Natural Resources, Winnipeg, Canada. Only a doubtful trace of indium was observable, equivalent in quantity to the limit of detection for the spectrochemical determination of indium in cassiterite, which, with the aid of a series of standards, was estimated to be very close to 0·0001 per cent indium. This value represents the maximum concentration of indium in the specimen of cassiterite, and as the tin content of pure cassiterite is about 75 per cent Sn, the period of half-life (T) for tin-115 is equal to or greater than 5·0 × 10^{12} yr.

From this analysis of cassiterite, several conclusions may be made: (1) The relative abundance of indium-115 (95·5 per cent) in natural indium, and the paucity of tin-115 (0·4 per cent) in natural tin, cannot be attributed to electron capture decay of Sn^{115} during earth periods. (2) The presence of traces of indium in many tin minerals is not due to decay of tin-115 because, even in the oldest known specimen of cassiterite (2,100 × 10^6 yr.), only a doubtful trace (equal to or less than 0·0001 per cent indium) could be observed. (3) Should tin-115 have decayed very feebly indeed to indium-115, the rate of decay is extremely slow, and T (Sn^{115}) is equal to or greater than 5·0 × 10^{12} yr., which accords with the observations of Rusinov and Igelnitzky[7], who determined T as 1·0 × 10^{13} yr. by direct experiment. The spin[11] of In^{115} is 9/2, whereas that of Sn^{115} is 1/2; this difference in spins is very great indeed, and should decay occur, an extremely long life would be expected.

The spectrochemical analyses were made in the Department of Mineralogy and Petrology, University of Cambridge; grateful acknowledgment is made to Prof. C. E. Tilley for providing facilities for carrying out the investigation.

L. H. AHRENS

Department of Mineralogy and Petrology,
University of Cambridge. July 17.

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Human Colour Vision and Granit's Theory

GRANIT'S brilliant experiments on electroretinography[1] have led him to postulate photopic and scotopic 'dominator' mechanisms which have all the properties of independent brightness receptors, and 'modulator' mechanisms which may give cues to colour because they are sensitive to relatively narrow bands of the visible spectrum. Many of the animals on which the experiments were done, such as the cat, rat, guinea pig and frog, are totally colour blind to the best of our knowledge; and Granit points out (*a*) that most laboratory animals, with the exception of the snake, possess very few modulators relative to their dominator units; (*b*) that these proportions in the highly colour-sensitive human fovea are not known; (*c*) that the demonstration of modulator units is not in itself a proof of the presence of colour vision.

In a previous communication the factorial analysis of a battery of colour vision tests, including red, orange, yellow, yellow-green, green, blue-green, blue, violet and purple, with corresponding brightness measurements, was reported[2]. This seemed to give strong support to a four-colour theory of the Hering or Houstoun type. There is, however, every reason to suppose that such results might be co-ordinated with Granit's findings.

In a subsequent series of tests, the following results were obtained on a group of 357 subjects with normal colour vision, the brightness readings being separately inter-correlated with the measurements of colour sensitivity, though there was, of course, only a single brightness-level measurement for each colour pair, because the tests were of the Rayleigh equation type.

Test	Factor loadings		
	I	II	III
Red	0·070	+0·767	−0·226
Yellow	0·007	+0·104	−0·451
Green	0·121	−0·683	−0·069
Blue	0·459	−0·061	+0·236
Y-blue brightness	0·179	−0·268	+0·395
R-green brightness	0·252	+0·141	+0·115

It seems reasonable to suppose that factorial analysis would tend to reveal any consistent patterns of variation in the sensitivities of the underlying visual mechanisms, and therefore to indicate their number and nature. In this analysis, as in the other analysis of the results for normal subjects[2], the first factor is light but represents general variabilities irrespective of differential hue sensitivity; the second factor is heavy and represents variability in the bipolar red-green sensitivity; and the third factor is light and represents variations in yellow-blue sensitivity. The variations of brightness sensitivity are distributed among the three factors. 'Blue' and brightness are the best representatives of the general factor; red-green brightness tends to vary with red, but yellow-blue brightness with green in the second factor; both yellow-blue brightness and red-green brightness with blue in the third factor.

It might be suggested that the general factor represents variations in the sensitivity of the dominator mechanism for photopic vision. The second factor would then represent the variations in sensitivity for the red-green modulator unit and the third factor the variations for the yellow-blue modulator unit. Three important conclusions may be drawn from this application of Granit's theory to the result of tests of colour vision upon normal human subjects: (*a*) that four modulators would be sufficient, namely, red, yellow, green and blue; (*b*) that they must be regarded as operating in two bipolar units, red with green, and yellow with blue; (*c*) that brightness is to some extent dependent on the modulator units.

R. W. PICKFORD

Psychology Department,
The University,
Glasgow, W.2.
May 24.

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A Simple Technique for the Differential Staining of Lignified Cell Walls

THE common methods for differential staining of lignified plant tissue are specific when used correctly, but minor errors in procedure may lead to unsatisfactory results. The following simple technique has been found a reliable, cheap and quick supplement to the other methods available, and to give good results in unskilled hands.

It is based on the observation that, in all cases which we have examined, a colourless solution of benzidine imparts an orange or yellow colour to lignified cell walls, but causes no colour change in cellulose or in cutinized or suberized walls. The most intense orange coloration is produced by a saturated solution of benzidine in glacial acetic acid. With lowered acidity the solubility of benzidine decreases, the resulting solutions producing a less brilliant but equally specific staining. This develops in sections after thirty seconds to sixty seconds treatment; but as the solution is colourless and the reaction occurs only in lignified tissue, sections can be left in it for many days without 'overstaining', and there is no need for subsequent washing or 'destaining'. This is an advantage when handling sections in bulk, it being possible to transfer them to the solution directly after cutting and to hold them in it until it is convenient to mount them with or without a light counter stain. A less acid solution may also be used for the vital staining of tissue, as vascular systems of leaves, etc., are clearly visible after impregnation. The colour is unaffected by treatment with alcohol or xylol, and has shown no signs of fading in sections exposed to daylight for three months.

In view of the constitution of benzidine, the chemistry of the staining is possibly similar to that of the colour reaction given by lignified cell walls with a number of primary and secondary amines.

IWO R. W. LOMINSKI

Department of Bacteriology,

S. A. HUTCHISON

Department of Botany,
University of Glasgow.
July, 1948

Influence of Time and Temperature of Storage on Dye-Reduction Tests in Milk

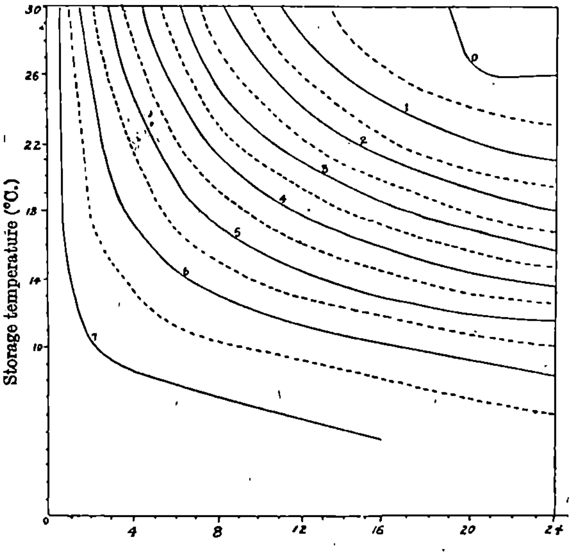
IN applying overseas data to the determination of suitable dye-reduction standards for the grading of milk in New South Wales, it soon became apparent that particular attention would have to be paid to the influence of time and temperature of storage on the reduction time[1]. Apart from Smythe's work in Queensland[2], for a relatively limited storage time, there is surprisingly little information concerning the significance of these factors, and it is thought that our own approach and results will prove of interest beyond Australia.

The primary aim of our work has been to study the trends in decrease of dye-reduction times with storage time and temperature, including within the range of our experiments conditions likely to be encountered both in Australia and Britain. By this means it has been possible to bring to bear on our own problem the large body of British experimental work and practical experience, as well as to arrive at a temperature compensation scale for local variations that are likely to be more extreme than those encountered in the United Kingdom. Samples from six producers, representing extremes of production conditions, were taken at the completion of milking and stored at combinations of time and temperature, namely, 4, 8, 12, 16, 20 and 24 hr. and 0, 10, 14, 18, 22, 26 and 30° C. Methylene blue and resazurin tests (both at 37·5° C.) were then performed on each sample.

With the advice of Dr. D. B. Duncan, of this Department, it has been possible to use the results so obtained to study the trends with storage time and temperature as a regression surface, having twelve parameters and allowing for quadratic variation with storage time and cubic variation with temperature as well as interaction between the two. The results for the modified methylene blue test are shown in the form of a contour graph (reproduced herewith) in which the lines join the points of equal reduction times. From this graph it is possible to arrive at an approximation of reduction time associated with any combination of storage time and temperature; but more fully the surface is represented by the equation:

$$Y = 7{\cdot}2 - 0{\cdot}005\,t + 0{\cdot}00027\,t^2 - 0{\cdot}047\,T + 0{\cdot}019\,tT - 0{\cdot}00044\,t^2T + 0{\cdot}0047\,T^2 - 0{\cdot}00293\,tT^2 + 0{\cdot}000039\,t^2T^2 - 0{\cdot}00010\,T^3 + 0{\cdot}000048\,tT^3 - 0{\cdot}00000005\,t^2T^3\,;$$

Y is reduction time in hours, t is storage time in hours, T is storage temperature in °C.



Influence of time and temperature of storage on methylene blue reduction time. Lines join points of equal reduction time in hour – half-hour intervals

The surface represented in the graph and the accompanying equation appears, from a consideration of British temperatures (as recorded at Kew), to pass through the British Summer Standard (12 hr. storage at mean summer air temperature of 16° C., reduction time, 4½ hr.). However, the height of the surface can be conveniently altered by adjustment of the constant (7·2 in the above equation) to comply with any other standard.

Similar methods have been applied to data for the resazurin tests obtained on the same milks, thus permitting an accurate comparison of the time–temperature trends together with a comparison of existing British standards for both tests. Our data suggest, in fact, that the standard set for resazurin[3] is appreciably lower than that for methylene blue[4].

Furthermore, by taking account of data for the individual producers, it is possible to determine the degree of discrimination associated with each combination of time and temperature; so that the storage period can, within certain practical limits, be adjusted to obtain greater sensitivity in the test.

Other advantages of our approach might then be summarized thus. Comparable standards can be established for widely different conditions of production. A reasonable adjustment in acceptable reduction time can be made throughout the year according to temperature and time of storage, thus freeing the test of its present undue dependence on atmospheric temperature[5]. The length of time between production and testing can be allowed for in evaluating producers. The time–temperature effect can be related for several tests.

R. K. MORTON
J. M. VINCENT

Milk Research Laboratory,
School of Agriculture,
University of Sydney,
April 19.

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Pregnancy Test using the Male Toad

THROUGH the kindness of the originator of the test, who forwarded us a supply of *Bufo arenarum* Hensel, we have recently been able to carry out the Galli Mainini male toad test for pregnancy.

Ten ml. of urine are injected into a lymph sac of the toad. It is important to note that the animals seem particularly susceptible to drugs in the urine. But apart from this fact, the urine samples need no special preparation. The appearance of spermatozoa in the urine, which constitutes a positive result, is observed by low-power microscopic examination of a drop or two obtained by a pipette from the cloaca. We have found the test to be positive in 2–4 hr., depending on the time of examination. In some cases, a positive result occurs in one hour and the amount injected may be reduced to 5 ml. Within 20–24 hr., re-sampling of the urine shows either absence of spermatozoa or fewer and non-motile spermatozoa. The temperature averaged 22° C. during the tests.

In a consecutive series of fifty inoculations, we have encountered no false positive and only one false negative. This latter may be explained on the basis that the urine sample was abnormally dilute. The series included gonadotrophins, cases of confirmed pregnancy, incomplete abortions, uterine fibroids, secondary amenorrhœa and normal women.

Over a limited series, we have confirmed claims made for this test by Galli Mainini[1], Lima and Pereira[2], who used *Bufo marinus*, and Wiltberger and Miller[3], using *Rana pipiens*. It remains to be seen whether *Bufo bufo* or *Rana temporaria* will be equally suitable.

MAGNUS HAINES

Department of Pathology,
Chelsea Hospital for Women,
Dovehouse Street,
London, S.W.3.
June 15.

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Shortage of Scientific Text-Books

As one who is associated with a group of firms dealing with all aspects of the production, publishing and retail selling of learned, scientific and technical books, I have read with very considerable interest the article on the survey of the present shortage of scientific text-books in Cambridge carried out by the Cambridge Branch of the Association of Scientific Workers which appears in *Nature* of August 7, p. 209. Unfortunately some of the conclusions appear invalid.

That there is a shortage of text-books in this category there is no question. Under present conditions it is inevitable that in any discussion of this shortage mention must be made of the Board of Trade, so let me at once pay tribute to the officers of the Board of both the Import Licensing and Raw Materials Divisions, who have been approachable at all times, and, I am convinced, have done their utmost, often in circumstances of considerable difficulty, to ameliorate the position.

That too great a proportion of British scientific text-books has to be exported is a statement difficult to support. Export there is and must be; but there are few scientific books which are exported to an extent which harms the home market.

With regard to American books, the surveyors appear to be under one serious misapprehension. Despite what they say, it is possible for any individual requiring any American learned, scientific and technical book to go into a bookshop (preferably one with some experience of this type of work) and to order that book. If it is in print in the United States, there is no reason why it should not be in Great Britain within a month of the order being placed.

Secondly, with regard to the 200 per cent quota: this figure, taken in conjunction with the 'single copy' *modus operandi* referred to above, should be adequate to meet requirements at the present time. I agree that it is not so; but the reason lies not in the 200 per cent total figure but in the allocation of that figure on the basis of individual firms' imports during either the last half of 1939 or the first half of 1940. The reason is quite simple—in ten years the emphasis of business has altered as between firms, both booksellers and publishers, in Great Britain so that the ratio of supply does not fall in the regions where the requirements are greatest.

If the 200 per cent total were to be re-allocated (a difficult but not insuperable task) according to present-day demands, many of the difficulties would be eased and indeed might very well disappear, provided the 'single copy' method of working is used intelligently. This point has been put on more than one occasion to the Board of Trade who, I believe, are shackled by Treasury restrictions.

With regard to the Survey's comments on British books, there is one misunderstanding which should be got rid of immediately: for books in this category paper is no longer a restrictive factor in so far as quantity is concerned. The Board of Trade in conjunction with the Publishers' Association maintain a reserve, known as the Moberly Pool, for 'educational' books: this has been gradually increased as circumstances allow, and it has been administered with the utmost fairness and with the approbation of all concerned. After fairly extensive inquiries, I have yet to find a publisher with a sound case who has been refused an allocation which he required for a book in the categories under discussion. There still are, of course, difficulties with paper in regard to quality and price.

The only other difficulty with material is in regard to cloth. This would appear to be a difficulty not of the basic essentials being unavailable but of the output of the Lancashire mills. Again, both with cloth and with boards there are reasons for complaining of quality and of price.

The production obstacles which any publisher must confront at present are very slowly easing in the field of printing, although a shortage of apprentice entrants as compositors during the war years has caused a bottle-neck which it will take some years to overcome.

In binding books the position is bad indeed. But the lack is not of material, apart from cloth, but of machinery: nearly all of it American. The Board of Trade has been helpful in every way, but the fact must be faced that the source of supply is limited in the beginning, so long as there are so few British types of machines suitable for the work which must be undertaken.

But the main difficulty with regard to all production hold-ups is the shorter working week and the policy which has been psychologically instilled into the minds of so many of the workers that they can expect more pay for less work. This factor cannot be overstressed, and until it is remedied we can expect no real improvement in the supply of scientific text-books.

JOHN GRANT

Oxford.

MAY I be permitted three comments on Mr. Grant's letter. With regard to his third paragraph, the original article did not suggest that too great a proportion of scientific text-books is being exported. It was stated "that a good case can be made out for the large percentage of book production which goes to export". It was emphasized, however, that this trade and reputation "are in danger unless our total volume of 'learned, scientific and technical' book production is increased, so that both the home and export markets may be better supplied".

On Mr. Grant's fourth paragraph, it was specifically stated in the article that no account was taken of books imported as single copies as this factor was not thought to be important so far as students are concerned. In fact, our experience is that it takes 8–10 weeks to get such books and often longer.

If binding causes great difficulties, have the publishers considered bringing out temporary editions of some of the most needed books in an unbound form similar to *Nature* or *Hansard*. Students to-day could be relied on to treat them with due care.

ROY INNES

Association of Scientific Workers,
15 Half Moon Street,
London, W.1.

International Exchange of Scientific Information

IN the editorial article in *Nature* of August 14, in criticizing a recent statement of the Atomic Scientists' Association, it is argued that collaboration between scientific men east and west of the 'Iron Curtain' may be undesirable, because it is likely "to promote, for the present, a one-way traffic to the disadvantage of the Western democracies". This view was expressed in the same words on July 14 by the editor of the *Economist*, who, professionally concerned as he must be with economic policy and its effect on foreign affairs, may be excused for including scientific ideas among the commodities available for exchange. But the same view expressed in *Nature* suggests a change in the traditional policy of the journal, which has always stressed the international aspects of science, and it shows strikingly the way in which military considerations can affect the outlook of scientific workers and lead them to adopt against their will a totalitarian view of their function. It is therefore necessary to inquire whether these military considerations really make it necessary to abandon the whole tradition of science, and to break off such contacts as are still possible with the scientific workers of Eastern Europe.

It is stated in the editorial that the man of science in totalitarian countries is essentially a servant of the State, and that it is treason for him to divulge any knowledge save as the State allows. But in fact this statement is true only in the opinions of the men who control the Government of the U.S.S.R.; we may be sure that most scientific men in the satellite countries would not take that view of their functions, and probably many outstanding men in Russia itself hold other views.

Our policy, then, of allowing the free exchange of ideas even across frontiers is one which our scientific colleagues in these countries will feel to be the right policy, and in which we shall have their sympathy. It should not be lightly thrown away through the fear that some small help might be given to their military science.

N. F. MOTT
(Vice-President,
Atomic Scientists' Association)

H. H. Wills Physical Laboratory,
Royal Fort,
Bristol 8.
Aug. 20.

THE CORE OF THE INSULIN MOLECULE

By Dr. J. A. V. BUTLER, D. M. P. PHILLIPS
AND
Miss J. M. L. STEPHEN
S. A. Courtauld Institute of Biochemistry,
Middlesex Hospital, London

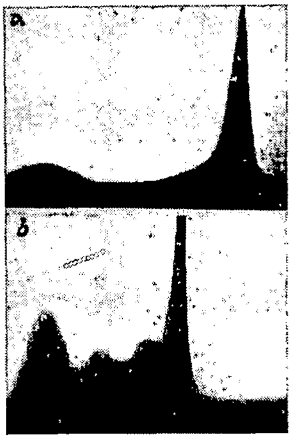
ON account of its stability and well-defined crystalline character, insulin is a favourable point at the present time to attack protein structure. Its composition is probably better known than that of any other protein. The stoichiometrical molecular weight, that is, the least weight into which all the analytical values can be fitted, is 12,000, indicating a comparatively simple character[1]. Recent researches[2] show that the most prevalent molecule in aqueous solution has a molecular weight approximately four times as great, dissociating somewhat in acid and moderately alkaline solutions. The facts, therefore, suggest that the basic unit of insulin is a molecule of molecular weight 12,000. X-ray analysis has indicated that three of these units form the unit cell in crystals[3].

Knowledge of the chemical structure of insulin has been greatly advanced by Sanger[4], by the use of the reagent fluorodinitrobenzene, which reacts with the amino-groups of proteins under very mild conditions, forming a bond which resists acid hydrolysis, so that the amino-acid residues which form the amino-end of the peptide chains can be identified. Sanger has shown in this way that the sub-molecule of insulin consists of four chains, of which two terminate in glycine and two in phenylalanine residues. These chains are presumably held together by the –S–S– links provided by the cystine, of which six exist in the molecule. Sanger has shown that by oxidation with hydrogen peroxide in formic acid solution, according to the method of Toennies and Homiller[5], these disulphide links are oxidized and a product is obtained which has been shown by adsorption analysis[6] and electrophoretic analysis[7] to consist of three or four distinct substances. A fraction was obtained from this which contained no phenylalanyl residues and contained no lysine, arginine, histidine, or threonine, and in which all the terminal residues are glycine[8].

Another line of approach has emerged from the work of Woolley[9], who has found in the partial hydrolysates of various proteins a growth-promoting factor for *L. casei* which he calls 'strepogenin'. Insulin was found to be a particularly rich source of this substance. Strepogenin appears to be a peptide which occurs in insulin at the end of one or more of the chains, since elimination of the free amino-groups of insulin with fluorodinitrobenzene destroys the activity[10]. Woolley has also found that the dinitrophenyl derivative of insulin and of oxidized insulin can be digested by pancreatin. The products have been fractionated by a series of counter-current distributions by the method of Craig[11], and several crystalline dinitrophenyl peptides obtained[12] containing, in addition to dinitrophenyl glycine, the following amino-acids: (1) glutamic acid, (2) glutamic acid, serine, threonine, valine and leucine; (3) same as (2) plus aspartic acid; (4) glutamic acid, serine, tyrosine and leucine; (5) same as (3) plus *iso*leucine and cysteic acid.

A study of the enzyme breakdown of insulin has been made by Butler, Dodds, Phillips and Stephen[13]. It was found that whereas pepsin breaks the insulin molecule into fragments with a molecular weight of *c.* 3,000 and an average chain-length of about seven residues, chymotrypsin removes from the molecule a number of smaller peptides of molecular weight *c.* 800, leaving a more massive residue which is precipitable in 0·25 *N* trichloroacetic acid. After extracting the trichloroacetic acid with ether, it was found that its molecular weight is 4,000 ± 1,500. In two separate experiments, it was found to contain between 80 and 90 per cent of the total amount of cystine of the insulin molecule. It thus appears that the result of chymotrypsin digestion is to remove parts from the ends of the insulin chains, leaving a 'core' in which the chains are united by –S–S– links. This core is slowly broken down by the long-continued action of chymotrypsin.

Attempts made to separate the smaller peptides in the trichloroacetic filtrate have on the whole been unsuccessful. Paper chromatography with phenol divided them into four broad bands[14]; but it has been found that this is at best only a partial separation, since eluting the bands separately and repeating the process gives a very similar pattern. Paper chromatography with butyl alcohol – acetic acid as solvent has given a series of fifteen distinct spots, most of which are peptides; but it has not so far been possible to isolate these substances in sufficient quantity for examination.



(*a*) Electrophoretic diagram of the core material (C11*B*) at *p*H 8·0. (*b*) Electrophoretic diagram of the oxidized core (C11*B*) at *p*H 7·0. Experiments by Dr. J. M. Creeth. Ascending boundaries shown.

Further examination of the material precipitated by trichloroacetic acid has provided evidence of its essential homogeneity. It gives a single sharp boundary in electrophoresis (Fig. *a*). Dr. K. O. Pedersen, of the Institute of Physical Chemistry, Uppsala, has kindly determined its diffusion coefficient by the free diffusion method[15], obtaining the figures $D_A = 18{\cdot}6 \times 10^{-7}$, $D_M = 18{\cdot}3 \times 10^{-7}$ at 20°. This corresponds to a molecular weight, assuming a spherical and unhydrated molecule, of approximately 5,000. All the amino-acids of insulin are present, except possibly arginine, threonine, proline and phenylalanine, which have either been absent or shown up weakly in one of the fractions resulting from oxidation of the core.

After oxidation by hydrogen peroxide in formic acid solution, the product shows four well-defined peaks in the electrophoresis diagram (Fig. *b*). The slowest of these (left-hand peak in the diagram) may be due solely to the δ-anomaly, since this material cannot be equilibrated with the buffer by dialysis. Their isoelectric points are below pH3, indicating the presence of strongly acid groups, as may be expected from the presence of cysteic acid. When the oxidized material is taken in aqueous solution to pH 4·5, a small fraction corresponding to Sanger's fraction B, but containing only 5 per cent of the material, separated. This could be shown to contain *all* the amino-acids of insulin, that is, those present in small amounts and undetectable in the whole core are concentrated in this fraction. The remainder lacks arginine, proline, lysine, threonine and phenylalanine. It is possible that the small separated fraction is a small amount of material, carried along by the core but not really belonging to it, or to a portion of core not broken down as much as the remainder. The oxidized soluble substance was also found to be complex by paper chromatography in butyl alcohol–acetic acid mixtures and showed three or four separate spots with ninhydrin.

The core can also be converted into its dinitrophenyl derivative by Sanger's method. The product, when examined by paper chromatography with phenol, gives two distinct yellow spots, a main spot and a fainter one, and is therefore apparently not completely homogeneous. Different digests behaved differently in the relative intensities of these spots, and it is probable that the core is more digested away in some cases than in others. After hydrolysis with 6N hydrochloric acid, the dinitrophenyl core was found (in one experiment) to yield the following amounts of dinitrophenyl amino-acids, calculated for a core molecular weight of 5,000: glycine, 2·5 molecules; with smaller quantities of valine (0·4 molecule), terminal histidine (0·8 molecule) and ε-lysine (0·5 molecule). This core was 40 per cent of the insulin molecule. Another core (36 per cent) gave glycine, 2·4 mol.; valine, 0·3 mol.; histidine, 1·7 mol. The glycine figures involve a considerable correction for the decomposition of dinitrophenyl glycine during the hydrolysis and may require revision. The fractional numbers and the variation of different cores would suggest that the core molecules are not all of the same kind.

After oxidation of the dinitrophenyl derivative, the product is divisible into two portions: (1) soluble in water, (2) insoluble in water. It has been found that the soluble portion can be separated into three bands, the first rather diffuse and the other two sharp, by passing its aqueous solution down a starch column. The insoluble fraction can be made soluble by dissolving in dilute ammonia. After neutralizing with acetic acid, it also gives three bands similar to those of the original soluble portion. Since a mixture of the soluble and insoluble parts when dissolved together also gives the three bands, it is concluded that the original soluble and insoluble portions are either made up of the same or of closely related substances. The proportions seem, however, to be different. Work on characterizing these fractions is being continued.

We have frequently observed in our work on the digestion products of insulin that a preparation became insoluble after thorough drying, and that treatment with dilute acid or alkali was necessary to bring it into solution. The removal of water apparently causes loose bonds to be established between the peptide chains, possibly through the interaction of neighbouring acidic and basic groups to form an insoluble complex, which is only broken by the application of acids or alkalis.

We acknowledge with pleasure financial assistance by Messrs. Courtaulds, Ltd., and Messrs. Imperial Chemical Industries, Ltd.; advice and assistance in characterizing dinitrophenyl derivatives by Dr. F. Sanger, the technical assistance of Mrs. I. D. R. Goodwin and the interest and help of Prof. E. C. Dodds. We are also indebted to Dr. J. M. Creeth for the two electrophoretic diagrams reproduced, and to Dr. K. O. Pedersen for his examination of the core material, details of which he is publishing elsewhere.

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BIREFRINGENCE AND ORIENTATION-RATE OF THE LEPTONES OF PROTOPLASM

By Dr. HANS H. PFEIFFER
Laborat. für quantitativ Polarisationsmikroskopie, Bremen

PRESENT knowledge indicates that the submicroscopic or 'leptonic' state of organised gels[1] consists of a framework of reciprocally associated macromolecules or molecular bundles (micelles). Their orientation-rate within the gels, as observed in polarized light, decides whether there are formed anisotropic gels in which the particles (leptones) are arranged parallel to each other, or isotropic gels in consequence of perfect disorientation of the leptones. Between these two limiting cases, there are many textures with differently graded orientation-rates. If a system contains imperfectly oriented leptones, the orientation-rate, and hence the birefringence, will be increased by tension[2]. Thus the birefringence will reach a maximum when the leptones are maximally oriented. But the theoretical relation between birefringence and orientation-rate is somewhat indefinite, for even in the case of perfect orientation the rate of grid-like disposition cannot be comprehended apart from the remainder. Moreover, isotropy includes cases of perfect disorientation as well as adjacent organisation in the immediate environs (*Nahordnung*). Further complications in consequence of different rates of swelling and extension cannot be taken into consideration here. The distribution function of O. Kratky, P. H. Hermans and co-workers[3], defining the frequent repetition of the different directions of leptones, has been obtained from the extension-rate of the gels and their orientation state *before* the extension. But with biogels, the deformation-rate during the unextended, that is, isotropic, state is not appreciable. Frey-Wyssling[3] has derived expressions describing the field or cone of scattering of leptones by means of a single angle. This method, however, gives only a comparative measure of the increase of orientation. I have now been able to investigate the *streaming birefringence* of protoplasm and to calculate the orientation-rate of its leptones.

By means of much improved experimental arrangement, it has been shown that protoplasm sucked up into a capillary becomes doubly refractive if it is made to flow by a compressing force[3]. Continuing these experiments[4], the birefringence has been found to be negative with regard to the flow direction. Hence, evidence is available that the effect first described by Pfeiffer is produced by lipids of the protoplasm. The interpretation of the experiment is perhaps doubtful, and we do not know whether, by sucking up the material, the protein chains are straightened out and the lipids have to follow the orientation, or whether the lipids, by the interlocking, are released and become able to arrange themselves parallel with one another. But the flow experiment with protoplasm makes it possible to evaluate the *maximal* streaming birefringence, and hence a given orientation-rate, and to make other measurements (for example, length of leptones, to be described shortly elsewhere).

For the quantitative study of the birefringence of protoplasm flowing within a capillary, the latter has been embedded in a liquid of the same index of refraction as the protoplasm[5] (about 5 mm.^{3} of the *Physarum polycephalum* plasmodium grown on oat agar). A detailed description of the apparatus and the method of stimulating the flow have been published already. The quantitative studies relate to the character (sign) and the phase difference (intensity) of the anisotropy of protoplasm, and to its direction of extinction. If, as with protoplasm, long-chain molecules are not oriented at 45° to the gradient of flow, but at angles between 45 and 90°, it is necessary to define the direction or *angle of extinction*, χ (*Auslöschwinkel*, angle of isocline, *Kreuzwinkel*). For this purpose we find the orthogonal position of the crossed nicols in a lateral, extinguished flame of the capillary[6]. The flow capillary is fixed and the optical polarizing equipment adjusted as a whole; then the angle required results from the extent of the turning movement against the direction referred to. The *negative sign of anisotropy* results from the use of a Red I (gypsum) plate oriented, like the object, with its direction of fast and slow transmission at 45° to the planes of polarizer and analyser, and, as usually employed, the slower vibration direction (larger index) extending from the upper right to the lower left quadrant of the field of view. The *phase difference* of the object (Γ) has been measured with a very sensitive Brace compensator (rotating λ/30-mica compensator) and the half-shadow wedge according to Macé de Lépinay at varying velocities of flow[7]. The polarizer is set at 0°, the object brought into focus and oriented in a diagonal position (45° to the polarizer plane), and the compensator and the analyser are inserted (nicols crossed). After the compensator has been adjusted so that the field surrounding the object is maximally dark and the angle noted (average of five to ten readings), the compensator is then moved round so that the object is maximally dark (five to ten readings again). If the difference between the two series of readings is β, then the retardation is $\Gamma = (\lambda/30) \sin 2\beta$, and the birefringence, as usual, $\Delta n = \Gamma/d$, where d is the thickness of the preparation.

In regard to the rate of orientation, it is necessary to mention especially the *extinction angle*, χ. As usual, it increases with the flow gradient and the viscosity, and decreases as the temperature goes up; but above all, it depends upon the length of the leptones. The extinction angle has been found to have values between 61° and 76°. For each series of experiments with successively increased shearing forces, the angle shows a constant value over the period during which the preparation could be kept free from denaturation. For smaller flow velocities smaller values of χ are found, which, however, are well reproducible and do not show any ageing effects. Sometimes the measured values show more scatter than could be expected from an estimation of the usual experimental errors. Hence this scattering must be due to variations in the origin and nature or special character of the material. If the same measurements are taken by varying the λ (using a cadmium spectral lamp or a perfect monochromator), with other conditions constant, a similar set of characteristic curves is obtained.

The movability of the protoplasmic leptones is measured, according to Boeder[8], by the *rotation diffusion constant*, D_R. The quotient of the gradient of flow dv/dn and of D_R represents the parameter α, which is related to a precise *direction density* ρ. If α is increasing, the maximum of the accumulation is displaced to higher χ-values. The gradual transition from lower to higher χ-values, depending on the decreasing gradient dv/dn, takes place, of course, the earlier the lower D_R is obtained. Using only one measurement of χ at a known gradient dv/dn, the constant D_R and the parameter α are, theoretically, measurable with protoplasm double refractive by flowing.

By measuring the *phase difference* Γ at an extinction angle χ sufficiently far from 45°, we are able to calculate the *maximal birefringence*, that is, the double refraction in case of orientation of all the leptones. With regard to the coefficient μ, with which we have to multiply the measured phase difference, in order to obtain the saturation value of birefringence, we find :

χ	50	55	60	62½	65	67½	70	72½	75	77½	80	85
$\Delta n_{\text{obs.}}/\Delta n_{\text{max.}}$	0·09	0·15	0·23	0·28	0·35	0·40	0·44	0·48	0·51	0·54	0·56	0·61
μ	11·1	6·7	4·3	3·5	2·9	2·5	2·3	2·1	1·9	1·8	1·7	1·6

We have, however, to accept the limitation to the *plane* problem; the three-dimensional problem does not seem to be capable of solution with our present knowledge. With this restriction, only a limited number of leptones become arranged parallel with the direction of flow; calculation indicates 20–30 per cent, and for very long chain molecules only 3–5 per cent. Further complications are to be expected if the leptones should be deformed by the flow[10].

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CARNEGIE INSTITUTION OF WASHINGTON

THE feature of most general interest in Dr. Vannebar Bush's report as president of the Carnegie Institution of Washington for the year ended October 31, 1947 (Year Book No. 46), is his review of the range of the Institution's activities, and particularly the relation of the Institution to Federal support. Dr. Bush points out that the Institution has always recognized that research stands or falls by the men who are responsible for its prosecution, and from its earliest days has consistently sought the exceptional man and provided him with facilities and resources to pursue problems which he discerned and by his own methods. Latterly, in establishing its own research centres, the Institution has recognized that such centres are of ultimate value in the search for knowledge only as they are utilized by groups of investigators including leaders of proved skill and acumen and younger men of real promise. Dr. Bush pays a high tribute both to the creative work of the Institution's scientific staff, and is also satisfied with the general plan of organisation of the work and with the effectiveness of its administration. Discussing next the termination at the end of the War as expeditiously as possible of all research for the Government, to enable the Institution to return to its own programmes of fundamental research and its policy of free dissemination of results, he considers the policy of the Institution of not seeking broad support for its research from federal funds in the light of the increasing support of fundamental investigation from Government funds.

Dr. Bush considers that the policy governing grants by the National Government for fundamental research has so far been characterized by vision and wisdom, and that it is highly important the federal policy should continue. Acceptance by the Carnegie Institution of such funds for enlarging its research programmes should depend first, however, on any such research activity forming as nearly as possible an integral operative and administrative unit, or that the activity can be terminated easily if the support terminates. The activity should, moreover, be one both intrinsically worth while and a natural addition to the Institution's own regular programme. It should also be one to which the Institution can genuinely contribute by reason of the skills and operations of the regular staff and the presence of the regular programme. Finally, the conditions under which the Institution accepts such funds should in no way infringe the independent status of the Institution in pursuing its own regular programme of research, and they should be genuinely adapted to the prosecution of fundamental investigation of the highest quality.

In reviewing the research activities of the past year, Dr. Bush notes that 1946–47 was the first since 1940 in which all departments and divisions had been fully engaged on normal programmes. Continuing his investigation at Mount Wilson Observatory of the general magnetic fields of stars, Dr. H. Babcock has surveyed likely stars down to the sixth magnitude, finding magnetic fields stronger than 1,000 gauss in several and a polar field of 5,500 gauss in one. At the Geophysical Laboratory, the development of a new type of pressure apparatus has facilitated the study of equilibrium relations in hydrous mixtures. In the magnesia – silica – water system, all the commoner natural hydrous silicates of magnesia, as well as two anhydrous silicates, could be prepared with only the solid phases and vapour present. Equilibria up to 900° C. at pressures up to 15,000 lb. per square inch and at 800° C. up to 30,000 lb. have been determined. New procedures developed in the Department of Terrestrial Magnetism have indicated that, within the accuracy of the measurement, the strength of the magnetic field of the earth has not changed during the past 30,000 years. A large increase in the intensity of cosmic radiation at all observing points except at the equator was observed at the time of a marked solar flare and radio blackout on July 25, 1946.

Extensive study of a wide variety of plants in the Division of Plant Biology indicates that the chloroplast pigments essential in the photosynthetic apparatus of all plants have changed but little in the evolution both of the species in major taxonomic groups and of the main groups themselves. The active pigments of present-day green algæ are thus the same as those possessed by their fossil ancestors, and results obtained in the further study of the unicellular alga *Chlorella* have shown that while the chemical composition of the alga varies widely with the culture conditions selected for its growth, the nature of the chlorophyll pigments is unchanged. The grass-breeding programme of the Division of Plant Biology undertaken in co-operation with the Soil Conservation Service of the United States Department of Agriculture has yielded hybrids of high promise owing to their combination of favourable yield, resistance to disease and continued activity in dry summer weather. The species used in the crossings produce most of their seed asexually but, unexpectedly, it was found that two-thirds of the hybrids between asexual parents were themselves sexual.

The aerosol method developed in the Department of Genetics for investigations involving the treatment of *Drosophila* with chemical solutions has been used for testing the power of various carcinogenic agents to effect mutations in genes. Most of the carcinogens thus tested were mutagenic, and most substances related chemically to the carcinogens but not themselves carcinogenic did not produce mutations. Dr. Dobzhansky's work in the same Department has shown that the proportion of certain types of *Drosophila* in wild populations changes with the season. The fly thus shows substantially the same kind of differentiation into altitudinal races as Drs. J. Clausen, D. D. Keck and W. M. Hiesey, of the Division of Plant Biology, found for species of *Achillea*.

In the Department of Embryology, Dr. L. B. Flexner and his colleagues, using radioactive sodium and heavy water, have obtained further evidence that the ratio of water within the cells of newborn infants to extracellular water increases as growth proceeds, and further studies of the permeability of the placenta are being pursued. Dr. S. R. M. Reynolds is investigating the physical forces involved as the uterus accommodates itself to its growing contents, as a contribution to the fuller understanding of the problems of advanced pregnancy and of parturition.

More detailed accounts of the investigations in progress or completed during the year are to be found in the departmental and divisional reports which follow that of the president, and to which bibliographies are appended. From this it is only possible to select a few further investigations for mention.

such as the attention being given by the Geophysical Laboratory to thermal measurement and to studies on radioactivity, and by the Department of Terrestrial Magnetism to studies of the earth's crust and of the upper atmosphere as well as to cosmic ray research. A feature of this report is the review of the magnetic survey and observatory programme of the Department over the period 1904–46. In the Division of Plant Biology, investigations on the chemistry of chlorophyll formation have been extended to include analysis of the process at different temperatures, and in that of Embryology tests have been made of the action of a large series of dyes related to Nile Blue on tumours in mice. Full accounts of work on the organisation of the chromosome, of cryptogenetic studies of maize and *Neurospora*, of chromosome studies on gall midges, and of work on mouse leukæmia and on the genetic structure of natural populations are included in a long report from the Department of Genetics, while that from the Division of Historical Research deals with the results of the expedition to Bonampak, in Chiapas, Mexico, the field work in the Guatemala highlands and the preparation of a hand-book of ceramic technology for archæologists and a preliminary analysis of Usulatan ware.

INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION

A MEETING of the European Continental Section of the International Committee for Bird Preservation held in Paris during July 17–20, under the chairmanship of Dr. Boje Benzon, was attended by representatives of Austria, Belgium, Denmark, France, Great Britain, Hungary, Italy, Netherlands, Norway, Sweden and Switzerland; though the German National Section has not yet been reorganised, the interests of that country were represented by the chief game warden of the British Zone accompanied by a German adviser and by a German adviser from the American Zone. The president of the Zoology Section, International Union of Biological Sciences, and an observer from the Natural Sciences Section of Unesco attended, and the Conseil International de la Chasse was also represented.

The chief business of the Conference was the discussion of proposals for the revision of the Paris Convention of 1902 for the Protection of Birds Useful to Agriculture, on which the International Committee for Bird Preservation commenced work thirteen years ago. In 1935 representatives of the Finnish, Norwegian and Swedish Governments drew up a Draft Convention for the International Protection of Birds which was presented at a Conference of the International Committee for Bird Preservation held in Brussels that year. After due consideration it was decided at this Conference that an entirely new Convention was not practicable and that proposals for the revision of the Paris Convention of 1902 should be put forward. Lord Justice von Seth (Sweden), on behalf of the Scandinavian countries, accepted this suggestion with the proviso that the broad outlines of the Scandinavian proposals should be maintained. The matter was then referred to an International Sub-Committee consisting of M. A. Chappellier (France), (the late) Dr. Percy Lowe (Great Britain), Prof. M. Siedlecki (Poland) and Lord Justice von Seth (Sweden), with Miss Phyllis Barclay-Smith (Great Britain) and M. Leon Lippens (Belgium) as secretaries. Each national section in Europe was then requested to send to the secretariat suggestions relating to the modification of the Paris Convention. The Sub-Committee, taking into consideration the views of all countries, drew up these suggestions into a general report to serve as a basis for the discussion of a definite final proposal.

The report of the Sub-Committee was discussed at a conference in Vienna in 1937, attended by representatives of twelve European national sections, and proposals for a revision of the Paris Convention agreed. The necessary diplomatic steps to bring these proposals to the attention of the Governments concerned were in progress on the outbreak of war.

However, at a conference held in London in June 1947, attended by representatives of fourteen European national sections, it was decided that in view of the many changed circumstances during ten years, the Vienna proposals were in need of further revision. The matter was again referred to an International Sub-Committee consisting of Dr. Boje Benzon (Denmark), M. G. Olivier (France), Mr. R. A. H. Coombes (Great Britain) and Dr. J. H. Westermann (Netherlands), with Miss Barclay-Smith and M. Lippens as secretaries as before. This Sub-Committee met in Brussels in November 1947 and drew up recommendations which were forwarded to all the national sections of Europe for their comments before being discussed at the Paris Conference in July 1948.

The proposals for the revision of the Paris Convention, 1902, agreed upon at this Conference meet not only the changed conditions and circumstances but also the change in outlook during the course of nearly fifty years. Whereas the Paris Convention was designed to afford protection to birds useful to agriculture (with emphasis on the small insectivorous birds), the scientific, educational and æsthetic aspect of bird life is now recognized, and in point of fact, at the present day, the larger birds are in need of as much, if not more, protection than the small insectivores. Therefore, the fundamental basis of the present proposals is that all birds should have some measure of protection. Far more is known about migration than was the case in 1902, and the countries are becoming more and more aware of their interdependence and obligations towards each other in this matter; it is now appreciated that it is not possible for the country in which migratory birds breed to maintain the stock unaided. The broad outlines of protection now proposed are that birds should be protected during their breeding season and, so far as migratory species are concerned, during the times of their *return* to their nesting grounds; also that birds in danger of extinction should have special protection. Allowance for exceptions is made when and where necessary in the interests of agriculture, forestry, fishing, science, education, etc., and for the special economic conditions in certain regions. It is also realized that the all-important balance of Nature should be maintained in every way possible, and that any bird which may constitute a menace to other species must be kept in check. The sentimental idea of a 'sanctuary' for all species where everything is inviolate is, in fact, no sanctuary, and there have been far too many instances of this: to take one example, tern colonies have almost disappeared under the onslaught of gulls, to whom an all-embracing 'protection' has afforded an undue advantage.

Import, export, transport, selling or buying are also dealt with in regard to species taken illegally, and eggs are considered equally with the birds themselves.

Certain methods for the mass capture or destruction of birds are condemned. This is a particularly difficult subject owing to old-established customs and widely diverging points of view and national temperaments. What is regarded as a normal state of affairs in one country may be deplored by its neighbour, and it is not easy to arrive at a general agreement, a tolerant give and take and gradual change being the only solution.

A point which was of no great importance in 1902, but which has become of vital importance in 1948, is the safeguarding of habitat which is the fundamental for the existence of any species of bird; with the rapid spread of civilization this is becoming more and more serious so far as all forms of wild life are concerned.

In addition to the Convention another important question dealt with by the Paris Conference was the International Inquiry into the status of the Anatidæ in Europe, and the progress being made in the various countries regarding this. The British Section, which has been allocated the task of correlating the information sent in from all over Europe, presented a report on the arrangements being made to carry out this work.

Other matters discussed were the conditions of transport of birds by air, a biological station on the Neusiedlersee in Austria, and the publication of the second edition of an International Ornithological Dictionary by Denmark.

The membership of the International Committee now numbers thirty-five, Iceland having been the latest country to form a national section. The headquarters are at the British Museum (Natural History), London, with further secretariats in Brussels and New York.

BIOLUMINESCENCE

THE increasing use of the fluorescent lamp in recent years has served as a stimulus to the study of the mechanism of the emission of cold light; and this in turn has led to a renewed interest in the production and utilization of such light in luminous animals. The Section of Biology of the New York Academy of Sciences held a Conference on Bioluminescence in November, 1946, and the papers submitted, which have now been published*, provide a comprehensive review of the subject.

In a general survey, E. Newton Harvey points out that about forty different orders of plants and animals, ranging from bacteria to fish, contain self-luminous species. A few of these, such as the fish *Photoblepharon* and *Anomalops*, make use of luminous bacteria housed in special pouches which can be covered or exposed at will by a sort of eyelid. Chemiluminescence in general is reviewed by R. S. Anderson. Colour, fluorescence and chemiluminescence are probably degrees in an analogous process. Emission results from the loss of a quantum of energy during the change from an excited electronic state to a ground-state with less energy, these changes being independent of high temperature. Only in comparatively recent years, with the discovery of the bright chemiluminescence of aminophthalhydrazide and dimethylbiacridinium nitrate, have systems been obtained which can rival in luminosity the substances extracted from living organisms. It was in 1886 that Dubois first demonstrated that light production in animals results from the interaction of luciferin and the enzyme luciferase. In the Ostracod *Cypridina* these two components are discharged in the form of granules from separate glandular pores and then interact in the sea water. This animal, therefore, affords ideal material for the study of these substances *in vitro*, and the recent work in this field is reviewed by A. M. Chase. The structure of luciferin has not been fully elucidated; but there is evidence that it has a relatively small molecular weight and contains a hydroxybenzene structure which is reversibly oxidized to a quinone. F. H. Johnson and H. Eyring discuss the action of pressure, temperature and drugs on the enzymes concerned in bacterial luminescence.

By far the longest paper is by J. B. Buck, who provides a comprehensive review of the anatomy and physiology of the light organ of fireflies and contributes some new suggestions on the control of light emission. There is the utmost diversity in the anatomy of the light organ in the beetles; their histology ranges in complexity from a group of loose independent giant cells, apparently without tracheæ, similar to, and perhaps identical with, the œnocytes (such as occur in *Phengodes*), to the highly complicated arrangement in *Photinus* or *Luciola* where a reflective layer containing urate granules underlies the photogenic layer. In the most complex type a rich supply of tracheæ runs vertically through the reflective layer and then enters specialized cylindrical rods of tissue which pass straight through the photogenic layer. Here they give off lateral branches which end in conspicuous tracheal end-cells by breaking up into the tracheoles which supply the photogenic cells. Buck is satisfied that the tracheoles do not enter the cells; but there is evidence that they are connected together by an ultra-tracheolar network which may, perhaps, consist of open tubes.

It is this very highly evolved system which provides some of the most intriguing problems in the physiological control of luminescence. Light may be emitted as a steady glow or in the form of brilliant flashes showing a remarkable periodicity which is under the control of the organism. It is the control of flashing which has excited most controversy. There is no doubt that the organ is supplied by nerves which stimulate it to activity. It is equally sure that the production of light is dependent upon the access of oxygen to the photogenic cells. Argument has centred around the question whether the cells are stimulated directly to produce light—perhaps by the dissolution of barriers which normally separate the enzyme from its substrate—or whether the nerves control the access of oxygen. It is well known that the endings of the tracheoles in many insects contain liquid which may be absorbed into the tissues during activity and so replaced by air. It has been suggested that the enhanced oxygen supply which then results may be the cause of the light flash; but, as Buck points out, if this change does occur in the tracheoles of the luminous organ it is more likely to be secondary to the metabolic activity of the cells. The tracheal end-cells, an enlarged form of the cells which occur in many insects where the tracheæ break up into tracheoles, are a characteristic feature of the flashing type of organ. It has often been suggested that they play some part in the process. Dahlgren described what appeared to be a sphincter around the tracheole at this point, and beyond it a structure with radiating fibres. Buck outlines a reasoned hypothesis according to which the glowing of the organ is dependent on the diffusion of oxygen into the tracheoles, while the flashes are due to the mechanical projection of 'jets' of air into the tracheole by the controlled relaxation and contraction of the sphincter mechanism in the tracheal end-cell. But he concludes that the evidence at present available is insufficient to decide between this hypothesis and that of direct nervous stimulation of enzymic activity in the photogenic cells.

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* *Annals of the New York Academy of Sciences*, 49, 327 (1948).

V. B. WIGGLESWORTH

SYMPOSIUM ON SEARCHLIGHTS

ONE of the most important features of a scientific society is its capacity to arrange a symposium on a special feature of its activities and to publish the resultant papers. There are many subjects where the interested people are too few for the probable financial return to tempt an author to the publication of a book, and where in addition the knowledge is so specialized that no one author can easily do justice to it. The publication under review* is such, and the Illuminating Engineering Society deserves the thanks of those who, either as user or manufacturer, need to know about searchlights in some detail. The scope of the book is indicated by the sectional headings: "The Function and Design of Army Searchlights", by E. W. Chivers and D. E. H. Jones; "High-power Searchlights of Wide Divergence", by Air Commodore W. Helmore, H. K. Cameron, F. S. Hawkins, L. B. W. Jolley and L. M. King-Brewster; "Photometry of Searchlights", by H. K. Cameron, E. H. Rayner, E. R. Thomas and G. T. Winch; "The Visibility of Targets in a Naval Searchlight Beam", by W. D. Chesterman and W. S. Stiles; "Some Visibility Problems Associated with Anti-Aircraft Searchlight Beams", by S. S. Beggs and J. M. Waldram; "Aircraft Searchlights for Anti-Submarine Warfare", by Commander C. J. Carr.

There are, in addition, some twelve pages of discussion.

The meeting was held in London on April 15, 1947, and presumably the difficulties of post-war publication are responsible for the delay in the appearance of the book.

As the titles suggest, there is a marked war-time flavour about the publication, although some of the work was carried out before 1940 but has not previously been made available to the scientific public. The balance between the historical background of searchlight design, theory and photometry, and the immediate foreground of practical war-time development has been well maintained, and the result is a record which will find a place in many industrial and technical libraries.

It may come as a surprise to many that an increase in intensity of a searchlight from 100 megacandles to 500 megacandles only increases the range by some 50 per cent in clear weather and by only some 15 per cent in medium weather. One may therefore be allowed to wonder whether the effort put into the development of the larger sizes of searchlight was justified, especially as it meant the complication of additional spare parts.

Probably the part which will attract most attention is the description of the design and manufacture of high-powered projectors for such special purposes as the interception of night-flying aircraft and submarines lying on the surface of the sea. The 'Turbinlite'—to use the war-time code word—as finally designed consumed 140 kw. with a 90-cm. mirror and was supplied by batteries which could operate for four periods of 30 sec. The whole was carried in the nose of an aeroplane, and the success of the scheme was demonstrated on many occasions. Figures are also quoted for the 'Leigh Light'—used against submarines—showing that the number of U-boats seen was increased sevenfold by its use and that 11 per cent of all night attacks carried out by its use resulted in 'kills'. The specialist in photometry will find summaries of considerable value, of both theory and practice as applied to these mammoths of the illuminating engineer's industry, much of it available in convenient form for the first time. In the case of 'visibility', many of the problems only became urgent under the stress of enemy action. Some of the solutions are especially neat, such as the 'perspective' explanation by Beggs and Waldram of the case of the apparent sudden ending of a searchlight beam to an observer near the projector.

There are a number of errors and misprints which may cause difficulty, as, for example, p. 44, Fig. 17(*b*). The symbols θ and ψ appear to be interchanged. P. 45, third line, this expression has been disarranged in the printing. P. 133, in the formula the symbol φ has been omitted after K in the square brackets.

The book provides in a convenient form a technical treatise on its subject and, in addition, a record of war-time achievement of which the various authors have reason to be proud. The diagrams and pictures are clearly and well produced; but an index would have increased the reader's pleasure and the utility of the production.

W. M. HAMPTON

AFFORESTATION FOR BENGAL

ANYONE who has travelled by railway throughout India must have noticed the disparity reigning in the distribution of the forests in that country. In some parts the railways pass through great and apparently interminable tracts of forest and jungle. In others, of which Bengal forms one of the best of examples, the converse is the case. Between Calcutta and the foot of the Darjeeling Hills the traveller by railway passes over a great plain devoted mainly to the production of rice, the villages mostly in groves of palm trees, but a total absence of forest. The forest part in Bengal represents only 0·07 acre per head of population. Bengal has only 9 per cent of its surface under forest, and a considerable part of the latter is in the Darjeeling Hills and the Sundarbans south of Calcutta.

Modern conditions and demands resulting from the Second World War, to some extent, and the great necessity to improve the agricultural soils of the Province, have at length roused the authorities. These soils are not manured. The large quantities of cow dung obtained from the great herds of cattle kept by the villagers are at present, and have been for many centuries past, utilized as fuel for heating and cooking purposes. One of the objects of the projected afforestation plan for Bengal is to create plantations suitably distributed to provide fuel for these purposes and thus release the manure for its proper use. A Bill for the purpose of afforesting of waste lands and for conserving what is left of private forests was introduced in the Bengal Assembly in 1944. The Bill was enacted in April 1945, and already considerable progress has been made so far as private forests are concerned.

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* Searchlights. A series of five papers, with the discussion on those papers and a further written contribution. Pp. 164. (London: Illuminating Engineering Society, 1948.) 17*s*. 6*d*. net.

Here we have somewhat similar provisions to the Dedication of Woodlands scheme in Britain (*Nature*, Sept. 4, p. 364). The Bengal Government has the power and the duty of telling the owner how to use his forests, and the Government will meet all expenditure for the first ten years, and in certain cases and conditions the Government may make loans to private owners. As regards the waste land, the estimated area which should be, and could be, afforested is four million acres or 9 per cent of the area of the Province. If this area was afforested Bengal would then have no less than 18 per cent of its lands under forests. Much of this area, it is said is, above the paddy fields and is of a highland nature. It is said to have been under forest once, but with the forest removed soil deterioration, leaching and erosion resulted. Yet the land is believed to be afforestable. It is a big scheme and one which will make high demands on the forest staff of the Province in all its ranks.

In the paper read by Mr. T. M. Coffey, chief conservator of forests, before the members of the Rotary Club, Calcutta, in 1947 (reprinted in *The Indian Forester*, 73, No. 11; November 1947), it is said that to carry out the programme will require to have a forest officer in every district in the Province. At present there are ten districts with forest officers and seventeen without. There can be little doubt that this is a thoroughly sound scheme—but it will require pluck, perseverance and drive and continuity in management and working to see its successful completion. If this is fully recognized, enormous benefits will be conferred upon future populations in the Province. E. P. STEBBING

THE B.B.C. QUARTERLY

IN April 1946 the British Broadcasting Corporation inaugurated a new periodical entitled *The B.B.C. Quarterly*, which was intended for those in Great Britain and abroad who are interested, professionally or otherwise, in broadcasting and its organisation. During the past two years the successive issues of this journal have contained articles on a wide variety of subjects connected directly or otherwise with the purpose of broadcasting and its administration, and with the technical and radio engineering developments which are necessary for the ever-increasing needs of modern broadcasting, including its international aspects.

More than half the contents of the first number of the third volume, issued in April, comprises a series of articles by specialists introduced and edited by Sir Arthur Salter under the general title of "The Impact of Broadcasting on Great Britain's Life and Outlook—I". The remainder of the issue consists of three articles dealing with some present-time activities of the engineering sections of the B.B.C.

In the first article, Messrs. H. B. Rantzen and J. H. Holmes describe the proposed developments which are now being undertaken to provide adequate communication facilities, mainly telephone and teleprinter, over the whole network interconnecting London and the regional broadcasting centres in Great Britain. Following this, Mr. L. Hotine gives an interesting, illustrated account of the engineering arrangements which were made for broadcasting the Royal Wedding. On this occasion, commentaries and eye-witness accounts of the processions and marriage ceremony were made in forty-two languages for the B.B.C. Home, European and Overseas Services. Provision was also made for such accounts to be given to more than fifty stations and networks in the Dominions and Colonies, and for similar facilities to be provided for the big networks and independent stations in the United States and in various European countries. Certain limited television programmes were also provided; and the success of all these arrangements is a tribute to the efficiency of all those concerned with this phase of the operation of outside broadcasting technique.

The third article deals with a subject of great and increasing importance in modern broadcasting: the suppression of unwanted radiation from medium-wave transmitters. Mr. J. B. Webb describes the manner in which spurious radiations from transmitters can, by harmonics or combination frequencies, cause interference with other broadcasting services. This possibility has become more serious in recent years, due to the increase in both the number and power of stations in operation in the medium wave band. The identification and attenuation of existing spurious radiations is often expensive and complicated, requiring the use of widespread technical facilities. But it is very clear that careful consideration should be given to possible unwanted radiations before a new service is introduced, or an increase in power contemplated at an existing installation.

FORTHCOMING EVENTS

Saturday, September 11

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, DIVISION FOR SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE (at the Dome, Brighton), at 7.30 p.m.—Discussion on "Science Across the Frontiers". (Dr. Julian Huxley, F.R.S.: Introduction; Dr. Joseph Needham, F.R.S.: "Origins and Development of the Organisation of International Scientific Co-operation"; Prof. Pierre Auger: "Present Scientific Activities and Programme of UNESCO"; Dr. Paulo Carneiro: "The International Research Institute of the Hylean Amazon").

Sunday, September 12

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at the Dome, Brighton), at 8 p.m.—Rt. Hon. Viscount Samuel, P.C.: "Science and Philosophy".

Monday, September 13

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at the Royal Pavilion, Brighton), at 8 p.m.—Prof. J. D. Bernal, F.R.S.: "Waves and Beaches".

Monday, September 13—Tuesday, September 14

SOCIETY FOR GENERAL MICROBIOLOGY (at the University, St. Andrews).—Scientific Papers.

Monday, September 13—Friday, September 17

HORTICULTURAL EDUCATION ASSOCIATION (at Edinburgh).—Autumn Conference.

Wednesday, September 15

ROYAL INSTITUTE OF CHEMISTRY (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. A. J. Turner: "Research on Linen".

Thursday, September 16

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. C. von Fürer-Haimendorf: "Wealth and War among Two Himalayan Tribes".

Friday, September 17

Society of Leather Trades' Chemists (in the New Chemistry Building, The University, Leeds), at 2 p.m.—Mr. G. S. Adair, F.R.S.: "Recent Work on Osmotic Pressures, Membrane Equilibria and Solubility Factors of Proteins in the Light of the Work of Procter" (Third Procter Memorial Lecture).

Royal Institute of Chemistry, Newcastle-upon-Tyne and North-East Coast Section (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 3 p.m.—Symposium on "Polarography and Infra-Red Spectroscopy".

Friday, September 17—Monday, September 20

Association of Special Libraries and Information Bureaux (at Ashorne Hill, Leamington Spa).—23rd Annual Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer, and an Assistant Lecturer, with special qualifications in Organic Chemistry, and a Lecturer in Physiology—The Secretary, The University, Edmund Street, Birmingham 3 (September 18).

Technical Officer, State Advances Corporation of New Zealand, Wellington (with a university degree, or its equivalent, in Applied Science, and a thorough knowledge of timber entomology, timber pathology and timber preservation)—The Official Secretary, High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 25).

Lecturer in Geology, within the Department of Agricultural Chemistry, and an Assistant Lecturer in Plant Diseases in the Department of Agricultural Botany—The Secretary and Registrar, University College of North Wales, Bangor (September 25).

Assistant in the Science Services Department, London Headquarters—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (September 25).

Lecturer (Grade II c or II b) in Petroleum Production Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (September 30).

Biochemist with experience of research in cellular metabolism or enzymology for a research post in the Department of Lactational Physiology, to assist in the investigation of the intermediary metabolism of the mammary gland—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (September 30).

I.C.I. Research Fellowship in Pharmacology—The Secretary of University Court, The University, Glasgow (September 30).

Reader or Senior Lecturer in Applied Mathematics in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (September 30).

Lecturer in Psychology in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 30).

Assistant Lecturer in Biochemistry—The Registrar, King's College, Strand, London, W.C.2 (September 30).

Senior Assistant in the Pathological Department—The Director, West Midlands Forensic Science Laboratory, Newton Street, Birmingham 4 (October 1).

Lecturer (Grade II c or II b) in Mining (Coal)—The Secretary, The University, Edmund Street, Birmingham 3 (October 1).

Research Assistantships (2) for work on (*a*) Physical and Chemical Aspects of Selective Flotation, and (*b*) Mining Research Problems—The Registrar, The University, Leeds 2 (October 4).

Senior Scientific Officers, and Senior Experimental Officers, for analytical work involving modern physico-chemical methods, in the Chemical Inspectorate (Atomic Energy), Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2281 (October 7).

Principal Scientific Officer or Senior Scientific Officer (with first- or second-class honours degree in metallurgy, and experience in the metallography of light alloys) in the Ministry of Supply Headquarters in London—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2279 (October 8).

Lecturer in Medical Entomology—The Secretary, Department of Entomology and Parasitology, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool 3 (October 30).

Botanists (2) to assist in the preparation of a Flora of East (Tropical) Africa, which is being undertaken by the Royal Botanic Gardens, Kew—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (October 31).

Lecturer in Mathematics and Physics in New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (October 31).

Senior Lecturer (Grade I) in the Department of Geophysics—The Secretary, The University, Edmund Street, Birmingham 3 (November 13).

Production Pile Manager, and an Instrument Manager, in the Department of Atomic Energy, Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Civilian Lecturer in the Department of Applied Mechanics of the Royal Naval College, Greenwich—The Secretary, The Admiralty (C.E. Branch I), London, S.W.1.

Demonstrator in Physiology—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

Laboratory Technician (experience in electronics essential)—The Director, Neurological Research Unit, National Hospital, Queen Square, London, W.C.1.

Technician (Grade B)—The Area Pathologist, Musgrove Park Hospital, Taunton.

Entomologists and Plant Pathologists in the Scientific Department of the East African Groundnut Scheme—The Personnel Manager (Scientific), Overseas Food Corporation, Unilever House, London, E.C.4.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Quarterly Journal of Mechanics and Applied Mathematics. Vol. 1, Part I, March 1948. Pp. iv + 124. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 12*s*. 6*d*. net; annual subscription, 40*s*. [156

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British Agricultural Bulletin. (Published quarterly for Overseas circulation only.) Vol. 1, No. 1, Spring 1948. Pp. 40. (London: British Council, 1948.) 5*s*.; 15*s*. for 4 Nos. [216

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Symposium on Searchlights. Containing a Series of Five Papers presented at a meeting of the Illuminating Engineering Society held in London on April 15, 1947, the Discussion on those Papers and a further Written Contribution. Pp. 164. (London: Illuminating Engineering Society, 1948.) 17*s*. 6*d*. [246

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TELEVISION DEVELOPMENT IN BRITAIN

AN important statement was issued on August 24 outlining the Government's policy on the development of television in Great Britain. It will be recalled that the Television Committee, under the chairmanship of Lord Hankey, issued its report early in 1945 with a number of specific recommendations on the manner in which, after the War, a public television service should be resumed and developed in Britain (see *Nature*, 155, 615; 1945). Acting with commendable speed and efficiency, the B.B.C. implemented the first of the recommendations by reopening the London Television Service from the Alexandra Palace Station in June 1946. Next, with the view of extending the existing service to other parts of the country, work was begun on a similar station near Birmingham.

Following a further recommendation of the Hankey Committee, the present Television Advisory Committee under the chairmanship of Lord Trefgarne was appointed, and has recently been examining the technical characteristics of the B.B.C. television system in the light of the latest developments which have taken place both in Great Britain and elsewhere. It is considered that the improvements in the quality of the picture presented by any of the alternative systems are slight from the point of view of the ordinary viewer, and are not sufficient to justify a change of system which would make all the present British receiving sets obsolete. Moreover, any change, such as the addition of another hundred or two hundred lines to the existing 405-line standard of definition, would prejudice more substantial improvements, including possibly colour, at a later date. Such developments need further prolonged research before they can be realized in practice, and so far as can be foreseen, this will take several years.

On the advice of Lord Trefgarne's committee, based upon the above considerations, the Postmaster-General has now announced that the London television station will continue to operate for a number of years on the 405-line definition system, and that the same system is being adopted for the Midlands station, and is proposed for other British stations. This timely re-affirmation of another of the recommendations of the Hankey Report puts an end to the uncertainty which has been created from time to time by the claims and propaganda for other systems. It also clears the way for the radio industry to prosecute its plans for developing television markets both at home and abroad. Now that the public has been given a reassurance that the existing system will be maintained, the industry is planning to produce half a million sets during the next three years. Also, every effort will be made to demonstrate the advantages of the British system which, if it were adopted as the standard in Europe, could provide a highly developed source of programmes and benefit from Great Britain's unique experience of television.

Work on the Midlands station at Sutton Coldfield is being pressed ahead, and it is hoped to open it in the autumn of 1949. The station, although working on the same basic 405-line system as the London station at Alexandra Palace, will have increased powers of the vision and sound transmitters of twice and four times respectively. The carrier frequencies used will be in the neighbourhood of 60 Mc./s., and the station, with its aerial system on a mast 750 ft. high, will have a reception range of approximately fifty miles. The Post Office is providing alternative radio and cable links to convey programmes from London to Sutton Coldfield. The B.B.C. is working out proposals for further television stations on the 405-line system, with the next station in the north of England. The completion of this development should make television available to the greater part of the population of Britain, and set a standard of service which other countries may wish to follow.

DEMOGRAPHY BETWEEN THE TWO WORLD WARS

Europe's Population in the Inter-war Years

By Dudley Kirk. (League of Nations: Economic, Financial and Transit Department, Publication 1946. II. A.8.) Pp. xii + 312. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1946.) Paper, 15*s.*; cloth, 17*s.* 6*d.*

THE Office of Population Research, at Princeton, has abundantly justified its creation by issuing book after book of invaluable data often otherwise difficult to obtain. The book now reviewed is of primarily historical interest, as 1939 is almost lost in antique mist so far as demographic data and political units are concerned. Yet the data for those days must to a large extent remain our guide for the future in spite of the millions of displaced persons and the holocausts of victims of war and dictatorships.

The book is a modification of an earlier plan for a demographic atlas and it is well illustrated with maps and cartograms; but the author wisely emphasizes that a thousand persons in, say, northern Russia may be far more significant than a thousand people in some large urban centre; and on the other hand, he does not forget that, were spatial relations the only or even the main factor, London and the Low Countries would be the distribution centre for Europe. The student of population is always in trouble about the variable connotation of *rural* and *urban*, and this is one of many reasons why we should be grateful to Prof. Kirk for this book with explanatory discussion rather than only an atlas. A small community, of dormitory type, may be called rural simply because it is two or more miles from a town, and on the other hand, a large agricultural community, some attaining 50,000 people, may be called a town.

Estimates for Roman imperial territory run between twenty-three and thirty millions, so the population of all Europe at that time may have been some millions above this. Setbacks in the Dark Ages, through the black death and during the wars of religion, held back increase, so that estimates for 1600 are about one hundred millions, and people increased only slowly until 1750 when roads, communications, faster ships, banks, manufactures and so on started the great modern spurt, to 187 millions in 1800, 266 millions in 1850, 401 millions in 1900 and 540 millions about 1940. The fastest growth, be it noted, came between 1850 and 1900 when war devastation was relatively slight.

North-western and Central Europe had become before 1930 an area of incipient population decline, whereas in the U.S.S.R. increase is still very rapid; in fact, some fear a tendency to multiplication for some time so rapidly that standards of living may tend to sink to those which are such an unhappy feature of the monsoon lands of Asia. Another aspect of the situation is shown in the estimate (p. 64) that by 1970 there will be about 6·6 millions less men of military age in North-western and Central Europe but 13·2 millions more in the U.S.S.R. Military losses, excess civilian deaths and birth deficits together make war losses about 22 millions. Military losses in the Second World War were heavy on the eastern front but less elsewhere. The losses through systematized murder were very great, especially in Poland and Yugoslavia and Greece. It is estimated that the War's reduction of numbers in the U.S.S.R. was such that the population in 1946 was only equal to that in 1940 before the slaughter began. That equality was more or less attained gives an indication of the height of the birth-rate even during the War. The rise in birth-rates in Western Europe since 1945 may be a consequence of changes in social attitudes and in income schemes, but it may be in a considerable degree a result of the return of the men from the War. The dramatic falls in emigration to the United States after 1924 and to Canada and Latin America after 1930 are notable as a pointer to the reduced opportunities of open spaces. The emigrant would now tend to join an American proletariat, and in many cases he rather joins the proletariat in his own country and swells the prevalent discontent; movements from southern Italy to Milan and Turin are an important factor in Italian affairs. But, on the whole, birth-rates in cities are lower than in the countryside; and territory under Soviet influence generally proscribes emigration as a political crime.

Migration within Europe in the nineteenth century led to a large increase of population in the Ukraine; but in the twentieth century the most notable fact was the movement of Poles, Italians and some Spaniards to France, usually to try to cultivate the poorer soils or to do menial work, sometimes thereby making more 'superior' jobs for Frenchmen. In parts of south-east and north-east France aliens and naturalized persons were more than 10 per cent of the population about 1930; but the economic blizzard sent some Poles back to their native land. The immigrants to France naturally included a large proportion of men between twenty and forty-five. Parts of the south-east Plateau Central have lost population heavily. A renewal of migration within Europe on a large scale might become revolutionary in its effects; it proceeds, however, quietly and very effectively, generation after generation between Scotland and England in both directions.

Expectation of life has been lowest in Rumania and Yugoslavia, with Greece, Bulgaria and the U.S.S.R. a little better. It is highest in the Netherlands, Sweden, Denmark, Norway and Switzerland. Rumania in 1936–39 still lost more than 15 per cent of its babies in their first year of life.

The study of agricultural population could have been made more profitable by using more fully data collected by Dr. C. J. Robertson for a conference on rural life in 1939 and other analyses which show the crowding, under-employment and poverty of rural populations on several parts of the Loess zone of mid-Europe, a zone occupied from the early third millennium B.C. by peasants and clinging to traditional ways which the original fertility of the soil seemed to permit. In some parts of the Loess zone the yields of crops are very low, the holdings are miserably small, alternatives to farm work are far to seek, birth-rates remain high as usual among populations near the margin of subsistence. These parts would be better if 30–50 per cent of the population could be moved away. Even modernization of methods of cultivation would give only very partial relief.

But we must not ask for too much. Prof. Kirk has given us a mass of valuable data with a notable absence of tendentious arguments. The book should be in all serious libraries. H. J. FLEURE

ANCIENT EGYPTIAN MATERIALS AND INDUSTRIES

Ancient Egyptian Materials and Industries
By A. Lucas. Third edition, revised. Pp. xi+570. (London: Edward Arnold and Co., 1948.) 25*s*. net.

THIS book deals with a branch of prehistoric archæology in the Nile valley which the late Mr. Lucas made especially his own. So often prehistorians are mainly concerned with early sequence dating and a classification of the ancient objects found. But Mr. Lucas was interested in the details of the manufacture of everyday objects and of how and whence the necessary materials were obtained.

Although primarily dealing with the Nile valley and Egyptology, much of what he wrote can, with modification, be applied to other regions—at least from Neolithic times onwards. A glance at some of the chapter headings shows the kind of problems Mr. Lucas set himself to solve. For example, he asks what adhesives were used? These were required for many purposes such as sticking sickle-blades into their hafts and preparing surfaces for tomb-paintings. In the latter case it had been thought that white of egg (from the eggs of wild-fowl, as barndoor hens were at that time unknown in the area) was used as a ground, but now on further investigation this does not seem so likely. But beeswax, glue, gypsum, resin, solder, etc., have all been identified. The need for beeswax led to the extensive cultivation of bees: some resins occurred locally, but the aromatic varieties used in perfumes, etc., had to be imported from southern Arabia. All primitive peoples manufacture some sort of alcoholic drink. What materials did the ancient Egyptians use for the purpose from predynastic times onwards? It seems evident that both beer and wine were known, though it was impossible to produce any kind of spirit, as the process of distillation was unknown until much later. It appears to have been a new discovery in the time of Aristotle. What kinds of building stone were used, and how was granite cut at a time when steel was unknown? What mortar was used? How were finely made statuettes carved from very hard stones, and how were holes for suspension bored in such things as beads, amulets and the like? "Cosmetics are as old as vanity." Yes, indeed, and perhaps we may be thankful that eyelids are no longer painted green, though blood-red nails are still with us. The green mineral malachite (a hydrated copper oxide) was used, being ground to powder on hard stones and made into a paste. Woodash fires (the ash containing alkali) over quartz pebbles, which had been so utilized as mortars, may have led to the discovery of the well-known blue glaze. Lead glaze came later. What metals were known at the various periods, and where were they mined? How was mummification accomplished? What was the process employed to obtain flat sheets of writing material from the pith of the plant papyrus? These and many other fascinating questions are posed and answered by Mr. Lucas.

Finally, there is given a brief historical survey, and the above information is fitted, as it were, into the historical sequence.

It is very pleasant to find a chemist, trained in accurate determination, dealing with such prehistoric problems. There are some prehistorians who have reached back to their subject from their later historical studies; they bring with them the historian's outlook. Others again reach up from geological investigation and bring to bear on the problems the geologist's point of view. Here we have the chemist's outlook, and it is both novel and stimulating. Of course, Mr. Lucas was not the first of his kind to envisage such investigations; but he of all others had particularly made it his own. He opened up the new field in his earlier editions, and this revised and more definitive volume will be welcomed by all who are directly or indirectly interested in the way men lived in the Nile valley in the remote past. M. C. BURKITT

RECENT RESEARCHES IN PHYSIOLOGY

Annual Review of Physiology
Victor E. Hall, Editor; Jefferson M. Crismon, Associate Editor; and Arthur C. Giese, Associate Editor. Vol. 10. Pp. xi+552. (Stanford, Calif.: Annual Reviews, Inc., 1948.) 6 dollars.

IT is rather a sobering thought that within three years of the end of the War a book of more than five hundred pages is required to review the written contributions to one small corner of biological science. With such a literary output some kind of annual survey is clearly necessary, if only as a time-saving measure, to guide the worker or student to those articles relevant to his interests. Reviews, however, are something more than intelligently arranged catalogues, for they can present a periodical appreciation of the state of knowledge in the various fields and in this way help a worker to follow general trends in branches of the science other than his own. A third value to be attached to such surveys is that, by their general dissemination, they can exert a unifying influence which may be considered a direct contribution to a truly international spirit.

Viewed from these three points of view, the tenth volume of "Annual Review of Physiology" has great merit. A wide range of subjects is covered in its twenty-three sections, the only notable deficiency being "Excretion", and this omission is due to circumstances beyond editorial control.

As a guide to publications, each section provides a generous bibliography and there are large author and subject indexes. Certain sections have their bibliographies arranged in alphabetical order; this has a distinct advantage over a chronological arrangement where the reference hunter is concerned.

The most valuable sections are those in which the authors have made some assessment of the significance of the results recorded, or have attempted to harmonize evidence from various sources or to formulate plans for the resolution of conflicts or problems developed in the articles under review. Of course, this can only be attempted in a limited number of cases, but such constructive presentation is very helpful and fully justifies the careful selection of authors by the editorial board. Noteworthy examples of this type are found in Eccles' discussion on conduction in nerve, Osgood's account of hæmoglobin formation and erythropoiesis, Wilhelmi's picture of the significance of hepatic anoxia in shock, Brobeck's attempt to harmonize the 'central' and 'gastric' components of hunger and Anderson's account of thyroid physiology.

The third potential of this publication, its international influence, is recognized by the editorial board in the preface. The board regrets the persistence of difficulties in obtaining contributions from a truly universal field, but affirms its intention to persist in its attempts to overcome these barriers. In this it must receive every encouragement from those who believe in scientific freedom.

A COMPARATIVE HISTOLOGY OF VERTEBRATES

Microscopic Anatomy of Vertebrates

By Prof. James I. Kendall. Third edition, thoroughly revised. Pp. 354. (London: Henry Kimpton, 1947.) 30*s.* net.

IT is a defect of the great majority of text-books of histology that, being intended chiefly for medical students, they wholly neglect all vertebrate classes except the mammals. As a result, students of zoology either learn no histology, or, being led into the subject by men whose interest is limited to one class, and even to one species, acquire a slight superficial knowledge with the same limitation. The book under review attempts to tackle the subject in a less limited manner. Inevitably, because of the vast preponderance of work done on mammals, it is heavily influenced by our knowledge of the microscopic anatomy of that class; but it is rich in descriptions of histological structures in other classes. Thus, the chapter on the integument deals with the skins of the dog-fish, of teleostean fishes, of the frog, reptiles, birds and mammals; that on excretory organs discusses separately the pronephric, mesonephric and metanephric kidneys, as illustrated in such animals as the hag-fish, the frog and the mammal.

Of course, no book of this kind, held within these limits of size, could satisfy every reviewer, and the present reviewer would have preferred greater emphasis on considerations of function and especially, where possible, on the functional differences correlated with differences of structure. On points of detail, one is made a little uneasy by finding the terms 'pre-cartilage', 'chondroid tissue' and 'pseudo-cartilage', used as synonyms. In the section on bone there does not seem to be any recognition of the existence of a microscopically homogeneous substance between the fibres, or of a distinction between lamellar and non-lamellar types of bone. The description of the dog-fish skin and placoid scale could well be revised, and the figure replaced; in the ganoid scale it is incorrect to describe the ganoin layer as "fibrous and uncalcified". In the paragraph on myogenic and neurogenic theories of heart-beat, statements are made which will lead students to believe that the elasmobranch heart is two-chambered and that of amphibians three-chambered.

The book is well illustrated with photomicrographs and diagrams, a number being new since the second edition. Some of the diagrams are rather crude, and one would have liked to see an illustration which would have made easier the identification of leucocytes in some laboratory animals below the mammalian level, especially of the Amphibia.

However, the reviewer, having done his duty by carping a little, would like to end: this is a good book, and it should be in every zoological library.

P. D. F. MURRAY

CYANOGEN COMPOUNDS

Cyanogen Compounds:

Their Chemistry, Detection and Estimation. By Herbert E. Williams. Second edition. Pp. xvi + 443. (London: Edward Arnold and Co., 1948.) 40*s.* net.

THE chemistry of the cyanogen compounds is one of the more difficult branches of the subject, and is one on which it is not easy to find collected information. The first edition of this book, published in 1915, served a very useful purpose in bringing together a large amount of information in a systematic form, and the new edition is necessary in view of the work which has appeared since that time. The treatment is practical, scarcely any space being given to theory, and in some cases this is a real defect of the book. The only formula for Prussian Blue is an old one which is incorrect, no notice being taken of recent work in this field which has cleared up much obscurity. Many of the formulæ given in all parts of the book are semi-empirical, and some account should have been taken of modern co-ordination formulæ for the compounds.

The treatment covers all that could be expected from the title, and a praiseworthy feature is the inclusion of many compounds which have not been investigated for a long time, some of which would, no doubt, repay new work and show interesting and useful properties. The chapters include the subjects of cyanogen and its derivatives, cyanamide, urea and related compounds, cyanates, cyanides, iron-cyanogen compounds, nitroferricyanides, thiocyanates, and five chapters on analysis, which are particularly noteworthy. References to literature are mostly given, and some patents are listed.

The book, taken as a whole, is good, and is one which should be found useful in the laboratory. The absence of an adequate theoretical background makes it essentially a work of reference. The reviewer noticed an unusually large number of errors in names, many of which appear also in the index: these include "Maequer" for Macquer, "Vanquelin" for Vauquelin, "Hautefeville" for Hautefeuille, "Blitz" for Biltz, etc. This creates a certain lack of confidence in the accuracy of the text. Some ordinary words also appear in unfamiliar forms:

"defraction" appears for diffraction, "tantallium" for tantalum, "turpin" for terpene, etc. Although the author claims that the full references will enable his often sketchy accounts to be extended, references are sometimes missing, as, for example, in the inadequate paragraph on cyanogen fluoride.

J. R. PARTINGTON

COLONIAL NATIONAL INCOMES

The Measurement of Colonial National Incomes

By Phyllis Deane. (National Institute of Economic and Social Research, Occasional Papers, No. 12.) Pp. xvi+173. (Cambridge: At the University Press, 1948.) 12*s*. 6*d*. net.

ONE of the most serious gaps in our knowledge of the Colonies has been the lack of adequate statistical analysis of their economic structures. True, there is much scattered statistical material, but it is not always easily accessible and little work has been done to bring it all together to form comprehensive surveys of the Colonial economies.

This book, of its kind a pioneer study, does much to fill this gap, in respect at any rate of three Colonial territories, and ably shows the possibilities as well as the difficulties of extending this work to other Colonies. The main objects of Miss Deane's study were, first, to discover by experiment the possibilities and limitations of applying to the Colonies the techniques evolved for the measurement of the national income of the United Kingdom; and secondly, to throw light on the economic structure and problems of the areas studied. For these purposes three Colonies were examined, Northern Rhodesia, Nyasaland and Jamaica, and their national incomes for the year 1938 calculated. As this inquiry had its beginnings in the early part of the War, 1938 was thought to be the most suitable year for which to make the calculation as there appeared to be relatively more material for that year than for other recent years. Nevertheless, it is impressed upon us throughout the study that the main limitation of all the calculations is lack of data. Moreover, the inquiry was carried out under all the difficulties of war-time London, without first-hand knowledge, by way of field-work, of the territories to which they relate, and therefore the results must be regarded as highly tentative and insufficient to "support firm conclusions on economic conditions in detail". It is the purpose of the research project, however, that the inquiry should be carried into the field.

Mention merely of two problems will serve to illustrate the difficulties that Miss Deane had to face. The first is that of measuring the national income of a territory where a large proportion of the inhabitants are wholly dependent, or nearly so, on subsistence farming; and secondly, the problems created by the existence of two races in one Colony, Africans and Europeans, the latter often with little degree of permanency, and where a significant proportion of the wealth created in the area in fact goes abroad in the form of profits, rents, interest and extra-colonial expenditures. That there are bound to be errors of calculation in the attempt to circumvent such problems with so little data is inevitable; the surprising fact is that the margins of error which Miss Deane has worked out for her calculations should be so small.

But even for those not versed in the finer points of statistical practice there is much that is revealing about the Colonies in the figures presented. In fact, at the end of her study Miss Deane suggests some of the more obvious ways in which the figures may be applied to bring out certain conspicuous features of Colonial economies, for example, the proportion of income that flows abroad from such territories, the distribution of income between Europeans and Africans, the industrial structure of the economies and so forth. Above all, for the purposes of planning Colonial economic development such figures are absolutely essential. Planning, to be successful, must be done in the light of its effect on total national income, its distribution, and on the channels by which it is spent. For purposes of Colonial development, therefore, we are going to need many more Colonial national income calculations such as the painstaking work Miss Deane has given us—and the sooner the better.

D. RANDAL WIGHTMAN

BIRD PICTURES

Fifty Prints

By Emerson Tuttle. With an Introduction by Chauncey Brewster Tinker, a Critique by Lewis E. York, and a Complete Catalogue from 1921 to 1946. Pp. xv + 21 + 50 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1948.) 82*s*. 6*d*. net.

Wings in the Wilderness

By Allan D. Cruickshank. Pp. xiv + 125 + 125 plates. (New York and London: Oxford University Press, 1947.) 35*s*. net.

THE beauty of the bird, its elegance, its grace and its wonder of colouring have ever attracted the artist; note, for example, the prominence of the bird in Chinese and Japanese art. We have here two books dealing with bird portraits, in which the artistic theme is the predominant one; but the approach is from different angles, one being that of the etching and the other that of the camera.

The first mentioned is a collection of fifty prints by the late Emerson Tuttle. There are landscapes among them, but the greater part consist of portraits of birds, including many pictures of owls and hawks. Feather texture and bird character are remarkably delineated in these dry-points, the owls being especially satisfying, in particular the portrait of a snowy owl. The feathers are so soft and fluffy you feel as if you must stroke them. One mammal breaks the sequence, an alert and vigorous red squirrel.

In "Wings in the Wilderness" we have reproductions of 125 photographs from the camera of Mr. Allan Cruickshank, in which birds and birds only are portrayed, and as in the case of Mr. Tuttle's pictures, chiefly the birds of North America. We are accustomed to think that British bird photographers do well with their cameras; but this volume shows the high standard achieved by the ornithological camera users of the United States. Young birds, old birds, birds feeding young, birds swimming and birds in flight are portrayed with great skill. Among so many masterpieces of the camera, it is difficult to select pictures for particular praise; but the osprey on the wing is remarkably good and the wild turkey, a fine old gobbler, of especial interest. This is a book to interest everyone who has ever taken a snapshot of a bird.

FRANCES PITT

The Feeding of Farm Livestock

By J. C. B. Ellis. (Agricultural and Horticultural Series.) Second edition, revised. Pp. xiv+271+26 plates. (London: Crosby Lockwood and Son, Ltd., 1947.) 18s. net.

THE author's primary object has been to show how rations for any class of livestock may be constructed by the use of the Kellner starch equivalent system and protein-equivalents as measures for energy and protein requirements, and this object he has achieved in a smooth and satisfying manner. Like other books on the scientific feeding of farm animals, this volume conforms to the usual pattern, a preliminary explanation of the theoretical bases of scientific rationing being followed by a general description of feeding stuffs in common use, while in the latter chapters the principles of the rationing and management of the various classes of farm livestock are clearly and simply expounded. Following the experimental results of American investigators, the author has based the maintenance requirements for energy on the three-fourths power of the live-weight of the animal instead of on the usual surface law, and has also applied the same principle to the protein requirement estimations.

Owing to compression of material, the reader may be led falsely to assume that digested fat material is transported in the portal blood stream (p. 14), that ptyalin is present in the saliva of all animals (p. 13), and that metabolizable energy is the same as gross digestible energy (p. 23). There are also a few typographical and cross-indexing errors (pp. 1, 12, 214, 215 and 219). Apart from these minor faults, the book is attractively produced, the print is very readable, and the twenty-five photographic illustrations help materially to sustain the reader's interest.

E. T. HALNAN

Tables of Supersonic Flow Around Yawing Cones

By the Staff of the Computing Section, Center of Analysis, under the direction of Zdeněk Kopal. (Massachusetts Institute of Technology, Department of Electrical Engineering, Center of Analysis, Technical Report No. 3.) Pp. xviii + 321. (Cambridge, Mass.: Massachusetts Institute of Technology, 1947.) n.p.

THESE tables are prefaced by an account of the theory, which is based on work by Stone, hitherto unpublished. It is assumed that the motion is steady and isentropic along each streamline behind the shock wave, but not irrotational. The steady angle of yaw is taken to be a small quantity of the first order, and the equations for the first order perturbations of the known flow for zero yaw are worked out. Ultimately the solution is made to depend on a non-homogeneous ordinary differential equation of the second order. It appears that the shock wave is a circular cone the angle of yaw of which differs from that of the body.

Numerical integrations of the fundamental differential equation are the basis of the tables. The ratio of the specific heats for air is taken as 1·405 and the semi-apex angle of the cone ranges from 5° to 15° in steps of 2½°, and upward to 50° in steps of 5°. For each apex angle results are tabulated for equally spaced values of the ratio of the axial component of velocity at the surface to the velocity of escape into a vacuum. Consequently the Mach numbers, which are stated, show irregular increments.

W. J. DUNCAN

The Experimental Situation in Psychical Research

By S. G. Soal. (Being the Ninth Frederic W. H. Myers Memorial Lecture, 1947.) Pp. iv + 64 + 4 plates. (London: Society for Psychical Research, 1948.) 2s.

IN the ninth Frederic W. H. Myers Memorial Lecture, Dr. S. G. Soal has given an admirably succinct summary of the present situation as regards experimental psychical research, and has added a few short criticisms on the various attempts now being made to bring the phenomena of telepathy and telæsthesia under a rigid system of control. He describes his own experiments with Mr. Shackleton and Mrs. Stewart, briefly considers the various group experiments associated with the late Mr. Whately Carington, and has a few words to say on the Duke University series and the picture tests favoured by Dr. Hettinger.

From the results of his own work, Dr. Soal thinks that it is largely a waste of time to conduct mass experiments with unknown percipients unless it be with the view of discovering sensitives of marked ability. He prefers to concentrate attention on persons of promise and, if possible, develop the faculties so that they may become amenable to experimental procedure and the results to statistical analysis. Unfortunately, good subjects and trained experimenters are rare, so that the prospect of rapid progress does not appear to be bright. The technique for a repeatable experiment already exists; but for this to be successful the co-operation of a reliable subject must be obtained, and thus the search for such subjects must be considered to be of major importance.

Nairobi, Master Plan for a Colonial Capital

A Report prepared for the Municipal Council of Nairobi. By Prof. L. W. Thornton White, L. Silberman and P. R. Anderson. Pp. vii + 92. (London: H.M. Stationery Office, 1948.) 21s. net.

NAIROBI started in 1896 as a transport depot on a site that was none too favourable except for the railway which reached it three years later from the coast. Since then it has grown rapidly but largely without a plan, and now, with more than 100,000 inhabitants, is one of the largest inland towns of tropical Africa. The population is mixed, with Bantu Negroes in the majority; next in number Indians, and fewest, but in a dominating capacity, Europeans. At an altitude of 3,600 feet it has a climate suitable for Europeans and its centrality marks it out as the eventual capital of all European-held East Africa. At its present rate of growth it should reach nearly 300,000, which the authors think will be a desirable size about 1975, that is to say, if the serious problem of an adequate water supply can be solved. The rapid rise called for the planning and regulating of the town growth, and the present volume is the outcome of a careful study of the site and the functions of the town both at present and in the years to come. It was prepared at the instigation of the Municipal Council of Nairobi, by an architect, a civil engineer and a sociologist. The inclusion of the last in the team was a recognition that problems of race, caste and religion as well as purely material considerations had to be faced. The report not merely plans Nairobi for many years to come; it is also a discussion of the problems involved by Europe's introduction of the town and all it involves to the agricultural and pastoral peoples of tropical Africa.

OBSERVATIONS ON SLOW MESONS OF THE COSMIC RADIATION

By U. CAMERINI, H. MUIRHEAD
AND
DR. C. F. POWELL.
H. H. Wills Physical Laboratory, University of Bristol
AND
D. M. RITSON
Clarendon Laboratory, Oxford

Introduction

RECENT observations[1] have indicated that the slow negative mesons observed to be created in nuclear interactions taking place in photographic emulsions exposed to the cosmic radiation can produce disintegrations of both light and heavy nuclei. Both the modes of creation and extinction, of at least the majority of these particles, are therefore consistent with the assumption that they have a strong interaction with nucleons. In this paper we describe experiments which indicate that the negative mesons of mass $\sim 200\, m_e$ in the penetrating component of the cosmic radiation, even when captured by heavy atoms, rarely, and possibly never, produce disintegrations of nuclei with the emission of heavy charged particles.

The results also show that in experiments made near the ground, there is present, in addition to the downward stream of mesons of mass $\sim 200\, m_e$, an upward stream of similar particles with an intensity approximately half that of the downward component. These mesons are accompanied by σ- and π-mesons, and a comparison of the relative numbers of the different types allows us to make an estimate of the mean life-time, τ_π, of the heavy particles. The value thus obtained is $6 \pm 3 \times 10^{-9}$ sec.

Experimental Method

The present experiments were initiated as part of a series designed to determine the life-time of the different types of mesons present in the cosmic radiation. The main principle of the investigation was to observe the reduction in the number of heavy positive and negative mesons ($\sim 313\, m_e$), brought to rest in our emulsions after being generated in matter disposed around the plates, as the distance between the plates and the surrounding matter was increased.

As a first step in this programme, preliminary experiments were made at the Jungfraujoch with the simple arrangement shown in Fig. 1. We anticipated that the observations would allow us to determine the quantity of neighbouring matter which it would be necessary to employ in order to obtain a sufficient increase in the number of tracks of heavy mesons. In each case, twenty-four plates, Ilford Type *C2*, boron-loaded, 100 μ thick, in their original packing, were enclosed in a box of tinned iron (0·5 mm. thick), and supported 2 metres from the floor, and about 60 cm. below a light roof, with the surfaces of the emulsion lying in a vertical plane. In one case the plates were supported from the roof by strings; in the other they were placed on a light iron tripod, and surrounded on the four sides by lead blocks 5 cm. thick, the top and bottom of the assembly being left free.

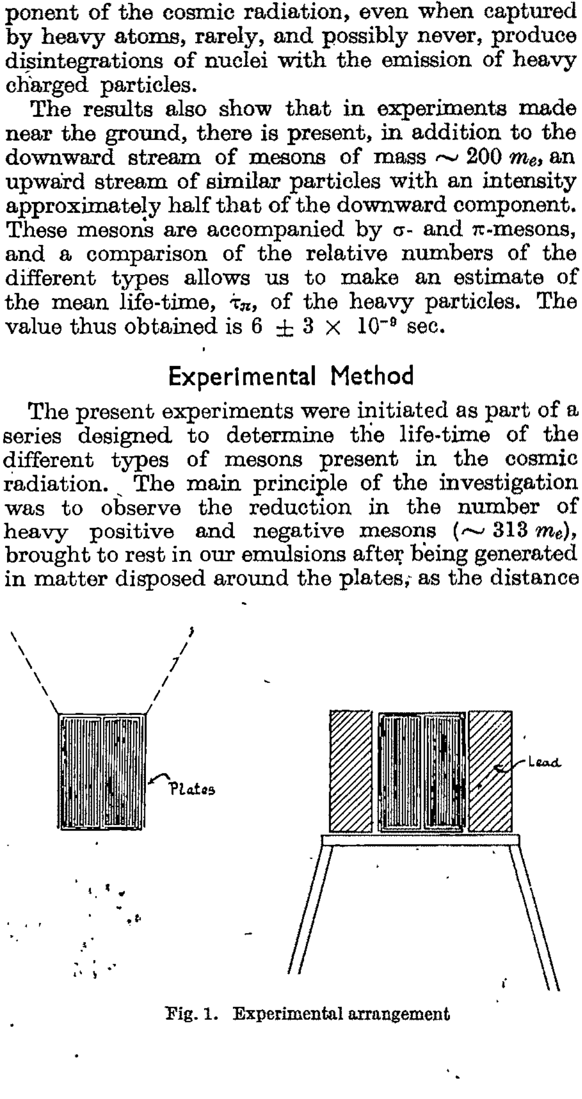

Fig. 1. Experimental arrangement

After an exposure of 35 days, the plates were marked so that their orientation during the exposure and their order in the assembly was known; and they were afterwards developed by the methods recently described[2]. The present results were obtained in the microscopic examination of 9·6 cm.^{3} of the emulsion of the plates thus obtained. In analysing the experimental results, we employ the classification for the different types of mesons given in an earlier paper[1]. The terms 'ρ-meson', 'σ-meson', etc., are employed for the different categories of mesons classified phenomenologically; and 'π-particle', 'μ-particle', when it is possible to distinguish particular types more precisely.

Angular Distribution of the ρ-Mesons

The directions of motion of the mesons, at their points of entry into the emulsion, were first determined. In every case, we chose to measure only the angle, relative to the vertical, of the projection of the track on the plane of the emulsion. The resulting angular distributions thus obtained, for ρ-mesons, are shown in Fig. 2*A*, the full lines corresponding to the measurements on the plates obtained without lead, curve *a*; and the dotted lines, to those obtained with lead, curve *b*.

It will be seen from Fig. 2*A* that, both in the experiments with and without lead, there is a pronounced downward flux of particles accompanied by an upward stream of about half the intensity; and that the numbers of particles in these directions are not appreciably influenced by the presence of the lead. The difference in the two distributions is given in Fig. 2*A*, curve *c*, and shows that a considerable number of ρ-mesons enter the plates in directions which indicate that they come from the lead.

We must anticipate that the Coulomb scattering in the plate assembly will cause the observed directions of motion to differ from those of the particles before they have been reduced to the relatively low speeds at which we can observe them. An analysis indicates, however, that these changes in direction are not serious, and that the original distribution must have been similar to that observed. Deviations become more frequent as the velocity of a particle is reduced, and we have therefore drawn the corresponding angular distributions for those particles of residual range greater than 300 μ. These are shown, in the form of a polar diagram, in Fig. 3, curves *a* and *b*, and display the same features as the results obtained by including the measurements made for

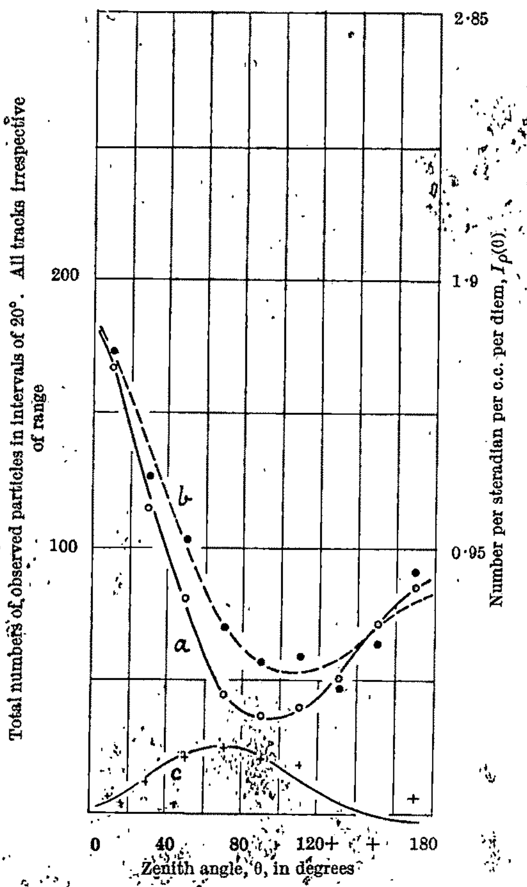

Fig. 2A. Experimental results, ρ-mesons

Curve (a), exposure without lead; (b) exposure with lead; (c) difference between (b) and (a)

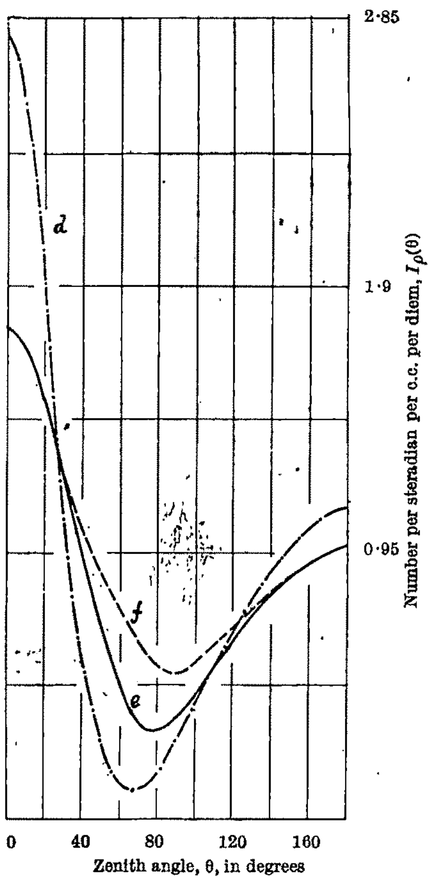

Fig. 2B. Calculated distributions to fit experimental data. Curve (d) calculated original angular distribution unmodified by scattering; (e) estimated distribution to be observed in experiment without lead; (f) similar distribution with lead. Curves (e) and (f) are calculated for tracks greater than 300 μ

all mesons, irrespective of their residual range in the emulsion, curves c and d. It is a satisfactory feature that the pronounced 'waist' in the distribution without lead is accentuated when the results for the short tracks are excluded.

We have estimated the original distribution of the directions of motion of the mesons which stop in the plates, employing the scattering formulæ developed by E. J. Williams, and the result is shown in Fig. 2B, curve d. Owing to scattering in the plates, such an original distribution should appear in the experiments without lead like that shown in curve e of the same figure; and, in the experiment with lead, as curve f.

The estimated original angular distribution of the downward flux of mesons appears to be in reasonable agreement with the measurements, made by Greisen[3], with a counter telescope, on the mixed stream of electrons and slow mesons which form the soft component of the cosmic radiation.

As a step towards calculating the absolute intensity of the mesons, we have plotted the distribution in range of the observed particles. In agreement with the previous results[4], the observations show that the observers record the mesons, of which the length of the projection of the track is greater than 200 μ, with constant efficiency. Further, the consistency between the results of two observers, obtained in the examination of the same plate, shows that this efficiency is close to unity. The absolute intensity, $I\rho(\theta)$, the number of ρ-mesons per c.c. per unit solid angle per

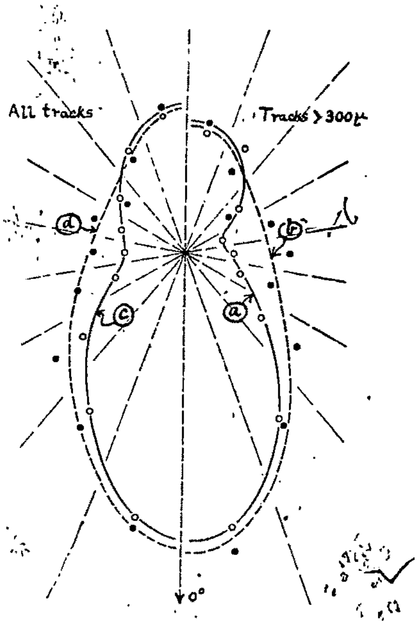

Fig. 3. Polar diagram showing angular distributions observed experimentally. (a) Tracks longer than 300 μ, without lead; (b) with lead; (c) all tracks, without lead; (d) with lead

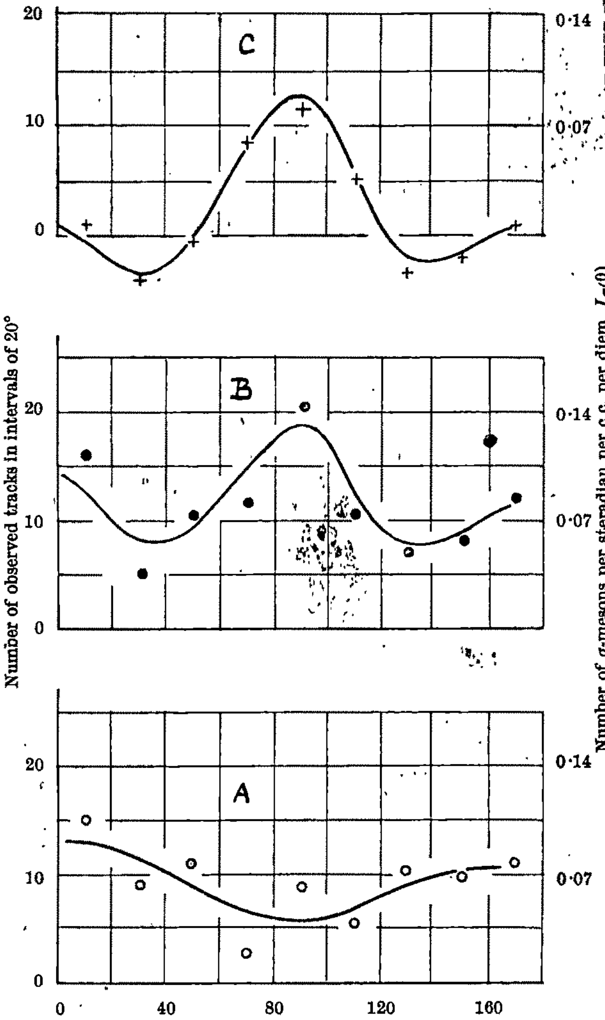

Fig. 4. Angular distribution of σ-mesons. (*A*) Without lead (*B*) with lead; and (*C*) difference (*B*)–(*A*)

diem, has been calculated, therefore, from the numbers of tracks of which the projections are greater than 200 μ, using a procedure similar to that described in a previous paper[4]. This has allowed us to insert a scale of absolute intensity in Figs. 2 and 4.

Angular Distribution of σ-Mesons

The number of tracks of σ-mesons in the volume of the emulsions examined hitherto is much smaller than that for the ρ-mesons, so that the statistical fluctuations are more serious. The results are shown in Fig. 4, *A* and *B*, for the exposures with and without lead. It will be seen that the addition of the lead results in a considerable increase in the number of σ-mesons and that these enter the emulsions in directions which indicate that they have originated in the lead. In Fig. 4*C*, we plot the difference in the two distributions. Although the standard deviations associated with each of the points in this figure are relatively large, so that the small departures of the points from the smooth curve drawn through them must be regarded as fortuitous, Fig. 4*C* gives good evidence for the existence of a pronounced lateral stream of σ-mesons, produced by the presence of the lead.

Interpretation of Observed Angular Distributions

The above observations can be interpreted in terms of the relations of the mesons of different types, outlined in the previous paper. We regard the downward stream of ρ-mesons as corresponding to the particles of the penetrating component of the cosmic rays, which originate by the decay in flight of π^+- and π^--particles formed in the atmosphere.

Strong support for the view that the particles in the main downward stream observed in the present experiments are identical with the mesons of the penetrating component is provided by a comparison of our results with the observations of Rossi, Sands and Sard[5]. These workers have investigated the rate of arrival of slow mesons with a life-time of 2·2 μsec., using a delayed coincidence method, at an altitude of 14,000 ft. We have recalculated their results on the assumption that the energy of the electrons formed by the decay of the mesons is 25 MeV., as suggested by the recent experiments of Anderson and his colleagues[6]. The values so obtained can be compared with the rate of arrival of mesons in our emulsions from all directions in the upper hemisphere. The two values are thus found to agree to within 30 per cent (see Table 2).

Table 1

Ratio of the integrals, $N = \int I(\theta).d\theta$, for different intervals of the angle θ. $I(\theta)$ = the intensity per steradian per cm.³ per diem, at the Jungfraujoch, 11,000 ft.

Interval in θ°	With lead		Without lead	
	$N_\sigma/N_\rho \times 10^{-2}$	$N_\pi/N_\rho \times 10^{-2}$	$N_\sigma/N_\rho \times 10^{-2}$	$N_\pi/N_\rho \times 10^{-2}$
0– 40	5·0 ± 1·3	3·5 ± 2·1	5·8 ± 1·5	3·5 ± 2·1
60–120	21·0 ± 3·6	18·1 ± 6·8	9·2 ± 2·5	12·0 ± 6·0
140–180	7·2 ± 2·1	16·7 ± 6·7	11·5 ± 2·6	6·6 ± 4·1

Table 2

Values of the total integrated intensity, $J^\pi = \int_0^\pi I(\theta).\sin\theta.d\theta$ in mesons per cm.³ of the emulsion per diem, for different classes of mesons, at the Jungfraujoch, 11,000 ft.

	J_ρ	J_σ	J_π
With lead	8·42 ± 0·48	1·09 ± 0·14	1·04 ± 0·35
Without lead ..	7·59 ± 0·46	0·74 ± 0·11	0·68 ± 0·23
Mean values ..	8·0 ± 0·3	0·9 ± 0·1	0·9 ± 0·2

For ρ-mesons, in the exposures made without lead, the total intensity in the upper hemisphere, $J^{\pi/2}$, is 4·1 mesons per cm.³ per diem. The calculated value, based on the experiments of Rossi, is found to be ∼3 mesons per cm.³ per diem, assuming the decay electron to have an energy of 25 MeV.

We attribute the difference in the two distributions of the ρ-mesons, observed in the exposures with and without lead, to the particles in the main downward stream which have been scattered into the plates in traversing the surrounding lead. A comparison of the calculated curves Fig. 2*B*, curves *e* and *f*, with the corresponding experimental results represented in the accompanying diagram, 2*A*, shows that we can thus account for at least a large part of the increased number of ρ-mesons. We cannot, however, exclude the possibility that some of them are due to particles which have been created in the lead.

The form of the distribution in angle of the σ-mesons, in the exposure made without lead, is similar to that of the corresponding curve for ρ-mesons. We attribute the lateral stream of σ-mesons, produced by the addition of matter around the plates, to negative mesons produced in the lead which have not had time to decay in flight. The distribution in angle of these mesons is consistent with this assumption. The presence of the lead also gives rise to an increase in the number of π-mesons, but in this case, because of the low probability of observing these particles[4], the numbers are too small to allow any conclusions to be drawn regarding their distribution in angle.

Nature of the ρ-Mesons in the Upward Stream

If we apply a similar analysis to the meson stream arising from the matter beneath the plate assembly, we find that the ratio of the numbers of ρ- to σ-mesons is about half as great as that observed in the main downward stream (see Table 1). It seems reasonable to suppose that the ρ-mesons are in this case, also, composed mainly of μ^+- and μ^--particles, formed by decay in flight; and that in spite of the relatively close proximity of the matter in which the parent π-particles are produced, only a small fraction of them reaches the emulsion before they have decayed.

Comparison of the Number of ρ- and σ-Mesons in the Downward Stream

It is of great interest to compare the downward intensity, $I_\rho(\theta)$, of the ρ-mesons, measured in mesons per steradian per cm.^{3} per diem, with the corresponding quantity for σ-mesons, $I_\sigma(\theta)$. The estimated number of ρ-mesons entering our plates, in the angular range 0–40° with the vertical, $N_\rho{}^{40°} = \int_0^{40°} I(\theta)\,.\,d\theta$, is 0·86 ± 0·07 per cm.^{3} per diem. The corresponding value for the σ-mesons, $N_\sigma{}^{40°}$, is 0·05 ± 0·01.

Reference was made in the previous paper to recent observations on the sign of the charge of the ρ-mesons, using the method of magnetic deflexion, by which it was shown that approximately half these particles are negatively charged. This result is in accord with magnetic deflexion experiments made with expansion chambers on cosmic ray mesons[7]. In order to allow for a small positive excess, and for the presence among the ρ-mesons of some π-mesons of which we fail to distinguish the tracks of the associated μ-mesons, we shall assume that 40 per cent of the ρ-mesons are negatively charged. It follows that the number of negative ρ-mesons in the downward stream (0–40°) is 0·34 ± 0·03 per cm.^{3} per diem.

Of all the negative mesons in the downward stream, a certain fraction, f, will be stopped in silver bromide grains and will be captured by atoms of high atomic number; and the remainder, $1-f$, will be brought to rest in gelatine. Through the kindness of Dr. Gardner and Mr. Lattes, two of us (U. C. and H. M.) have recently obtained plates exposed to the negative mesons generated artificially at Berkeley. The emulsions of these plates were made up of alternate layers of normal emulsion and of pure gelatine. It was thus possible to study the difference in behaviour of the mesons stopped in gelatine, and of those stopped in the mixture of gelatine and silver bromide composing the ordinary emulsion. Among other features, the observations made it possible to show that the fraction, f, of negative mesons stopping in a normal emulsion which are captured by heavy atoms is greater than 0·3. Theoretical estimates of the stopping power of the different constituents of the emulsion give values lying between 0·4 and 0·6, and we shall assume that $f = 0{\cdot}5$.

It is known, from the delayed coincidence experiments, that most of the negative mesons of the cosmic rays, of which the life-time is 2·2 μsec., undergo normal decay with the emission of an electron, when brought to rest in light elements. We shall therefore not expect to observe disintegrations produced by those of the μ-mesons, whether positively or negatively charged, which stop in the gelatine of the emulsion; and we confine our attention to those negative mesons which stop in silver bromide.

Let us assume tentatively that all the σ-mesons in the downward stream are μ^--particles. We must then conclude that the number of μ^--particles which produce observable disintegrations, in comparison with the total number of ρ-mesons, is less than 6 per cent (Table 1). Further, if 40 per cent of the ρ-mesons are μ^--particles, it follows that only 15 per cent of the latter produce observed disintegrations. Taking $f = 0{\cdot}5$, we conclude that only 30 per cent of the μ^--particles which stop in silver bromide produce observable disintegrations.

The above values must represent upper limits, for a certain fraction, φ, of the σ-mesons must be heavy particles with a strong interaction with nucleons. There is good evidence that φ is nearly equal to unity. Thus we can compare the intensity of σ-mesons in the downward stream, $N_\sigma{}^{40°}$, with that of π-mesons in the same angular range, $N_\pi{}^{40°}$. The numbers so obtained are $N_\sigma{}^{40°} = 0{\cdot}054 \pm 0{\cdot}010$ and $N_\pi{}^{40°} = 0{\cdot}035 \pm 0{\cdot}015$. The corresponding numbers for the complete angular range are $N_\sigma = 0{\cdot}20 \pm 0{\cdot}03$ and $N_\pi = 0{\cdot}16 \pm 0{\cdot}03$. It is therefore reasonable to assume that the positively charged π-mesons, π^+, and the negatively charged heavy particles, $\pi^-(313\, m_e)$, are produced in approximately equal numbers. We should then have to regard at least the great majority of the σ-mesons in the main downward stream as particles with a strong interaction with nucleons probably produced in the roof and other neighbouring matter above the plates, for they are accompanied by π-mesons in approximately equal numbers.

Thus suppose we take the values for the number of σ- and π-mesons in the downward stream (0–40°), from the experiments both with and without lead, and assume that the number of σ-mesons, with a strong interaction, π^-, is equal to the number of π-mesons, π^+. We can then write:

$$\frac{N_\sigma(\mu^-)}{N_\rho} = \frac{N_\sigma}{N_\rho} - \frac{N_\pi}{N_\rho}.$$

Using the values given in Table 1, we thus find:

$$\frac{N_\sigma(\mu^-)}{N_\rho} = 1{\cdot}9 \pm 1{\cdot}8 \text{ per cent.}$$

Assuming, as above, that 40 per cent of the ρ-mesons are μ^--particles, it follows that only 9·5 ± 9·0 per cent of them, which stop in silver bromide, produce observable disintegrations. The results, therefore, show that most, and possibly all, the light negative mesons of the penetrating component of mass $\sim 200\, m_e$ fail to lead to a nuclear disintegration with the emission of protons and other heavy charged particles, when stopped in silver bromide.

This result depends on estimates of quantities which are not known with precision; but even if we choose the most unfavourable values, we are still led to substantially the same conclusion. Thus assume that the proportion of negatively charged particles among the ρ-mesons is only 30 per cent; and that all the

σ-mesons in the downward stream are due to μ^--particles, none being attributed to π^--particles generated in the plates and in local matter. Even with these assumptions, both of which it would be difficult to support, we must conclude that 60 per cent of the light negative mesons of the cosmic radiation, when stopped in materials of high atomic number, produce no nuclear disintegrations with the emission of heavy charged particles.

The correctness of the assumption that the numbers of positively and negatively charged ρ-mesons are approximately equal (that $\rho^+/\rho^- \sim 2\cdot 0$, or less) has been supported by reference to the results of experiments on the penetrating component[7]. It might be objected that, in order to reduce the intensity of the soft component, these experiments are commonly made under considerable thickness of absorbing materials; and that there is no guarantee that the small values for the positive excess which are thus found will also occur under a light roof. This appears to be the weakest point in the interpretation of our results. While the preliminary measurements by the magnetic deflexion method indicate that the positive excess is, in fact, small, it is important to continue the observations in order to increase their statistical weight. It would, however, be very difficult to account for any great positive excess in terms of our present views on the nature of the processes which lead to the production of the different classes of mesons, and our conclusions would not be seriously modified if the ratio μ^+/μ^- were as great as 2.

Marshak[9] and others have considered the possibility that the interaction of a light negative meson with a nucleus may lead to the emission of a neutretto; and that the ejection of heavy charged particles from the nucleus as a result of the interaction is never, or only rarely, to be expected. Further, recent experiments[10] indicate that the capture of these mesons by lead atoms results in the emission of neutrons from the nuclei, a result which is consistent with the view that the meson interacts with one of the protons in the nucleus, as represented by the equation: $H^1 + \mu^{-1} \rightarrow n^\circ + \nu^\circ$, where ν° denotes the neutretto. Such an assumption allows us to account for the absence of the emission of heavy charged particles as a result of the interaction, for the total release of energy to be accounted for is reduced by the amount corresponding to the rest-mass of the neutretto; and it is perhaps reasonable to assume, from the principle of the conservation of momentum, that most of the balance of energy will appear as kinetic energy of the neutretto. In any case, it appears to be certain that if a light negative meson is captured by a nucleus, only a small fraction of the energy liberated by the disappearance of its rest-mass is distributed among the nucleons.

The Life-time of the π-Particles

Recently, the results of experiments on the intensity of the penetrating component of the cosmic radiation at great depths underground have been employed to obtain an estimate of the mean life-time of the heavy mesons, τ_π, and the value so obtained is 6×10^{-8} sec.[11]. The present experiments have allowed us, however, to make an independent estimate of this quantity, and we have found a much smaller value, namely, $\sim 6 \times 10^{-9}$ sec.

The new estimate is based on the following considerations: We have attributed the upward stream of ρ-mesons to μ^+- and μ^--particles formed by the decay in flight of upward moving π^+- and π^--particles which have been generated in the matter beneath the plate assembly. By comparing the number of ρ-mesons in the upward stream with that of the π-particles which have escaped decay; and by estimating the time of flight of the particles, in moving from their points of origin to the plate assembly, we can calculate the life-time of the heavy mesons.

This method depends for its success on the correctness of the assumption that the majority of the ρ-mesons in the upward moving stream are produced by the decay of π-particles; and that not more than a small proportion of them are generated directly in nuclear interactions. This view is supported by the results of the previous paper[1] which suggest that the number of μ-particles directly produced is small compared with the corresponding number of π-particles; but in order to obtain a further check, we have examined plates exposed in the ice of a glacier. In such plates, an upward moving stream of mesons can be detected, but it is now found to be composed of π-particles and ρ-mesons in roughly equal numbers. This observation proves that the number of ρ-mesons directly produced is less than that of the π-particles. We show, afterwards, that we can account for the ρ-mesons, in this case also, by decay in flight of π-particles.

In calculating the life-time, we require to know the distribution of the matter beneath the plates. The floor immediately beneath the assembly is composed of layers of various materials—granite, reinforced concrete, cork and wood—with a total weight of ~ 100 gm. per cm.^{2}. Beneath this is a number of rooms, one above the other, 2·5 m. high, with floors of weight ~ 80 gm. per cm.^{2}.

The mesons forming the upward stream are found to reach the end of their range at points which are distributed uniformly throughout the emulsions; and the energy at the point of entry into the assembly, of a meson which comes to rest in the central regions of the plates, is about 35 MeV. We therefore assume, as a first approximation, that the mesons originate in the central layers of the first floor, and come to rest in the centre of the plates; that none of the π-particles is locally produced in the plate assembly itself; and that 90 per cent of the ρ-mesons in the upward stream are μ^+- and μ^--particles.

With these assumptions we find

$$\tau_\pi = 5 \times 10^{-9} \text{ sec.}$$

We have made a more precise analysis, in which account is taken both of the generation of the mesons at different depths in the floor; and of the difference in energy, at the points of entry into the plate assembly, of those mesons which stop in different regions of the plates. This leads to substantially the same value, namely,

$$\tau_\pi = 6 \times 10^{-9} \text{ sec.}$$

It may be objected that a considerable proportion of the upward stream of mesons could have been generated at greater depths; in the lower floors of the building, for example. Such mesons must, however, have sufficient energy to penetrate the floors above their points of creation, in order to reach the plates. As a result, the relativistic contraction of the time-scale begins to play an important part. If, for example, we assume that all the mesons have been generated in the second floor, we find the following value for the life-time:

$$\tau_\pi = 7 \times 10^{-9} \text{ sec.}$$

and if generated in the third floor:

$$\tau_\pi = 8 \times 10^{-9} \text{ sec.}$$

The calculated values of τ_π are therefore rather insensitive to the assumed range of the 'primary' radiation. We take as the best value $\tau_\pi = 6 \times 10^{-9}$ sec., corresponding to the assumption that the 'primary' radiation is reduced to an intensity $1/e$ of its original value in traversing 50 cm. of concrete. It appears reasonable to assume that the contribution to the observed backward stream made by the mesons generated in the lower floors will be relatively unimportant not only because of the absorption of the primary radiation by the overlying matter, but also because there will be a tendency for the mesons to be thrown forward in the direction of the motion of the primary radiation as their energy of emission increases.

Apart from these uncertainties, the above values must be regarded as upper limits, for some of the observed π- and σ-mesons, in the angular interval under consideration (140°–180°), will have originated in processes taking place in the plate assembly itself. Assuming that 0·03 mesons per steradian per cm.^3 per diem are produced in this way, the calculated values of τ_π are reduced by about 30 per cent.

Returning now to the consideration of the exposures made on the glacier, it is found possible, using the calculated value of τ_π, to account for the presence of ρ-mesons in the backward stream, in spite of the much greater proximity to the plates of the matter in which the mesons are generated. The ice, which may be regarded as of indefinitely great extent, contributes a stream of π-particles with an intensity two or three times as great as that produced by the lead. It is therefore reasonable to assume that the effective thickness of the producing layer of ice, which contributes to the σ- and π-mesons stopping in the plates, is at least 110 cm. Calculations indicate that the relative numbers of π- and μ-particles observed are in agreement with a lifetime of 6×10^{-9} sec. The observations are thus consistent, in this respect also, with the assumed absence of the direct generation of μ-particles.

Alternatively, by combining the results of the two experiments—that made in the glacier, and that with the plates supported 2 m. above the floor—it is possible to obtain the following limits to the value of the life-time, without assuming that the μ-particles are not produced directly:

$$3 \times 10^{-9} \text{ sec.} < \tau_\pi < 1\cdot5 \times 10^{-8} \text{ sec.}$$

We believe, however, that the π-particles are alone produced directly, and if this is correct our results indicate that

$$\tau_\pi = 6 \pm 3 \times 10^{-9} \text{ sec.}$$

The present experiments were designed only as a preliminary step towards determining the life-time of the heavy mesons, and the possibility of making the present estimates only appeared during the course of the investigation. Further experiments, using a more favourable geometrical disposition, are now in progress.

Summary

The main conclusions which follow from our results may be summarized in the following terms:

(1) Observations have been made on the directions of motion, of mesons recorded by photographic plates exposed to the cosmic radiation, at their points of entry into the emulsion. The results show that there is a pronounced downward stream of ρ-mesons. The rate of arrival of these particles, and the estimated original distribution in angle of their directions of motion, before they have been scattered in the plate assembly, show that most of them are identical with the mesons of the penetrating component of the cosmic rays.

(2) Near the surface of the earth, in addition to the downward stream of mesons of mass $\sim 200\, m_e$, there is an upward stream of similar particles of considerable intensity. These particles may be regarded as being formed by the decay in flight of those π^+- and π^--particles, generated in the matter beneath the plate assembly, which are ejected upwards.

(3) Less than 15 per cent of the light negative mesons of the cosmic radiation, when brought to rest in the emulsion, produce nuclear disintegrations with the emission of heavy charged particles. It appears to be necessary, therefore, to attribute the failure to observe electrons arising from the decay of these particles, when they are stopped in materials of high atomic number, to other causes. While the results do not preclude the possibility that mesons of this type sometimes produce observable disintegrations, the low value of the upper limit for the fraction which do so, leads to a strong presupposition that they always disappear through processes of another type. Taken in conjunction with the results of other experiments, our observations give support to the view that the capture of the meson leads to the emission of a neutron and a neutretto.

(4) By comparing the relative numbers of the π- and μ-particles in the upward flux of mesons, it is possible to make an estimate of the mean life-time of the heavy mesons. Assuming that the μ-particles are not directly produced in nuclear interactions, the value thus obtained is $\tau_\pi = 6 \pm 3 \times 10^{-9}$ sec.

WE are greatly indebted to Mr. G. R. de Salis for assistance in making the exposures at the Jungfraujoch; to Dr. C. Franzinetti and Dr. S. Rosenblum for kindly making available to us the preliminary results of their experiments on the determination of the sign of the charge of the ρ-mesons; to Mr. C. M. G. Lattes and Dr. E. Gardner for the plates exposed to the mesons produced by the Berkeley 180-in. cyclotron; and to Prof. von Muralt, director of the Hochalpine Forschungsstation Jungfraujoch, for assistance and kind hospitality. The plates exposed on the glacier were obtained in a collaboration between Mr. Y. Goldschmidt-Clermont, of the Centre Physique Nucléaire, Brussels, and three of us (U. C., H. M. and D. M.), for the purpose of determining the absorption in ice of the radiation responsible for the production of 'stars'. A full account of these experiments will be published shortly elsewhere.

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THE HUMAN MILK BANK

By EDITH G. DARE, O.B.E.

Formerly Matron of Queen Charlotte's Hospital, London

[The first Human Milk Bank in Great Britain was established at Queen Charlotte's Hospital, London, in 1938, through the initiative and under the expert guidance of Miss Edith Dare, then the matron, with the financial assistance of the late Sir Julian Cahn through the National Birthday Trust Fund. This Bank followed closely on the heels of similar banks and bureaux in the United States (which Miss Dare visited in order to study their organisation, equipment and method of working), Germany and the U.S.S.R. The author has recently retired from her post as matron of the Hospital which she has held with distinction for twenty-eight years (she has been connected with the Hospital since 1911); but she still retains an active interest in the Human Milk Bank based at the Hospital as honorary director of the former for life. In the following article she describes the founding of the Bank, and reviews the advances made there and elsewhere since its inception.—EDITORS.]

THE Human Milk Bank at Queen Charlotte's Hospital, London, was founded in 1938—the first of its kind to be established in Great Britain. By its means, the lives of many sick babies have been saved and others have been safely brought to normal especially by supplementing the mothers' milk and assisting during periods of crisis.

Having visited several such banks and bureaux in the United States during 1938, I soon became convinced that here was a valuable social and medical service that neither Great Britain nor any other country could afford to ignore. Such a service should be established, at any rate in Great Britain, without delay. At the inception of this, the first, Bank, it was necessary to obtain funds; these were soon forthcoming from the National Birthday Trust Fund, through the generosity of the late Sir Julian Cahn. To-day, however, the Bank has succeeded in becoming entirely self-supporting; indeed it is paying its own way with a reasonably safe margin. The leading pædiatricians keenly support it; in fact, they look upon it already as an essential part of the social services of the country, especially since it is recognized by physiologists that no food other than human milk is suitable during the neo-natal period. The premature baby, the sick baby, operation cases all can benefit from the human milk so supplied. As pointed out by Dr. Martha Dynski-Klein, the "incidence of infection in infancy is estimated to be twice as high in artificially fed babies as in breast-fed ones, and the death-rate ten times as high"[1].

At the Queen Charlotte's Hospital the milk is obtained mainly from women who have been patients in the Hospital, though other women also come forward. The surplus milk is withdrawn, either by means of a breast pump, which the mother learns to manipulate herself, or manual expression is used. The mother gathers her surplus milk into a sterilized bottle which is kept in an ice box, both of which are supplied by the Bank. This is collected daily by a member of the staff of the Bank. All equipment, including sterilized towels, dishes, etc., are also supplied. Most of the donors are paid for their services.

All the surplus milk thus collected from nursing mothers (now returned to their homes) is taken to the clinic and there strained and mixed, after it has passed exacting chemical and bacterial tests. Though human milk varies somewhat in chemical content, especially in proteins and lactose, the resulting mixture has been proved to be quite satisfactory for any baby. From the mixer the milk is bottled, and then the bottles are placed in pasteurization tanks. Later, they are labelled and put into refrigerators where they are kept until required. The milk can be, and is, sent to many parts of the country, where it is required, either by special vans or train (in the latter case, special arrangements have been made for express delivery); on certain occasions even the aeroplane has been pressed into service. Queen Charlotte's Milk Bank supplies several of the leading London and provincial hospitals. A charge is usually made for the service, both to the hospitals and to individual patients; but where there is financial hardship the service is free.

To meet acute emergencies some milk is 'quick frozen' in order that it may be stored for an indefinite length of time. For this purpose 'dry ice' is used. Special moulds are placed over the 'dry ice'; into these moulds the milk is placed by means of a sterilized syringe. Another block of 'dry ice' is placed over the filled moulds, and the milk left for about two minutes to freeze. Then the disks of frozen milk are removed under aseptic conditions and kept in refrigerators until required. Such milk will keep almost indefinitely at about −10° F. Milk not thus treated, that is, milk which has been placed in the refrigerator immediately after pasteurization, will last for about forty-eight hours only. Milk which is to be 'quick frozen' must be quite fresh, that is, it must have been withdrawn from the mother on the same day that it is to be frozen.

Dr. Dynski-Klein[1] has shown by the following data that human milk which is boiled before quick cooling shows only little effective change in content, and no viable bacteria are present.

	Before boiling	After boiling
Protein	1·8–2·2 gm./100 ml.	1·5–3·0 gm./100 ml.
Fat	2·7–4·6 ,,	3·0–0·0 ,,
Lactose	5·7–6·5 ,,	6·2–7·3 ,,
Vitamin C	3·9–4·6 mgm./100 ml.	3·0–7·3 mgm./100 ml.

At her clinic, Dr. Dynski-Klein administers ascorbic acid to premature and sick babies.

The staff at Queen Charlotte's Hospital, who carry out the work of the Bank, comprise two specially trained sisters. It is their responsibility to collect milk from the mothers in their homes (two motor-cars are supplied for the purpose), and to carry out the entire routine of testing (except bacterial and chemical, which is done by an outside laboratory, which specializes in milk testing), pasteurizing, sterilizing and storing at the clinic. As much as eighteen gallons of milk have been dealt with in one week in this way. The staff, equipment and costs of a human milk bank is therefore not prohibitive considering its very wide scope, its great potentialities and its consequent importance to public health and service. To-day the Bank at Queen Charlotte's Hospital has its own Board of Governors, of which the Lord Chancellor, Viscount Jowitt, is the chairman.

There seems to be little room for doubt that the establishment of human milk banks throughout the country, organised on a county or some other regional basis, should be treated as a social and medical service of prime importance. The pioneer work done at Queen Charlotte's Hospital has now expanded so substantially as to provide a complete pilot plant or type specimen for the guidance of future banks. The space required is not great, and the staffing and other problems are of not considerable magnitude. Indeed, a human bank has already been established at Cardiff; there is a smaller unit at Manchester; another is being formed in Birmingham. There are other milk bureaux, which are usually centred in hospitals, but their services are confined to the hospital patients themselves; that is, though the human milk is obtained from mothers both within and without the hospital, it is given only to babies in the maternity wards of that hospital; and if there is any left over it is sent to the children's wards.

But much remains to be done, for even now, banks and bureaux are adversely affected by the inconstancy of supply, depending as the supply does on propaganda and the efficiency and cleanliness of the donors, to say nothing of their goodwill. Now that the National Health Service Act is in force, there are already hospital regions which might well form the necessary units on which to base new human milk banks. This point well might be considered in view of the possibility that if such banks are established over the entire country they will eventually come under the charge of the Ministry of Health through its regional or local authorities now set up under the Act.

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[1] *Brit. Med. J.*, 258 (Aug. 24, 1946).

THE BRITISH GAS INDUSTRY

THE eighty-fifth annual meeting of the Institution of Gas Engineers was held in London during June 8–11 under the presidency of Dr. Harold Hartley. It was a notable event in its history, being probably the last before the gas industry becomes integrated on a regional basis. Dr. Hartley reviewed the rise of the industry—the pioneer in the practice of distributing fuel and power as a public utility. He initiated a stocktaking of the present position and surveyed the prospects of the future. The papers presented for discussion centred round these themes. In the past, the industry experienced the advantages of competition as a stimulus to progress, not without the disadvantages of a multiplicity of independent local undertakings. For many years the need for reorganisation had been recognized. Progress in this direction had been made—some people had thought not rapidly enough. In 1943 a report of the Post-War Planning Committee of the British Gas Federation proposed geographical integration of its undertakings. This concept was eventually endorsed by the Heyworth Committee of the Government of the time. Since then the Government has decided that the desired end shall be attained by nationalization, and the necessary legislation is now before Parliament.

One cannot assess usefully the gas industry, or rather the industry of coal carbonization, apart from the supply and utilization of coal. Never was the efficiency of utilization and conservation of reserves so important. Formerly, when coal was cheap judged by present standards, and freely available, it was used as though future supplies faced no limit. Often little attention, either domestic or industrial, was paid to matters of efficiency or expenditure of labour in use. To-day the struggle to raise adequate supplies of coal to the surface is continuous. Adequacy has come to take priority over cost. One of the most effective means of meeting scarcity is to practice efficiency in use—a means promoted by the Ministry of Fuel and Power since its formation. The problems of scarcity create the most serious difficulties for public utilities, which undertake to maintain an adequate supply of a manufactured product liable to extreme and daily peaks of demand. The shortage of plant has created difficulties of a national scope for the electrical industry, difficulties only met by the shedding of load. Peak loads occur weekly in the consumption of gas; but these, owing to difference in conditions of distribution, pass almost unnoticed. To-day a new factor has come into prominence owing to the need for maintaining exports of coal. Formerly the export of coal was one only of the ample means of balancing the national budget in Britain. Now it is an indispensable means for maintaining national and international policy.

Export now obtains priority in the supply of coal, and even for the higher grades of coal. The loss of our higher grade coal—especially the best coking coal—is regrettable, although apparently inevitable at present. From the long-term point of view the consequences may be disastrous.

Every circumstance points to the need for promoting the conservation of fuel, and scrutinizing industrial practices to see how far policy or practice conforms to this need. From this point of view the papers presented at the Institute's meeting are timely. T. C. Finlayson and F. S. Townend examined critically the types of plant available to provide the supplies of coke and gas in relation to seasonal needs. Seasonal variations play a vital part in the organisation of public utilities. The gas industry requires to control the ratio of coke to gas production according to supply and consumption; but existing means to this end are only partially effective. The usual method is based on the gasification of oil, but now this is no longer adequate. Whatever the future productivity of the oil-fields, at present there is a shortage. The complete gasification of coal might make a valuable contribution to the necessary control of coke-gas ratio of production. A measure of success has been realized in Germany with the complete gasification of lignite under pressure; but so far the use of British bituminous coal has not proved serviceable. These authors conclude that "it is difficult to envisage this process as producing a therm of gas substantially cheaper than that obtained by existing methods provided that the coke can be sold". In short, there is still no certainty that costs will allow complete gasification to displace existing methods of carbonization. Linked with complete gasification of coal is the problem of distribution required to provide the 'whole-house' domestic service which is a present ideal. This might involve a tenfold increase of supply per dwelling. H. J. Escreet's survey of gas distribution is intended to examine current practice and experience with the view of finding the answer. Cost, he said, need not exceed present figures. There would, however, be a loss of the convenience given by the presence of stocks of solid fuel already distributed to meet the seasonal peak of demand for fuel. The fact is that the gas supply is a two-fuel industry, able to supply both solid and fluid fuel, and thus enjoys a unique position for dealing with the fluctuations of load caused by the British climate. If the two-fuel system persists, it points to the need for attention to the improvement of manufactured smokeless fuels and consequent conservation of high-grade coking coals.

Other papers dealt with ancillary subjects—availability of British gas coals, purification and marketing of gas and administration. At a time when everything points to the need for conserving coal and promoting efficiency in its use, the series of papers makes a valuable compilation.

H. J. HODSMAN

THE BALANCE OF RESEARCH AND TEACHING AT UNIVERSITIES

ONE session at the sixth Congress of the Universities of the Commonwealth, which was held in Oxford during July 19–23, was devoted to what is perhaps the most fundamental of all the problems which face a university: What should be the relation between teaching and research? Should one think of a university primarily as a place where learned men learn more? Or should it be a place where learned men, from their reserves of information, instruct the comparatively ill-informed? Dr. W. T. S. Stallybrass, vice-chancellor of the University of Oxford, presided at the discussion.

Prof. G. A. Currie, vice-chancellor of the University of Western Australia, introduced the topic by pointing to the very wide difference between the two concepts of a university held by Bruce Truscott, the creator of "Redbrick", and by Ortega Y. Gasset—two authors who have had considerable influence on those who are concerned with university life. Ortega Y. Gasset holds that the inquiring mind has been disastrous, that the constant, restless wish to discover has led the universities from the cultural centre of the community which is their proper place. Bruce Truscott's view is that "an urgent ferment of the mind" is the essence of a university. Unless the teachers are actively engaged in research, their teaching will be barren and unimportant. The spirit of research is the justification of a university. The two theories are diametrically opposed to each other.

None of the representatives assembled at Oxford was prepared to go all the way with Ortega Y. Gasset—though it was noticeable that two Indian representatives spoke most eloquently of the primary obligation of a university being to teach, and emphasized the harm which has been done by an ill-directed urge to publish the results of research of little value. There was general agreement that the question was, in fact, one of balancing two rival claims, each valid in itself, but each in some danger of strangling the other.

However, to say that there is a need to balance the claims of teaching and research is not to say that every university should strike the same balance. The situation, the development and the size of the university are among many factors which must be borne in mind when deciding how much time each teacher should be able to set aside for research. Similarly, the different faculties will give different answers. There was very general agreement among the scientific speakers at Oxford that it is literally impossible for a teacher of any of the scientific subjects to maintain a high standard unless he is given time for private research. Speakers from other faculties were less emphatic. But it was very clear that the need to safeguard the time of the science teachers, who are at present over-worked and overcrowded, is a very pressing need indeed.

It would be desirable to safeguard the time which a teacher should be able to give to his research by limiting the number of hours during which he or she is required to teach. But the curriculum must be so arranged as to give the teacher not merely the requisite number of hours, but also two or three days in each week when he is able to dedicate himself to research without interruption. It is obviously still more desirable to make it possible for the teacher to carry out research elsewhere if it is more convenient—which can be done only by providing sabbatical years more frequently than any universities can at present afford to do. But sabbatical years are not in themselves the solution of the problem. The teacher needs to be able to do his research concurrently with his teaching.

The problems of safeguarding the teacher's hours of research, the curriculum which makes it possible for him to carry out research, and sabbatical years—all these are administrative problems which the governing body of each university must deal with when it has decided how it proposes to balance the claims of teaching and research. The Congress at Oxford did not make any *ex cathedra* pronouncements on this problem. It was obvious that while the representatives assembled in Oxford were very conscious of the existence of the problem, they were equally clear that it is one which must be settled by each individual in each faculty. There is much research now going on which cannot be said to be of any value either to the research worker himself or to the very few students who will read the printed results. But imaginative research, undertaken, not because promotion depends upon it, but because it is a result of the researcher's enthusiasm for his subject, will make him a better teacher—and will be the more likely to be worth-while research. It is the duty of the academic administrators to make sure that they do not so overload the teacher that this type of research is made impossible.

INTERNATIONAL CONGRESS ON MENTAL HEALTH

THE International Congress on Mental Health held in London during August 11–21, was an event of considerable significance for the social sciences and psychiatry, and the repercussions will be felt far afield. It marked a stage in the struggle of these disciplines, on one hand, for acceptance among the family of sciences, and on the other, for recognition in the world of affairs. The undoubted success of the Congress springs from the marriage of these two aims. It is only possible to give here a passing reference to some of the more important aspects of the Congress, to the immense amount of preparatory work, and to the implications for the future.

The Congress comprised three separate international conferences. The first, on child psychiatry, and the second, on medical psychotherapy, were held during August 11–14; the third and main conference, on mental hygiene, during August 16–21. The Congress was organised by the National Association for

Mental Health, with Dr. J. R. Rees, formerly consulting psychiatrist to the British Army, as president. About two thousand people attended from some fifty countries.

The conferences on child psychiatry and psychotherapy were run on conventional lines. For the first conference the theme chosen was the development of personality in its individual and social aspects, with special emphasis on aggressiveness. Specific topics included aggression in relation to emotional development and in family life, psychiatric problems in education, and the community and the aggressive child.

The subject of guilt formed the theme of the second conference. This was considered under the headings: genesis of guilt, guilt and the dynamics of psychological disorder, and collective guilt. Several of the papers were of exceptional merit, notably those by Dr. John Rickman and Dr. Margaret Mead. The fourth day of this conference was devoted to advances in group therapy. Here the most interesting contribution was perhaps made by Dr. Bion, originator of the 'leaderless group' technique first used in officer selection in the British Army. In the group procedures employed by him, Dr. Bion found it important to elucidate three aspects, first, the group 'mentality' created by the anonymous participation of members; second, the efforts of the members to achieve a full life in the group; and third, the culture of the group.

The International Conference on Mental Hygiene was the third in a series, the first having been held in Washington in 1930, and the second in Paris in 1937. Under the broad heading of "Mental Health and World Citizenship", five topics were considered: problems of world citizenship and good group relations, the individual and society, family problems and psychological disturbance, mental health in industry, and problems of planning. The Conference had the active support of Unesco and the World Health Organisation.

In addition to the plenary sessions, there were more than twenty specialist group meetings, sponsored by such professional bodies or organisations as the Maudsley Hospital, the Institute for the Scientific Treatment of Delinquency, the Royal Society of Medicine, the Tavistock Institute of Human Relations and the British Psychological Society.

The preparations for this conference were on altogether novel lines. Indeed, the conference may be said to have begun eighteen months ago when multi-disciplined professional groups were formed all over the world to collect and evaluate available data, or carry out new inquiries, bearing on the conference topics. During the intervening period about five thousand members of the professions concerned worked in discussion groups in twenty-seven countries. Their deliberations resulted in some three hundred reports dealing with various aspects of the themes chosen for each day of the conference. About one in ten of the members of these discussion groups attended.

These groups were kept in touch with one another by a printed bulletin issued periodically. Ten such bulletins were circulated, and the contents included not only notes on the work of each of these groups, but also a critical discussion of the aims of the conference. The bulletin will continue to circulate for some time after the Congress, so as to provide an early opportunity for publishing material not to be included in the Congress Proceedings.

The three hundred reports, classified according to the five conference topics, were collated and carefully edited, and the edited material passed on to an International Preparatory Commission for further study.

In my opinion, the work of the International Preparatory Commission was the outstanding point of interest in the Congress as a whole. The primary tasks of the Commission were to examine the reports of the national study groups and to prepare a statement to serve as a basis for consideration at the conference. The Commission consisted of twenty members from ten countries and representing disciplines including psychiatry, sociology, psychology, political science, anthropology and social science. The chairman was Mr. Lawrence K. Frank (director of the Caroline Zachry Institute of Human Development). Dr. Otto Klineberg attended as representative of the Unesco project on "tensions affecting international understanding"; and during the last two days, Dr. Brock Chisholm, director-general of the World Health Organisation, was present as observer.

The statement produced by the International Preparatory Commisssion is a document of great significance, not so much because of any original pronouncements it makes, but because it conveys the agreed views of a group of experts from many countries on issues of great moment to-day, particularly those arising out of the problem of war. The statement includes recommendations addressed to national organisations and United Nations agencies in any way concerned with 'mental health'. It is important to make clear that this term 'mental health' was not used by the Commission in any narrow sense, certainly not in the sense of a state of mind which secures immunity from certification under the Lunacy Laws. It denoted rather a state of social well-being, affecting and affected by every important aspect of the life of the individual and community.

Those who took part in the work of the International Preparatory Commission found it a unique and remarkable experience. Ample opportunity was provided to observe tensions in the making, and there were many such tensions to overcome—inter-national, inter-disciplinary and inter-personal. It is safe to say that, in my view, in this particular group the third type of tension was the most difficult to resolve. In the result, an astonishing degree of group cohesion was achieved and a wide measure of agreement on controversial issues cutting across many disciplines. The major psychological effect on the individual members was the extent of 'group involvement' which many of them experienced.

Overshadowing all other topics in the minds of the members of the Commission was the problem of mental health in relation to world citizenship, or more correctly perhaps, as Dr. Edward Glover put it, the problem of "diseases of sovereign groups". Much thought was devoted to detecting points of intervention in the vicious circle of sovereignty and preparation for war; this is discussed in the statement.

Of special interest was the light thrown on the processes involved in an intimately co-operative intellectual effort, on the technique of approach to complex problems, on the correct division of labour between individual and group in a collective activity of this kind, and above all on the curious distorting effect of unconscious factors on reality thinking, even to the extent of blocking the recognition of the most crucial problems of all.

One triumph of the Commission was the final acceptance of the view that what is understood by the term 'mental health' is part of a system of values; it is, in other words, a culturally determined and approved end. It required a tremendous effort to pluck out this view from the mass of anxieties, tensions and resistances which obscured it.

If the Commission made no striking new discoveries, at least it brought to light the fact that multi-disciplined thinking involves more than the mere coming together of diversely educated persons in order to exchange views. Multi-disciplined thinking may operate at many levels. In its most rudimentary form it is simply 'additive', combining the points of view of different disciplines. At a more advanced stage, it requires a new type of concept, which reflects the many-faceted situations of real life. This is one aim of operational research which is essentially a multi-disciplined activity.

The major outcome of the Congress was the formation of a World Federation for Mental Health. This Federation has already been accepted by the World Health Organisation and Unesco as a consultative body on all matters pertaining to mental health in the widest sense. The new organisation will have its roots in the professional groups formed in so many countries to prepare the way for the Congress. These groups will be strongly encouraged to broaden the base of their activities to include all the social sciences as well as psychiatry, and machinery will be devised to link all these groups with the new World Federation. In the way it is hoped to mobilize all the efforts of social scientists, in research and practice, towards the study of the most urgent human problems agitating the contemporary world.

John Cohen

OBITUARIES

Dr. P. R. Lowe, O.B.E.

Percy Roycroft Lowe, who died on August 18, was born at Stamford, Lincolnshire, on January 3, 1870. He was educated privately and went to Jesus College, Cambridge, where he graduated as a B.A., and afterwards qualified in medicine and surgery at Guy's Hospital, London. He served as house physician and surgeon at two hospitals in the Midlands. In 1899 he volunteered for service in South Africa and was appointed medical officer in charge of Princess Christian's hospital train. It was while he was in South Africa that he became interested in ornithology and began to make a collection. On the termination of hostilities he returned to Great Britain and a short time afterwards was appointed private physician to Sir Frederic Johnston. This was a most fortunate appointment for an ornithologist, as Sir Frederic Johnston spent the winters abroad in his private yacht and during the next six years Lowe visited the West Indies and a number of islands in the Atlantic. On these voyages he took every opportunity to study birds and brought together a collection of some three thousand skins which he later presented to the national collection. Lowe contributed a series of papers on his collections, including a study of the genus *Coereba*, in which he paid special attention to the variations in colour in that genus.

In the First World War, Lowe served in Lord Dunraven's yacht fitted up as a hospital ship, and afterwards as a captain in the R.A.M.C. in command of Princess Christian's ambulance train. In 1919 he succeeded Mr. Ogilvie-Grant in charge of the bird collection in the British Museum, and retired in 1935.

Lowe was specially interested in the anatomy and osteology of birds, and was an exceptionally careful and painstaking worker. He made a close study of the Charadriiformes, or wading birds, and published several papers on their classification based on osteological characters and colour pattern. He wrote extensively on the ostriches—both recent and fossil. His studies of the primitive characters of penguins aroused a good deal of criticism, but all will admit that his work on the microscopical structure, arrangement and moult of the feathers of these birds was of outstanding importance. For long there had been much discussion as to whether there were two species of the steamer duck (*Tachyeres*) but it was left to Lowe to prove, in 1934, that there was a volatile and non-volatile species.

Archæologists are indebted to Lowe for proving that the supposed remains of the pheasants from Roman sites in Great Britain are nothing more than the bones of domestic fowls.

It is no exaggeration to say that in the last fifty years Lowe has done more than anyone to advance the study of the anatomy of birds and their classification.

Although Lowe had always been interested in the preservation of birds, it was not until 1925 that he began to take an active part in the cause. In that year he received a letter from the late Prof. Lönnberg directing attention to the grave decline in the numbers of wildfowl in Sweden and asking his advice and assistance. He took up the matter with characteristic energy and started extensive inquiries in Britain and elsewhere. His conclusions, which were published in pamphlet form, went to show that the decline in numbers was mainly due to increased commercialization, and that unless something was done the numbers of wildfowl were bound to go on decreasing. Through his efforts the British Government was persuaded to hold an International Wildfowl Conference in 1927. A year or two earlier the International Committee for Bird Preservation had been founded, and Lowe became secretary of the British Section and for many years was chairman. His efforts in the cause of bird preservation were greatly appreciated on the Continent, and in 1938 he was elected chairman of the European Section. He was president of the British Ornithologists' Union during 1938–43 and in 1946 was awarded the Salvin-Godman Medal for his outstanding work on the anatomy of birds and his efforts in the cause of protection.

In 1924 he married Harriette Dorothy, widow of Charles Parker of Fairlee and younger daughter of the late E. G. B. Meade-Waldo. He is survived by his widow and one daughter.

N. B. Kinnear

Dr. C. A. Elsberg

Charles Elsberg, who died at his home in Stamford, Connecticut, on March 18, was one of the most distinguished neurological surgeons of his generation. When he started his career, neurological surgery did not exist as a specialty. While brain surgery was being developed by Harvey Cushing, the surgery of the spinal cord, in which Elsberg was to win international renown, was in its infancy.

The son of a merchant, Elsberg was born on August 24, 1871, in New York City—the scene of his life's work. Educated at the College of the City of New York, he graduated B.A. in 1890, and three years later took the M.D. at the College of Physicians and Surgeons ('P. and S.') of Columbia University. After serving as interne at the Mount Sinai and Sloane Hospitals, he worked under von Mikulicz-Radecki in Breslau, and on his return was appointed adjunct surgeon at the Mount Sinai. When in 1909 the Neurological Institute opened its doors at 149 East 67th Street, he was offered the post of chief of surgery, which he held until 1937. In 1929 the Institute moved to its present home (168th Street and Fort Washington Avenue) in the Columbia-Presbyterian Medical Center. Its history was told by Elsberg in 1944, in his fascinating and colourful "The Story of a Hospital", which contains a wealth of biographical and autobiographical material. He was editor of the *Bulletin of the Neurological Institute*, begun in 1931, the fifth volume of which was dedicated to him on his sixty-fifth birthday.

In 1917, at the request of the Surgeon-General, Elsberg organised the New York Neurosurgical School for Medical Officers of the American Army, of which he became military director.

His more important writings include "Experimental Investigation of the Treatment of Wounds of the Heart by Means of Suture of the Heart Muscle" (1898), which was translated into many languages, and the classic "Surgical Diseases of the Spinal Cord, Membranes, and Nerve Roots" (1941), which was a revised edition of "Diseases of the Spinal Cord" (1916) and of "Tumors of the Spinal Cord" (1925).

Many honours came Elsberg's way: he was president of the American Neurological Association and of the Society of Neurological Surgeons, and his name is associated with the operation of drainage in syringomyelitis (also known as Pussep's operation). An inspiring teacher—he was very popular as professor of neurological surgery at 'P. and S.' (1921–37) —he was distinguished and youthful in appearance, charming in manner, deeply cultured, and he radiated energy and enthusiasm. W. R. BETT

Mr. J. S. Dow

MR. JOHN STEWART DOW died on August 12. He was born in 1881. After passing through a course in electrical engineering at the City and Guilds of London Engineering College he was for some years on the staff of the College and was later engaged on research work, chiefly on photometric problems.

His early association with Leon Gaster led to the first publication in 1908 of *The Illuminating Engineer*, on which he acted as assistant editor. Since 1928 he had been editor, the name of the journal having been changed to *Light and Lighting* in 1936.

Mr. Dow was even better known for his unbroken connexion with the Illuminating Engineering Society since its foundation in 1909 when he was honorary assistant secretary. In 1928 he became honorary secretary, a position he held until he became president in 1946. After his term of office as president, he continued to serve on the Council of the Society, and during the whole thirty-nine years he was present at every Council meeting. He was a fellow of the Society, and in 1942 was elected an honorary life member, an honour which was shared only by the late Mr. A. P. Trotter.

He was a member of the Departmental Committee on Factory Lighting and of the Illumination Research Committee, as well as of the Lighting Committee of the Building Research Board and numerous other committees concerned with lighting.

He was honorary secretary of the Association of Public Lighting Engineers from 1931 until the end of 1935.

His life's work for the Illuminating Engineering Society cannot be over-valued. He always avoided publicity; but it is due to his work and foresight that the Society has reached its present position. He will be deeply mourned by all associated with lighting matters.

NEWS and VIEWS

New British Association President: Sir John Russell, O.B.E., F.R.S.

AT the British Association meeting just held at Brighton under the presidency of Sir Henry Tizard, Sir John Russell was elected president for the 1949 meeting at Newcastle-upon-Tyne. Sir John has a world-wide reputation as an agricultural scientist. He joined the staff of the Rothamsted Experimental Station in 1907, and succeeded the late Sir Daniel Hall as director in 1912. He retired in 1943, the year of Rothamsted's centenary. During his thirty-one years as director, there was a remarkable expansion of Rothamsted's activities. Various new departments were added, new buildings were erected, and the finest agricultural library in Great Britain, if not in the world, was built up. He also raised the necessary funds for the purchase of the Rothamsted Farm and the Manor House. Sir John has made outstanding contributions to soil science and is the author of several standard works on that subject. He is a former president of the International Society of Soil Science, a foreign associate of the Paris Academy of Sciences, and a member of numerous other academies. Among the distinctions he has received are the Messel Medal of the Society of Chemical Industry and the Albert Medal of the Royal Society of Arts. During the Second World War he was adviser to the Soviet Relations Division of the Ministry of Information and chairman of the Agriculture Sub-Committee of U.N.R.R.A.

Sir John is the first agricultural scientist to become president of the British Association. He has regularly attended the meetings for more than forty years and was the first recorder of agriculture when that subject was a sub-section of botany. Agriculture was made an independent Section in 1912 and Sir John was president of it in 1916 at Newcastle, in 1924 at Toronto and, again, at the centenary meeting in London in 1931. He has served several periods as a member of Council and has been chairman of various committees and a president of the Conference of Delegates of Corresponding Societies. Sir John has travelled widely and has made a special study of agriculture in the U.S.S.R. and Poland. He is about to visit Poland again to take part in the jubilee celebrations of the Academy of Arts and Sciences and will represent the British Association there. He will also give lectures and visit agricultural research institutions on behalf of the British Council.

British Association: Exhibition of Scientific Instruments

ONE of the many interesting features of the Brighton meeting of the British Association was a display of the latest scientific instruments, and particularly of electronic equipment, arranged by the Scientific Instruments Manufacturers Association of Great Britain in the Corn Exchange. The stands were well set out in the ample space available, so that visitors were not subjected to the crowding so often occurring at such exhibitions. In opening the exhibition on September 13, the president of Section A, Sir Lawrence Bragg, paid tribute to the enterprise of instrument manufacturers in organising the display at a time when they were actively engaged in participating in the British Exhibition in Copenhagen. He stressed the importance of accurate, and often very elaborate, instruments both in modern scientific research and in the industrial field. The research worker, he said, has outlived the days of home-made apparatus largely constructed of jam-jars and sealing-wax and has become more and more dependent upon the skill of the instrument maker; and it is necessary for the two to work hand in hand to secure progress. There was a time, and that not long ago, when the scientific world looked mainly to the United States and Germany for the most accurate instrument work, but to-day Great Britain can hold its own in every section of instrument making, and in many it leads the world; in this sphere, at least, Britain no longer fears foreign competition. On the following morning, the whole session of Section A was given up to a symposium on instrumentation and control, including industrial applications of electrical devices, opened by Sir Ewart Smith.

Museum of Archæology and Ethnology, Cambridge: Dr. G. H. S. Bushnell

FOLLOWING the resignation of Dr. T. T. Paterson, Dr. G. H. S. Bushnell has been appointed curator of the Museum of Archæology and Ethnology, Cambridge. Dr. Bushnell is the son of the Rev. D. G. S. Bushnell; he was educated at Wellington and Cambridge, taking his degree in 1925; recently (1947) he obtained the degree of Ph.D. In July 1926 he went to Ecuador as a geologist with Anglo-Ecuadorian Oilfields, Ltd., and remained there with intervals of leave until 1938. It was while working in Ecuador that archæology first attracted his attention, and he examined the southern part of the coastal plain, which up to then had never been studied. He also travelled in Peru, visiting Lima, the Cuzco region, etc., and began to write up the results of his investigations. During the War he held a commission in the Royal Engineers. While an important work is still in the press awaiting publication, there have been numerous articles from Dr. Bushnell's pen on such subjects as an archæological collection from Macas in Ecuador east of the Andes in Oran, and reviews, etc., in various learned journals. Dr. Bushnell is on the Councils of the Society of Antiquaries and the Royal Anthropological Institute. As a keen student of medieval archæology he has also been appointed vice-chairman of the Chelmsford Diocesan Advisory Committee for the Care of Churches. From every point of view Dr. Bushnell should make an ideal curator, for he has considerable personal charm and can arouse enthusiasm in others.

Mathematics in King's College, Newcastle-on-Tyne:

Dr. A. E. Green

ON the retirement of Prof. G. R. Goldsbrough, the chair of applied mathematics at King's College has been filled by the appointment of Dr. A. E. Green. Dr. Green obtained distinction at Cambridge in Part III of the Mathematical Tripos, was a Smith's Prizeman and research fellow of Jesus College. Since 1939 he has held the post of lecturer in mathematics at the Durham Colleges. Dr. Green's published work mainly covers the subjects of hydrodynamics and elasticity. In the former he has dealt with the production of small eddies from large ones, the gliding of a plate on a stream and the fluctuations of pressure in a turbulent fluid. In elasticity he has investigated the stability of thin twisted strips and corrugated plates, and numerous problems in the stress systems of æolotropic plates.

Dr. W. W. Rogosinski

THE chair of pure mathematics at King's College, vacated by Prof. A. C. Offord on his appointment to the chair at Birkbeck College, has been filled by the election of Dr. Werner W. Rogosinski. Dr. Rogosinski studied at the Universities of Breslau, Freiburg and Göttingen. At the last-named he proceeded to the degree of doctor of philosophy in 1921. He held the appointment of *Privatdozent* and later *Ausserordentliche* Professor at the University of Königsberg. In 1937 he came to Great Britain and did some teaching at Cambridge. Later he was appointed assistant in the Mathematics Department of the University of Aberdeen and in 1945 lecturer at King's College, University of Durham, where he was further raised to the status of reader in mathematical analysis in 1947. Dr. Rogosinski has written numerous papers on trigonometric series, Dirichlet's series and problems of complex analysis. He also published "Fouriersche Reihen" (Sammlung Schubert, 1930), and, with the late Prof. G. H. Hardy, the Cambridge Tract on "Fourier Series".

Nicolas Copernicus

IN an article in *The Times* of September 7 on "Poland's Northward Thrust", reference is made to Thorn (now Torun) Allenstein (renamed Olsztyn) and Frauenburg (now Frombork), the three places, in what was formerly East Prussia, in which Copernicus lived and died. To-day the district is a scene of destruction unparalleled elsewhere in Europe. Torun, where Copernicus was born, became Polish after the First World War, and Olsztyn, where he lived for a time, and Frombork, where he worked and died, are now also Polish. In Olsztyn castle, fortunately undamaged, one can see the chamber occupied by Copernicus when he was a canon and administrator of his uncle's diocese; and at Frombork, a small town completely ruined by the War, is the house he lived in and the cathedral in which he was buried. The Polish Government has given a sum of money towards restoring the old quarters of Copernicus in the cathedral close and his tower and observatory. Of the body of Copernicus, however, no trace can be found. "It appears," says the article, "that shortly after the Russians entered Frombork, unknown vandals raided the coffins of bishops and noblemen buried under the cathedral on the basis of a report that many of them wore gold and diamond rings."

Ontario Research Foundation

In his annual report for 1947 to the chairman and governors of Ontario Research Foundation (43 Queens Park, Toronto 5), the Director of Research refers to the virtual completion of the extension of the main building and to a considerable expansion of the scientific and administrative staff. During the year a new Industrial Research Services Department was established particularly to help the numerous small industrial units of the Province, and the Department is expected to handle about two thousand inquiries a year. The Chemistry Department prepared a comprehensive report for the Minister of Mines on the processes in operation for the removal of sulphur gases from smelter fumes; fellowships were concerned with emulsion inks, waxes and transparent paper, sulphite liquor, the manufacture of carboxymethylcellulose, and the polymerization systems butadiene – styrene, butadiene – isoprene and isoprene – styrene. In the Department of Engineering and Metallurgy, sixty-seven investigations were undertaken on behalf of various firms, and fellowships on the influence of chemical composition and physical structure of forged steel balls and their resistance to wear during grinding, and on wire rope, and work on the economics of ferrous smelting in Ontario continued. The Department of Parasitology carried further its work on the life-histories and the factors influencing the activity of black flies and leucocytozoon infection in ruffed grouse and other birds, especially domestic ducklings. Several drugs used successfully in combating malarial infection in man gave negative results on infected birds.

The Physiography Department is completing a study of the geological history of southern Ontario, has co-operated with the Department of Agriculture in a chemical investigation of pasture grasses, and has assisted the Meteorological Service of Canada in equipping and supervising twelve new weather stations at selected points. The work of the Textiles Department has been handicapped by shortage of staff and accommodation; but the Courtaulds (Canada) Ltd. fellowship has continued its work on dye formulæ and methods of finishing and the development of consumer standards, while under the Canadian Industries Ltd. fellowship, in addition to developing fabric construction to meet the demands of the consumer, the behaviour of the nylon fibre under different physical and chemical conditions is being investigated. Some progress is also reported by the Department in investigations on the transmission of water vapour through fabrics, the physical properties of nylon and the factors involved in removing oils used as lubricants after processing textile materials.

Barton's Ruling Engine

In the possession of the Science Museum, London, there are six beautifully engraved buttons, classified as diffraction gratings, which are still regarded as masterpieces. They were the work of Sir John Barton, deputy comptroller of the Royal Mint in the early part of the nineteenth century, about whom little is known personally, but who must have been an ingenious inventor and capable engineer, for in 1806 he invented a differential screw measuring instrument capable of measuring to 10^{-5} inch. In 1822 he was granted a patent for his engraved buttons. After Sir John's death the ruling engine on which the buttons had been ruled passed into the possession of his grandson and then to his great-grandson, Mr. R. V. Barton, who, in 1925, presented the engine, together with some handwritten notes of his father's concerning the working of the machine, to the Science Museum. The above details are given in a valuable and interesting illustrated article entitled "A Ruling Engine Used by Sir John Barton—and its Products" which P. Grodzinski, the technical editor of the *Industrial Diamond Review*, contributes to the February number of that journal. It would appear that this is the first authoritative description.

From his inspection of the machine and relevant documents, Grodzinski concludes that the engine was not Barton's own design but is probably a Harrison straight-line engine. The machine itself is made of brass except for the screws, spindles and pivots, which are steel. The tools are of well-ground steel; but diamond tools, generally octahedral Brazilian stones with curved edges, are provided. Six engraving tools work on six specimens simultaneously, and the method of movement of the tools is ingenious, kinematically sound, and simple. It is fully described in the article, with clear diagrams and photographs. The high precision of division and the engraving of six specimens at once are the special merits of this machine.

Tables of Uranus for the Period 4000 B.C.–A.D. 3000

MM. M. Kamieński and R. Walter have a paper with this title (*Extrait Bull. de l'Acad. Polon. Sci. et Lettres*, 1947) which provides a simple and rapid method for finding the heliocentric co-ordinates of Uranus, the perturbations of the other planets having been taken into consideration in the compilation of the Tables. An explanation of the method for applying the Tables is given, and an accuracy of about 1′ is obtainable, which is sufficient in a great many cases. The Tables should prove very useful, especially in investigating the influence of Uranus on the motions of comets in ancient times, though, of course, they will prove helpful in many other cases as well. Special investigations were made of the long-period inequalities of Uranus, and it seems that these, namely, those of the mean longitude, the eccentric angle, longitude of perihelion, and semi-major axis, can be approximately represented by a Fourier interpolation formula. These inequalities are so regular that the corresponding formula for perturbations in longitude can be extended even beyond the limits of the Table, for the period 6500 B.C.–A.D. 5500, with a mean error of less than 1′.

Conference on Experimental Biology, Peiping

More than one hundred teachers, research workers and senior students in biology of the universities and institutions of Peiping met in the new campus of the College of Agriculture of the National Tsinghua University during July 17–25. The instigator of the conference was Dean P. S. Tang, ably and generously assisted by his colleagues of the College. The campus is next to the famous Summer Palace which was freely accessible to the members during this conference, and one of the most enjoyable parts was the boating at night on the lake inside the Palace. Preliminary meetings consisted of lectures on the place of biology in ancient Chinese history, and on the teaching methods of biology in colleges and high schools. So many contributed valuable suggestions to the latter subject that a special committee was appointed to explore further this important and fertile field. The regular programme consisted of symposia and lectures on recent advances in genetics, hormones, nutrition, viruses and rickettsia, biophysics and aviation physiology. The round-table meetings were attended chiefly by senior members, and the following topics were discussed: cytology, growth and development, immunity, and effect of temperature on organisms. The general impression of the conference was that the time allotted to each speaker was too short, and plans are being made to choose one or two important subjects as the theme of the conference next summer. It was fortunate that the Peiping branch of the Chinese Society of Phytopathology was able to meet with the conference on the afternoons of July 20 and 21.

Hallucinations

The *Proceedings of the Society for Psychical Research* for July (48, Pt. 175) has a suggestive and highly critical article by the research officer, Dr. D. J. West, in which he examines afresh the evidence hitherto collected by the Society for the supernormality of such spontaneous phenomena as precognitive dreams, apparitions and other forms of hallucinations. In the case of the precognitive dream Dr. West concludes that a perfect case has not yet been printed in the Society's publications. "There is always a flaw somewhere," he writes, adding that "the perfect case is a myth" (p. 271). In dealing with the crisis apparition, he points out that numerous and unsuspected sources of error abound, and he indicates his dissatisfaction with the evidence on which those conducting the famous Census of Hallucinations were inclined to rely. Finally, he points out how better evidence could be secured if witnesses could be persuaded to forward their results immediately to some independent source, so that adequate inquiries might be forthwith made and the original documents preserved for subsequent examination and verification.

New Fungi of Madras

A new species of discomycete fungus, *Bulgariastrum tumifaciens*, which causes galls upon living leaves and inflorescences of *Capparidis sepiariæ* is described by T. S. and K. Ramakrishnan (*Proc. Ind. Acad. Sci.*, 27, B, 2; Feb., 1948). This is one of seven new species named by the same authors in their most recent additions to the purely indigenous fungus flora of Madras.

Culture Collections of Micro-organisms

As a result of a recommendation of the Specialist Conference of Culture Collections of Micro-organisms held in London in August 1947 under the auspices of the Standing Committee of the British Commonwealth Scientific Official Conference (1946), national committees were established in the several Dominions and in the United Kingdom for the co-ordination of the activities of existing collections of micro-organisms and to assist in the preparation of collection catalogues. The United Kingdom National Committee will deal also with the Crown Colonies. As a first step in this work, national committees are circulating a questionnaire to all laboratories in their areas at which collections of micro-organisms are known or believed to be maintained. Inevitably some such collections will be missed, particularly those in private hands. Owners of collections of micro-organisms in the United Kingdom and Crown Colonies who have not received a questionnaire are asked to notify Dr. Martin Ware, secretary of the United Kingdom National Committee, at the Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

Installing of Electric Discharge Lamps

Developments in electric discharge lamps and the very rapid increase in their application have produced an urgent requirement for the revision of Section 8 of the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers. A new edition, the twelfth, of the Regulations is at present in preparation; but to meet this immediate need Revised Section 8, "The Installing of Electric Discharge Lamps", has been produced and supersedes, as from July 1, the corresponding section of the eleventh edition. Fluorescent tubes operating at normal mains voltage become, for the first time, a subject of specific requirements under Section 8*A*, which covers all discharge lamp installations in which the open-circuit voltage does not exceed 650 volts. Section 8*B* gives additional requirements for high-voltage installations up to 5,000 volts to earth, which is the maximum voltage permissible.

Colonial Services Appointments

The following appointments in the Colonial Services have been announced: E. S. Porter, agricultural officer, Kenya; H. C. Butcher, chemist, Federation of Malaya; A. R. Giles, land surveyor, Hong Kong; A. L. Griffith, temporary forest officer, Zanzibar; R. A. Neve, specialist, Agricultural Department, Gold Coast; A. G. A. Sutton, Government geologist, Mines Department, Trinidad; R. H. Wharton, medical entomologist, Federation of Malaya; J. G. M. King (agricultural officer, Tanganyika), director of livestock and agricultural services, Basutoland; H. S. Purchase (senior veterinary research officer, Kenya), chief veterinary research officer, Kenya.

Royal Society Scientific Information Conference

A summary of the recommendations of the Scientific Information Conference held during June 21–July 2 has now been issued to delegates; they will be included in the report of the Conference which is now in preparation. The Council of the Royal Society considered these recommendations on July 8, and agreed to receive them. In one of the recommendations the Conference invited the Royal Society to consider setting up a standing committee on scientific information services, and the Council has agreed in principle to do this.

Announcements

A refresher course on "The Mechanical Working of Metals" is being organised by the Institution of Metallurgists and will be held at Ashorne Hill, Leamington Spa, during the week-end beginning October 1. Among those giving lectures are Dr. Hugh Ford, Dr. R. Genders, Dr. E. Orowan, Dr. L. B. Pfeil, Prof. H. W. Swift and Prof. F. C. Thompson.

A Fine Chemical Group of the Society of Chemical Industry, for "the discussion of fine chemicals, especially those of therapeutic or biological interest", has been formed. Meetings are to be held monthly, and the opening address will be delivered by Prof. J. H. Burn, on "Fine Chemicals for Medical Use", at the Royal Institution, London, W.1, on October 5. The chairman of the Group is Sir Jack Drummond, and the honorary secretary is Dr. W. Mitchell, Messrs. Stafford Allen and Sons, Ltd., Wharf Road, London, N.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Application of Paper Partition Chromatography to the Separation of the Sugars and their Methylated Derivatives on a Column of Powdered Cellulose

THE analysis of mixtures of sugars resulting from the hydrolysis of a polysaccharide has been greatly facilitated by their separation[1] and quantitative estimation[2] on the paper chromatogram[3]. The application of this technique to the analysis of mixtures of sugars from methylated polysaccharides[4] has simplified a task previously difficult, which involved the fractional distillation of the methyl glycosides and examination of the fractions obtained. The latter method suffers from two disadvantages, in that it requires large quantities of methylated polysaccharides, and that it is very difficult to obtain a complete separation of the methyl glycosides.

The paper chromatographic technique now offers a rapid method of separating and estimating the sugars quantitatively as well as giving a strong indication as to their identities. The final proof of their constitution, however, still depends upon their separation and identification by determination of their physical constants, and the formation of characteristic derivatives. With this in mind we have attempted the separation of the sugars and their methylated derivatives on a column of powdered cellulose, a method similar to that tried by Synge[5], who used a column of potato starch, and similar to that employed by Bell[6], who used a column of silica gel. Using a column of cellulose (Whatman ashless filter tablets, rubbed through an 80-mesh sieve and tightly packed, as a powder, in a tube of 12 in. length and 1½ in. diameter) and with *n*-butanol saturated with water containing 1 per cent of ammonia as the mobile phase, we have separated two- and four-component mixtures of sugars with individual recoveries of 95–100 per cent. The column is purified by washing it with the solvent until the eluate is non-reducing; this ensures that all the soluble impurities have been washed from the cellulose and that equilibrium is reached between the cellulose and the solvent. The maximum weight of any component sugar that can be placed on this column is proportional to its R_G value[4], and is of the order of 200 mgm. for galactose. The syrupy mixture of sugars to be separated is placed on the top of the cellulose and the solvent allowed to percolate down the column. At half-hourly intervals the receiver collecting the eluate is changed automatically. The time taken for any particular sugar to emerge is inversely proportional to its R_G value and is approximately 15 hr. for 2 : 3 : 4 : 6-tetramethyl glucose.

To determine which sugars are present in the receivers, a small spot from each is placed, in order of time, on the starting line of a paper chromatogram, and the sugars separated in the usual manner. On revealing the position of the sugars on the chromatogram by development with ammoniacal silver nitrate, a picture of the distribution of each sugar among the receivers is obtained. From such a chromatogram one may decide which portions of eluate to take in order to obtain a chromatographically pure sample of sugar. While such high recoveries as 95 per cent are quite practical where the components differ widely in R_G values, it is frequently expedient, where one has several components of closely similar R_G values with consequent overlapping of the sugars, to be content to divide the receivers in such a manner as to lead to a lower percentage recovery of a pure fraction. The ease of separation decreases as the R_G values of the particular sugars increase.

By use of the method described above, we have separated in the pure state and in yields of 95 per cent a two-component mixture consisting of *L*-rhamnose (300 mgm.) and *L*-arabinose (200 mgm.) and a four-component mixture consisting of *L*-rhamnose (50 mgm.), *D*-ribose (50 mgm.), *L*-arabinose (50 mgm.) and *D*-galactose (50 mgm.). The isolation of pure crystalline specimens of *L*-rhamnose hydrate and *D*-galactose and of *L*-rhamnose hydrate and *D*-xylose from *Sterculia Setigera* gum and from linseed (Var. Redwing) mucilage respectively has also been achieved.

Methylated sugar beet araban, on hydrolysis, yields in equimolecular amounts 2 : 3 : 5-trimethyl *L*-arabinose, 2 : 3-dimethyl *L*-arabinose and 2-monomethyl *L*-arabinose[7]; pure specimens of each of these sugars have been obtained by use of the above method.

The application of the above technique to the separation and identification of the hydrolysis products of various methylated polysaccharides will be the subject of a later publication.

L. HOUGH
J. K. N. JONES
W. H. WADMAN

University, Bristol.
May 13.

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Oxidation of Ferrous Ions in Aqueous Solution by X- and γ-Radiation

THE oxidation of ferrous ions in dilute sulphuric acid solution by X- and γ-radiation has attracted attention since the work of Fricke[1,2] as a possible method of integral dosimetry for aqueous media[3]. A study has now been made which confirms that the rate of oxidation with dose is essentially independent of the concentration of ferrous ions in the region 10^{-3} to 10^{-4} *M*, and which also shows that this rate is maintained independently of the wave-length of the radiation over a much wider range of wave-length than has hitherto been used in studies of this type.

Four different types of system were employed.

(i) An ionization chamber was constructed of 'Perspex' with graphite electrodes and connected to a D.C. amplifier circuit, and a 'Perspex' irradiation cell was made of identical geometry to the chamber to contain the solution under investigation. The cell and chamber could be interchanged on a stand which was kept in a constant position relative to the tube of an industrial X-ray unit operating at 200 kV. peak and 10 m.amp. The thickness of the cylindrical internal volume of the cell and chamber was only 3·23 mm. In another similar system where this volume was 9·75 mm. in thickness, the yields observed were about 30 per cent lower, due to the absorption of the X-rays in the solution.

(ii) Another ionization chamber and cell combination due to Dr. A. J. Cipriani was used. In this case the ionizing volume was in the form of a thin annulus round a central cylinder containing a 2-curie radium bomb. Cell and chamber were made of polystyrene, and the whole enclosed in a large block of lead.

In both these cases the ionization current in the chamber at saturation passed through a high resistor of known value to ground. The voltage above this resistor was estimated by a null method in both cases, a modified Lauritsen electroscope being used in system (ii). By showing that the ionization current was proportional to the area of the collecting electrodes, and by reversing the polarity of the electrodes, the effect of stray ionization currents was found to be small in both cases.

(iii) A set of stands, 3 in. in height, was placed inside a lead enclosure 18 in. square. On one of the stands was placed a 600 mc. radium capsule, and on another a cylindrical cell containing the solution. By using different combinations of stands the mean distance between source and solution could be varied between 3·7 cm. and 7·6 cm. The radiation intensity at the various positions was measured using a 100-*r*. 'Victoreen' condenser-type chamber with a 5 mm. thick 'Perspex' cap to ensure equilibration of the primary radiation with its secondary electrons.

(iv) A 'Pyrex' cell was constructed with a central thimble in which a glass tube containing a 1,200-mc. capsule of radium could be inserted. The cell could be attached to a vacuum apparatus and evacuated in order to ascertain the effect of removing all dissolved air. No dosimetry was attempted in this system, the purpose here being to compare the oxidation-rate of aerated and evacuated samples, as was done by Fricke[2] and Shishacow[4]. It was found during these experiments that very little oxygen was necessary to saturate the solution effectively with oxygen from the radiation chemical point of view. For example, a solution equilibrated with cylinder nitrogen containing about 2 per cent of oxygen was oxidized within a few per cent of the rate at which an oxygen-equilibrated solution was oxidized. This was true for the small doses used, none of which was higher than 13,000 r.; but at much higher doses one would expect a change of oxidation-rate of solutions initially saturated with air[1,4]. When the solution was evacuated hard for 20–30 min., the oxidation-rate fell sharply to less than one-half of its previous value, as was found by Fricke[1] and Shishacow[4]. The amount of water which evaporated during evacuation was not significant if the solution were made up to its original volume before analysis, as the oxidation-rate has been repeatedly shown to be independent of concentration of ferrous ions within much wider limits[1,2].

The water used in making up the solutions was redistilled successively from alkaline potassium permanganate and alkaline manganous hydroxide, and the solutions were made up with ferrous ammonium sulphate, the ferrous ion concentration varying between 10^{-3} and 10^{-4} *M*, depending on the dose to be administered. All were made 0·8 *N* in sulphuric acid, at which acidity the effect of the ammonium ions was found to be negligible. This acidity was used in order to effect comparison with earlier work. In less acid solutions the reaction is much more complex[5]. The concentration of ferrous ions was followed by potentiometric titration with *N*/5,000 ceric sulphate solution. The rate of change in absence of radiation was negligible during the time occupied by an experiment when the solution was stored in the 'Perspex' cells. Before irradiation, the samples of solution were equilibrated with nitrogen containing a small but constant percentage of oxygen, and the cells were filled in this atmosphere.

The results obtained in these various systems will be presented in detail later. Expressed as the number of atoms of ferrous ion oxidized per 32·5 eV. expended in the solution[6], the ionic yields for solutions containing dissolved oxygen lay between 4·9 and 6·0 in every case, the average value being 5·5. From the ratio of the yields in aerated and evacuated solutions obtained in system (iv) above, the average ionic yield for oxygen-free solutions was found to be 2·2.

Recalculation of the values obtained by Fricke and Shishacow in earlier work[1,2,4], reveals a substantial degree of agreement between the three sets of investigations:

	M/*N* (32·5 eV.) aerated	*M*/*N* (32·5 eV.) air-free
Fricke (refs. 1,2)	5·9	2·3
Shishacow (ref. 4)	5·2	2·0
Present work	5·5	2·2

The above results establish that higher ionic yields than 2·2 observed in solutions of this type which are either not de-aerated at all or are equilibrated with cylinder nitrogen can be ascribed to the presence of dissolved oxygen. The cause of this enhancement is very probably to be associated with the formation of the hydroperoxide radical HO_2 in the reaction $H + O_2 \rightarrow HO_2$, which converts the reducing fragment H formed in the primary act on irradiation of water into an oxidizing agent.

I wish to express my thanks to the National Research Council of Canada and the Ministry of Supply for the use of experimental facilities, and to Dr. A. J. Cipriani, Mr. F. H. Krenz, and Prof. W. V. Mayneord for valuable discussions and assistance in connexion with dosimetry.

N. Miller

Department of Natural Philosophy,
University of Edinburgh.

May 26.

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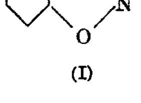
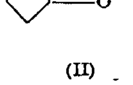
Diazo-Oxides

In relation to work recently summarized[1], we have under investigation a number of diazo-oxides. Certain of those theoretically derived from *o*- and *p*-aminophenols (and their derivatives) are included. Satisfactory formulations for these have been debated for


(I)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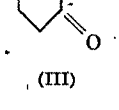
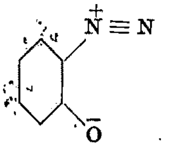

(III)

years[2,4]. Earlier writers proposed structures involving rings, such as I[3,4] or II[5], or quinonoid forms, such as III[6]. Hodgson and Marsden[2] conclude, however, that both the *o*- and the *p*- series are best regarded as resonance hybrids of the type

$$\overset{-}{O} - C_6H_4 - \overset{+}{N} \equiv N \longleftrightarrow O = C_6H_4 = \overset{+}{N} = \overset{-}{N}.$$

If such a view were correct, it is obvious from IV and V qualitatively that, while the polarity of a *p*-diazo-oxide *could* be small, that of its *o*-isomer should be large, and—in proportion as the ionized form predominates—approach that of a true 'zwitterionic' molecule[7]. Thus the dipole moment of IV is unlikely to be less than *c*. $10D$, while V, on reasonable analogies, might be so low as $4D$.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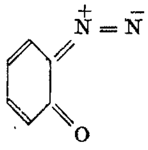
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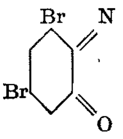
(VI)

Although we have not been able to prepare the unsubstituted parents IV or V, dipole moment determinations on representative derived members of both the *o*- and the *p*-series are now nearing completion. Results are proving close to those expected for V (that is, also III); for example, μ (found) for VI is $2{\cdot}9D$ (calculated, about $3D$). Ultra-violet spectroscopic evidence is in the same direction.

Very little contribution from fully dipolar forms seems, therefore, to be occurring. We make this preliminary communication because we note that dipolar structures for the *o*-diazo-oxides have been adopted recently by Vaughan and Phillips[8] to explain stability measurements.

J. D. C. ANDERSON
R. J. W. LE FÈVRE

Chemistry Department,
University of Sydney.
May 18.

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Preparation of Nitrogen-free Sulphuric Acid

OF the various methods suggested for the preparation of sulphuric acid suitable for use in nitrate estimations, the method of Atkins[1] is perhaps the most suitable. There is, however, one disadvantage in this method, namely, the precipitation of sulphur if a slight excess of hydrogen sulphide is added. This not only takes a long time to settle, but also interferes with the estimation, often giving lower values due to the presence of traces of sulphur dioxide.

Various alternative methods were tried in this laboratory for the preparation of a suitable sample of sulphuric acid for the estimation of nitrates in sea-water by the reduced strychnine method of Denigès. A good procedure seems to be to treat about 250 ml. of concentrated sulphuric acid (ordinary quality) with 6–10 drops of 40 per cent formalin solution in a 500 ml. Kjeldahl flask, and to boil the mixture until it is decolorized. It is possible to prepare about a litre of good acid in the course of a couple of hours by using a series of flasks. The acid so prepared gives an almost colourless reagent with reduced strychnine.

This method is, therefore, suggested as an alternative where difficulty is experienced in the preparation of acid according to Atkins' method.

B. V. RAMACHANDRAN

Central Marine Fisheries Research Station,
Triplicane P.O., Madras.
April 24.

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Decay and Capture of Slow Mesons in Dielectrics

Conversi, Pancini and Piccioni[1], and others[2], observed decay electrons from positive mesons coming to rest in solids of either light or heavy elements. For negative mesons, however, decay electrons were found in light elements only; for heavy elements it is generally assumed that negative mesons are captured by atomic nuclei before they can decay. The absence of capture of positive mesons can be understood as being due to the influence of Coulomb repulsion[3]; its absence for negative mesons in light nuclei has led Fermi, Teller and Weisskopf[4] to the conclusion that the interaction between nuclei and mesons is much weaker than was assumed hitherto. These authors show that it takes less than 10^{-13} sec. for a meson to reach an energy of about 1,000 eV., where its velocity is about equal to that of electrons in outer orbits, that is, 10^{8} cm./sec. They then consider that the meson quickly loses its remaining energy, reaching the K-orbit of an atomic nucleus in about 10^{-12} sec. It should then be captured by the nucleus in about 10^{-18} sec. if current ideas of interaction between mesons and nuclei are correct. In doing so they have, however, considerably overestimated the energy transfer from slow mesons to electrons[5]. In the present communication reasons are given for believing that in dielectrics the time required by a meson to reach a K-orbit is longer than estimated by Fermi *et al.*, but that it would be very difficult to decide from theoretical considerations whether this time may be of the same order as the decay time ($\sim 2 \times 10^{-6}$ sec.).

Mesons with a velocity less than about 10^{8} cm./sec. (kinetic energy $< 1{,}000$ eV.) transfer energy to electrons (the velocity of which is greater than 10^{8} cm./sec.) at a very low rate (at least in non-metals) because the electrons can follow nearly adiabatically. (This would not hold for free electrons. Even metal electrons are not entirely free, and it seems, indeed, that their deviation from free electrons largely determines inelastic scattering. For, in view of the screening of the meson charge, the collision is of very short duration; development of the effective meson field into a Fourier series will lead mainly to high-frequency terms. The electrons then behave as bound, as for their optical properties.) However, in this region, down to an energy of about $0{\cdot}1$ eV., the rate B of loss of energy to the lattice vibrations is considerable. In ionic crystals, in particular, with residual frequency $\omega_i/2\pi$, it has been shown[6] that:

$$B = C\,\frac{e^2\omega_i^2}{v}\log(v/\omega_i a),$$

where $C \sim 1$, v is velocity of mesons and $a \sim 10^{-8}$ cm. In other types of solids a similar order of magnitude may be expected. Hence the time to slow down a meson from an initial velocity $v_i \sim 10^8$ cm./sec. to a final velocity $v_f \ll v_i$ is

$$\int_{v_f}^{v_i} \frac{\mu v\,dv}{B} \sim \frac{\mu}{10}\,\frac{v_i^3 - v_f^3}{e^2\omega_i^2}$$

(μ is mass of a meson), which is about 10^{-11} sec. if $\omega_i \sim 10^{14}$ sec.$^{-1}$. The above formula holds practically throughout the whole continuous spectrum of the meson. As soon as the discrete spectrum has been reached, with a distance of more than $\hbar\omega_i$ between energy-levels (or rather energy-bands), energy transfer to the lattice vibrations becomes very improbable, because it would involve simultaneous emission of many quanta, $\hbar\omega_i$. In this range either radiative loss or loss due to the Auger effect should be predominant.

The latter was estimated[7] on the assumption that the highest discrete levels should have large quantum numbers and high angular momentum corresponding to nearly circular orbits with radius of about half a lattice distance. Larger orbits would lead to a continuous energy spectrum, whereas penetrating orbits (low angular momentum) would lead to much stronger binding. On the above assumption, emission of an electron (in dielectrics) must be connected with a considerable transfer of angular momentum, which leads to very much smaller transition probabilities than in the ordinary electronic Auger effect. An estimate of the time t_A required for emission of an electron[7] (whereby the reaction on the meson was neglected) gives

$$t_A \sim 10^{-18}\frac{r}{r_e}\left(\frac{v_e}{v}\right)^3 \exp\left(\frac{r}{r_e}\left(\alpha\frac{v_e}{v} + 2\right)\right)\text{ sec.}$$

Here r and r_e are the radii of the mesonic and electronic orbits, v and v_e are the respective velocities and $\alpha \sim 3$. One would expect $v_e/v \sim (\mu/m)^{1/2}$ to be approximately 15.

Although the above formula is based on a simplified model, it serves to show the extreme sensitivity of t_A to the exact value of $rv_e/r_e v$. Thus if, for example, $r = r_e$ and $v_e/v = 6$, then $t_A \sim 10^{-8}$ sec. If, however, $v_e/v = 8$, then $t_A \sim 10^{-4}$ sec.

To estimate the radiative loss it should be possible to treat the meson on a classical basis. Then the rate of loss of energy is approximately $e^2r^2\omega^4/c^3$. Assuming the meson to move in a Coulomb field with effective charge $\bar{Z}e$, it is found that $r^2\omega^4 = e^4\bar{Z}^2/\mu^2r^4$. Hence the time required by the meson to reach an orbit with radius r_f—starting with an initial radius r_i—is approximately

$$\frac{\mu^2c^3}{\bar{Z}e^4}\,(r_i^3 - r_f^3) \sim \frac{\mu^2c^3r_i^3}{\bar{Z}e^4}$$

if $r_f^3 \ll r_i^3$. Assuming $r_i \sim 10^{-8}$ cm. $\sim h^2/me^2$, the time for radiation loss is about

$$t_R \sim \frac{1}{\bar{Z}}\left(\frac{\mu}{m}\right)^2\left(\frac{hc}{e^2}\right)^3\frac{h^3}{me^4} \sim \frac{10^{-6}}{\bar{Z}}\text{ sec.}$$

It thus appears that energy loss due to the Auger effect is extremely sensitive to the properties of the highest bound meson orbit. In contrast to the assumptions made by others[4], it cannot be excluded that in dielectrics it plays only a negligible part compared with radiative loss, which leads to times of the same order as the natural decay time.

H. FRÖHLICH
R. HUBY
R. KOLODZIEJSKI
R. L. ROSENBERG
H.H. Wills Physical Laboratory,
University of Bristol.

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Relation between the Masses of Mesons

STARTING from Jeannine Viard's results[1] based on the notion of 'solide principal' in wave-mechanics, and from Eddington's considerations on fundamental frames, we are in agreement with Mme. P. Destouches-Février's principle[2] called the 'principle of respective frames': "All that concerns the actions of observers must be linked to a mean frame; all that concerns the objective properties of particles must be linked to a geometrical frame". It results that the laws of direct action between electrons and photons or between nucleons and mesons, which are actions of contact according to Dirac's δ-function, appear for the observers to obey a Gaussian distribution law with standard deviation σ; the self-energy of one particle in a field is then finite. σ is determined by the assumption that the mass of the electron originates entirely from an electromagnetic energy; thence

$$\sigma = \sqrt{\frac{2}{\pi}}\,\frac{e^2}{m_ec^2} = 5{\cdot}627 \times 10^{-14}\text{ cm.}$$

The self-energy of a nucleon in a mesonic field depends on the mass of mesons. For a given value of this self-energy, there are generally several values of masses. Mme. P. Destouches-Février[3] has proposed a 'principle of associated particles': "Each type of interaction between the particles of a C-kind being expressed by means of particles of spin 1 or 0, is such that one particle of C-kind has a well-determined self-energy $\mathfrak{E}_C$, in the field associated with particles of spin 1 or 0. When, for a given value $\mathfrak{E}_C$, there are several values of masses μ for the particles associated with the field such that $\mathfrak{E}(\mu) = \mathfrak{E}_C$, then the different particles are existing and playing a part in the suitable description of the interaction under consideration; in addition, the existing values of μ are in the neighbourhood of a minimum of the function $\mathfrak{E}(\mu)$".

If we study the function $y(\mu) = \mathfrak{E}(\mu)e^2/g^2$ (where g is the mesonic charge), as M. Cazin[4] has done, we find that $y(\mu)$, for μ increasing from 0, starts from the value m_ec^2 of the self-energy of the electron, and decreases to a minimum at approximately $0{\cdot}365\ m_ec^2$ reached for $\mu \cong 255\ m_e$, then increases to a maximum at about $6\ m_ec^2$ reached for μ slightly less than $800\ m_e$, then decreases to a minimum at about $1{\cdot}8\ m_ec^2$ reached for $\mu \cong 1{,}000\ m_e$.

Admitting the principle of the associated particles, two mesons play a part in the nuclear forces of masses m_μ and m_π, corresponding to the same $\mathfrak{E}_C$-value of the self-energy of a nucleon in the mesonic field; and we have $m_\mu < 255\ m_e$, $m_\pi > 255\ m_e$.

From the $y(\mu)$-function, we can draw the curve giving m_μ as a function of m_π (see accompanying table).

m_μ/m_e	m_π/m_e	m_π/m_μ	$y(\mu)/m_ec^2$
0	407	∞	1
100	364	3·64	0·657
108	360	3·33	0·631
127	350	2·75	0·578
158	331	2·09	0·500
164	329	2·06	0·489
176	320	1·82	0·46
180	318	1·76	0·447
188	313	1·66	0·434
189	312	1·65	0·432
192	310	1·61	0·427
200	305	1·525	0·412
202	304	1·5	0·408
207	300	1·45	0·401
212	297	1·40	0·395
225	284	1·26	0·377
240	270	1·125	0·368
250	260	1·04	0·367
255	255	1	0·365

According to the experimental results reported by Occhialini and Powell[5], Gardner and Lattes[6] obtain $m_\pi = (313 \pm 16)\ m_e$. From the above table, we derive $m_\mu = (188 \pm 24)\, m_e$ and $m_\pi/m_\mu = 1{\cdot}66 \pm 0{\cdot}26$. From the results of Goldschmidt, King, Muirhead and Ritson[7], $m_\pi = (270 \pm 40)\ m_e$; we derive from our table $255\ m_e < m_\pi < 310\ m_e$; $192\ m_e < m_\mu < 255\ m_e$; $1 < m_\pi/m_\mu < 1{\cdot}61$. From the results of Lattes, Occhialini and Powell[8] $m_\pi/m_\mu = 1{\cdot}65 \pm 0{\cdot}15$; we derive from our table $m_\pi = (312 \pm 8)\ m_e$ and $m_\mu = (189 \pm 13)\ m_e$.

These three experimental results agree with the relation between the masses m_μ and m_π given by the principle of the associated particles. The value m_π for the artificial mesons obtained by Gardner and Lattes agrees perfectly with the experimental value of m_π/m_μ for the cosmic mesons obtained by Lattes, Occhialini and Powell; this last determination gives the most accurate results.

So it seems that the nuclear forces may be interpreted as due to mutual exchanges of mesons of the two types. Their spins would be 1 or 0. No arbitrary constant has been introduced and the difficulties of divergence have been removed. Finally, the $y(\mu)$-curve and the principle of the associated particles leads to the possibility of the existence of two particles of spin 1 or 0 and of masses more than 900 m_e; one of these particles may be identified with that found by Leprince-Ringuet; these particles correspond with forces of a type different from ordinary nuclear forces.

JEAN-LOUIS DESTOUCHES
Institut Henri Poincaré,
Faculté des Sciences,
Université de Paris.
May 3.

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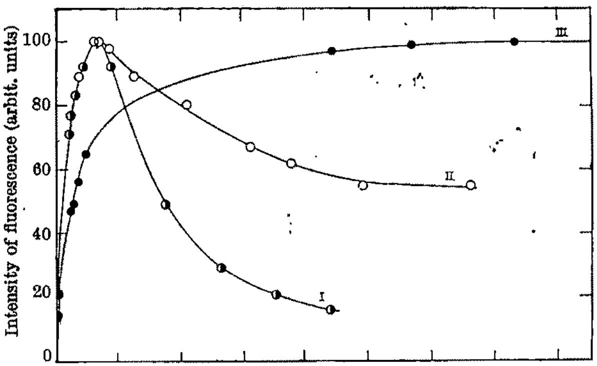
Concentration Quenching of Fluorescence in Chlorophyll Solutions

IN a paper concerned chiefly with the results of measurements of the self-quenching of the fluorescence of solutions of aromatic hydrocarbons[1], Weiss and Weil-Malherbe report a few measurements on the self-quenching of ethyl chlorophyllide solutions. They conclude from these latter results that it is unnecessary to postulate the existence of a long-lived form of excited chlorophyll. This conclusion has been shown by E. Rabinowitch[2] to be inconsistent with the observed[3] high quantum yields for chlorophyll-sensitized photo-oxidation. More recently, the same author[4] has pointed out that the value of the quenching constant obtained by Weiss and Weil-Malherbe is too large to be consistent with the number of encounters between chlorophyll molecules as calculated from kinetic theory.



Curve I: (moles/l.) × 4·75 × 10^4; curves II and III: (moles/l.) × 10^4

A comparison of the quantitative data[5] on the absorption and fluorescence spectra of chlorophyll solutions indicates that the mistake in the work of Weiss and Weil-Malherbe is their disregard of the reabsorption of the fluorescent light. Unfortunately, their report does not contain sufficient experimental detail to permit a computation of the effect of reabsorption upon their results. In particular, they do not specify the nature of the colour filter used in front of their photocell, the wave-lengths present in the incident light, or the ratio of the concentrations of chlorophyllides *a* and *b* present in their sample. For these reasons and because their claims have a direct bearing upon possible mechanisms for photosynthesis, it seemed worth while to repeat their measurements[1] under controlled conditions.

The accompanying graph shows the Weiss and Weil-Malherbe data for ethyl chlorophyllide (curve I) and our data for the fluorescence intensity, obtained by two different methods, of chlorophyll *a* in ether. Since the fluorescence intensities are expressed in arbitrary units, these have been adjusted to make all three maxima identical. For convenience in plotting, the concentration scale for curve I differs from that used for curves II and III.

In the experiments corresponding to these latter curves, the incident light was monochromatic, of λ 4358 A., and the intensity of the fluorescent light was measured with a photocell (Photovolt Corp. Mod. 500). The solutions were made up from freshly prepared chlorophyll *a* and dry ether, and were evacuated to remove oxygen.

The data plotted as curve III were obtained by a method which was designed to eliminate the effect of the reabsorption of the fluorescent light. A colour filter (Wratten Infra-red 88), transmitting only that wave-length region of the fluorescent light which is not detectably absorbed by chlorophyll *a* solutions, was placed in front of the photocell. To minimize further spurious effects of changing concentration, a thin layer (2 mm.) of solution was used, and the photocell faced the side of the cuvette upon which the exciting light was incident. The results obtained under these conditions demonstrate that the self-quenching of the fluorescence of chlorophyll is negligible at all concentrations up to 10^{-3} *M* (a concentration ten-fold greater than the highest value published by Weiss and Weil-Malherbe). Similar results were obtained with chlorophyll *b* and with solutions in acetone and in methanol.

In an attempt to duplicate the results of Weiss and Weil-Malherbe, the Wratten infra-red filter in front of the photocell was replaced with one (Corning 246) which is transparent to the fluorescent light of all wave-lengths but which absorbs λ 4358 A. The photocell was placed "in line with the light source", that is, behind the cuvette. Curve II represents the measurements made in this manner. The measured intensities show the expected effect of reabsorption of the fluorescent radiation by the chlorophyll solution. The reabsorption is not so great in this case as in the measurements of Weiss and Weil-Malherbe, the difference most probably being due chiefly to the different thicknesses of the cuvettes used, and to the fact that solutions of pure chlorophyll *a* (or *b*) were used in our experiments.

We may conclude, therefore, that the effect of self-quenching of the fluorescence (as distinct from possible self-quenching of long-lived excited states) of chlorophyll (and presumably chlorophyllide) solutions is negligible under conditions in which photochemical and optical measurements have been made on these solutions.

The present experiments were made possible by the support of the U.S. Office of Naval Research (Contract Noori-212, T.O. 1).

W. F. WATSON
ROBERT LIVINGSTON
Division of Physical Chemistry,
University of Minnesota,
Minneapolis, 14.
April 23.

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Polarization of the Raman Line of the Totally Symmetric Vibration of Stannic Chloride

It is well known that the depolarization factors of the Raman lines produced by the totally symmetric vibrations of the XCl_4 molecules of the tetrahedral type are not zero[1]. Recently in this laboratory, it has been shown that the depolarization factors are smaller than the results given by many investigators; but they definitely are not zero[2].

Cabannes and Rousset[3] have pointed out the fact that this residual depolarization could be caused by the isotopes of chlorine, and that a measurement of the depolarization factors of the individual lines due to the various isotopic molecules would decide this point. Welsh, Crawford and Scott[4] have shown that the intensity of the Raman line due to totally symmetric vibration of stannic chloride ($SnCl_4$) is about six times greater than that of the corresponding line of carbon tetrachloride (CCl_4); Langseth[5] has shown that the former gives the same type of isotopic structure as the latter.

Development of the method of polarized incident light[2] for determining depolarization factors, plus availability of a spectrograph suitable for fine-structure investigations[6] along with a newly developed powerful light source having suitable spectral characteristics[7], have made the above-mentioned fine-structure investigation a practical possibility for stannic chloride.

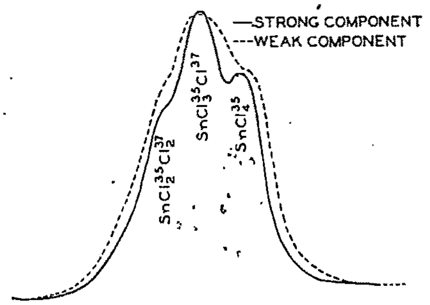
The 'weak' and 'strong' polarized components of the totally symmetric vibration of stannic chloride have been photographed using this high-dispersion spectrograph. The exposure time for the 'weak' component was 48 hr. and for the 'strong' component about 10 min. Microphotometer curves for the two components are reproduced herewith. From inspection of the microphotometer curves it is at once apparent that there is no sensible change in the relative intensities of the isotopic components in the two traces. It is also apparent that the fine structure is almost obliterated in the weak trace due to a broadening of the fine-structure components. The cause of the broadening is definitely not instrumental; since grating ghosts are equally sharp on the 'weak' and the 'strong' plates.

The 'weak' component of the Raman line due to the totally symmetric vibration of carbon tetrachloride is not sufficiently strong to be photographed on the high-dispersion spectrograph. However, if the lack of symmetry of the isotopic molecules is the cause of the residual depolarization, the centre of gravity of the line should be appreciably shifted on a photograph made with the 'strong' and 'weak' components in juxtaposition. This experiment was performed with carbon tetrachloride, using a fast prism spectrograph with excellent defining power (dispersion 30 A./mm.). No noticeable shift of the centre of gravity was observed. The results of these experiments show the following:

(1) The depolarization factors in the three isotopic molecules of stannic chloride are identical within the precision of measurement (better than 0·002). There is reasonable evidence to suggest that the same is true for carbon tetrachloride.

(2) A considerable part of the observed depolarization arises from a small fraction of the total intensity of the line; this small fraction has an intensity distribution different from that of the strong polarized component.

Apart from these experiments, there is evidence to suggest that the isotopes of chlorine cannot cause the finite depolarization factor. When one chlorine atom is replaced by an atom as heavy as bromine or as light as hydrogen, the depolarization factor of the corresponding vibration remains very small. Therefore, judging purely on the basis of the masses involved, the effect of a chlorine isotope should be negligibly small.



Microphotometer traces of the 'strong' and the 'weak' polarized components of the Raman line due to the totally symmetric vibration of $SnCl_4$

One can find at least two possible causes for the small residual depolarization. First, the interaction between the molecules in the liquid may be sufficient to cause both the residual depolarization and the observed broadening of the weak component. Secondly, in the XCl_4 type of molecules, at room temperature a large fraction of the molecules are not in the ground-state but in the degenerate vibrational levels. It is possible that some slight interaction between these modes of vibration may cause the residual depolarization.

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A. E. DOUGLAS
D. H. RANK

Physics Dept.,
Pennsylvania State College,
State College, Pa.

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Tilted-Plate Compensators

W. A. P. FISHER has recently described[1] a tilted-plate compensator which employed a plate of *CR* 39 resin in place of the usual calcite or quartz. This substitution permitted the development of apparatus of large aperture, although the material is not quite uniform and needs to be rather thick, so that the possible effect of lateral displacement must be considered.

I wish to direct attention to the suitability of lepidolite for the construction of tilted-plate compensators of large field. This material, which is a uniaxial variety of mica, cleaves at right angles to the optic axis and is practically colourless in the thicknesses needed for the production of convenient retardations. The use of such cleavage plates avoids the grinding and polishing required in the case of calcite or quartz and also the difficulties associated with the employment of *CR* 39 resin, including that of the possible variation of calibration with time. The axis about which the lepidolite is tilted lies in the plane containing the leading direction for the magnetic vector.

The following experimental results were obtained with white light using a plate of lepidolite the thickness of which was 0·245 mm. The angle of tilt was observed on a dial graduated in units of 1·8° and the readings have been converted to degrees. Values calculated by means of an approximate theoretical formula are included in the table.

Observed path-difference (λ)	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0
Angle of tilt (°)	19·31	27·18	33·93	39·87	45·00	50·04	54·18	58·86
Calculated path-difference (λ)	0·50	0·98	1·50	2·03	2·52	3·04	3·47	3·95

For a plate of thickness t tilted through an angle θ in air, the length of the light path is $t/\cos\varphi$, where $\mu\sin\varphi = \sin\theta$, μ being the refractive index of the material and φ the angle of refraction.

The equivalent path-difference is $(\mu_1-\mu_2)t/\cos\varphi$, μ_1 and μ_2 being the two refractive indices.

$\mu_1^2-\mu_2^2 = K\sin^2\varphi$, K being a constant[2],

$\therefore \mu_1-\mu_2 = (K/2\mu)\sin^2\varphi$. $\mu_1+\mu_2 = 2\mu$, very nearly.

The equivalent path-difference

$$= (K/2\mu)(t\sin^2\varphi)/\cos\varphi$$
$$= (K/2\mu)\,\{(t\sin^2\theta)/\mu^2\}\,\{\mu/(\mu^2-\sin^2\theta)^{1/2}\}$$
$$= (At\sin^2\theta)/(\mu^2-\sin^2\theta)^{1/2},\ A \text{ being } K/2\mu^2.$$

Application of the method of least squares to the experimental results above shows that $At = 6{\cdot}939$ or $A = 28{\cdot}32$, and that $\mu^2 = 2{\cdot}389$. These values were used in calculating the results given in the last line of the table.

Muscovite may also be used in the construction of a tilted-plate compensator of limited range. Tilting about the trace of the plane containing the optic axes causes the retardation to increase until it reaches four times the normal value at an inclination of about 70°. Tilting about a perpendicular axis causes a decrease to zero at an inclination of about 35°.

F. RECORD

79 Palmerston Street,
Derby.
July 21.

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Thorium and Uranium Content of the Velence Mountains, Hungary

THERE are few areas in Hungary where the occurrence of thorium and uranium minerals is theoretically possible. We investigated during the summer of 1947 the mountains near Lake Velence near the town of Székesfehérvár in Hungary.

Portable battery-operated Geiger–Müller counting equipments have been constructed at this Institute. One of them served in connexion with headphones for a qualitative search only. It was easily portable in a small case and weighed (including built-in batteries suitable for 400 counting hours, high-voltage supply and headphones) less than 5 kgm. The other counter-set possessed an electromagnetic impulse-counter, a more powerful amplifier, and was supplied by a motor-car starter battery (12 volts, 70 ampere-hours) by means of vibrating alternators. The Geiger–Müller counters were of brass, 45 mm. outer diameter, 1·8 mm. wall thickness and 88 mm. length, and were of the self-quenching type, filled with argon and alcohol vapour.

We observed a considerable γ-activity everywhere in the acid eruptive rocks of the area investigated over an area of about 30 km.², which exceeded the intensity of the cosmic radiation (40 impulses per min.) by a factor of 2–3, when the counter was placed immediately on the rocks.

In one case we drove in a boring about 50 cm. deep into the granite wall. We observed an activity of 260 impulses per min., with the counter in the boring. We evaluated this result quantitatively, taking into account the self-absorption of the γ-radiation within the rock, by calibrating the counter with the γ-radiation of thorium in radioactive equilibrium with its decay-bodies. To do this we placed a known amount of thorium (in equilibrium) at a measured distance from the counter and determined the number of impulses per min. The soft components of the γ-radiation were retarded by the thick wall of the counter and by 2 mm. of lead. Calculation shows that the concentration (c) of the radioactive material per gram rock substance, expressed in 'thorium-γ-equivalents', can be calculated from the following expression, approximately :

$$c \approx \frac{\mu J}{A.4\pi.\rho},$$

where μ is the coefficient of the self-absorption per cm. in the rocks, J is the number of impulses counted per min., A is the rate of counting per min. when 1 gm. of thorium is at 1 cm. distance from the counter (as determined above), ρ is the specific density of the rock.

We obtained in this way an approximate value for the concentration in thorium-γ-equivalents, $c = 0{\cdot}12 \times 10^{-3}$ gm. thorium equiv. per gm. rock. About the same order of magnitude of activity was observed everywhere in the acid eruptive rocks (granite, aplite, granitporphyre, etc.). On the other hand, basic eruptive rocks (andesite) and rocks of hydrothermic origin (quartzite) were found to be practically inactive.

Typical samples of the rocks mentioned were removed and tested carefully in the laboratory of the Institute. We checked at first the share of potassium in the γ-counting-rate. The potassium content of the rocks amounted to 3–4 per cent K_2O [1]. We mixed potassium nitrate to an inactive quartz powder in amount equivalent to 4 per cent K_2O content and found that the observed activity remained at about the level of statistical errors, and could be made responsible for no more than 10–15 per cent of the activity of the investigated eruptive rocks.

For the determination of the origin of the activity, Dr. M. Vogl-Földvári brought samples of the rocks into complete solution, and we determined the equilibrium radon content of the solutions by means of a calibrated emanometer. The equilibrium thoron content was determined under steady gas circulation, because of its short half-life. The calibration of the emanometer for thoron was carried out exactly in the same way, with the same velocity of gas circulation, using a small known dissolved amount of very old thorium nitrate. The accompanying table shows the results.

Rock sample, place	gm. U/gm. rock	gm. Th/gm. rock
Granite from Velence	$0{\cdot}87 \times 10^{-5}$	$4{\cdot}2 \times 10^{-5}$
Granite from Nadap (rich in biotite)	$0{\cdot}86 \times 10^{-5}$	$4{\cdot}0 \times 10^{-5}$
Aplite from Nadap	$0{\cdot}80 \times 10^{-5}$	$5{\cdot}6 \times 10^{-5}$

The acid eruptive rocks of the Velence Mountains everywhere contain similar concentrations of thorium and uranium, namely, about 8–9 gm. uranium per thousand kgm. rock and 40–60 gm. thorium per thousand kgm. rock. It seems doubtful whether so small a concentration will be of any use, unless very cheap concentrating processes should be found. It is of importance, however, that this thorium and uranium content makes possible the exact determination of the age of the rocks.

No concentrated deposits or ores were found during this preliminary survey.

A detailed publication (also in English) will appear in the *Transactions of the Hungarian National Geological Institution*, Budapest. I am indebted to the Hungarian National Geological Institution and to the Hungarian Ministry of Industry and Mining for supporting this investigation, and to Dr. A. Földvári, chief geologist of the Institution, for geological advice during this survey.

A. SZALAY

Institute of Physics,
University of Debrecen,
Hungary.

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Maxwell's 'Fish Eye' as an Ideal Electron Lens

THE most famous optical medium furnishing a perfect optical image formation is the well-known 'fish eye' of Maxwell[1], the refractive index of which $n(r)$ is given by the spherical distribution

$$n(r) = A/(a^2 + r^2), \qquad (1)$$

where A and a are constants. The trajectories are circles. Other media with ideal image formation have been found by W. Lenz[2], and they are of the form

$$n(r) = A/r\left[\left(\frac{r}{a}\right)^p + \left(\frac{q}{r}\right)^p\right] \quad (p = 1, 3, 5, \ldots). \qquad (2)$$

The most obvious way of analogous construction of an ideal electron lens would be the realization of the corresponding potential

$$V(r) = \frac{A^2}{(q^2 + r^2)^2}, \text{ or } V(r) = \frac{A^2}{r^2\left[\left(\frac{q}{r}\right)^p + \left(\frac{q}{r}\right)^p\right]^2},$$
$$(p = 1, 3, 5, \ldots), \qquad (3 \text{ and } 4)$$

by a spherical or axial symmetrical distribution of space charge[3]. This method is technically impossible, however, in the present state of development.

But limiting ourselves to plane image formation, an ideal electron lens could be constructed by a set of axially symmetrical metallic electrodes without space charge, which in a plane $z = z_0$ perpendicular to the axis must produce the potential distribution (3) or (4). We shall show in the following that such an electron lens can be constructed.

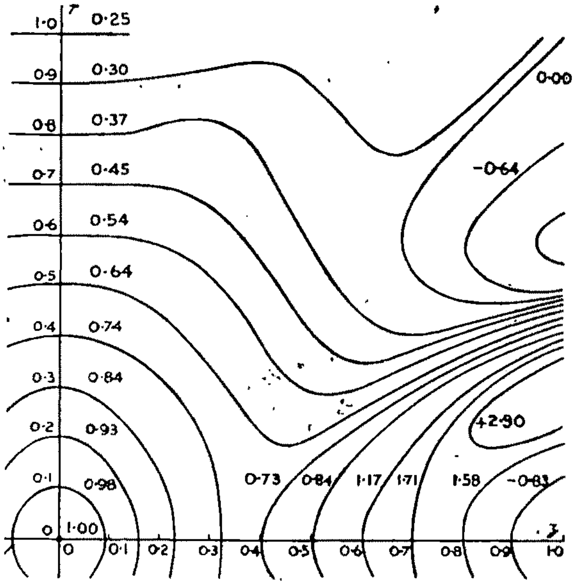
The general solution of the differential equation for an axially symmetrical potential is

$$\varphi(r,z) = \int_0^\infty C(k) J_0(ikr)\,(c_1 e^{ikz} + c_2 e^{-ikz})\,dk. \qquad (5)$$

The function $C(k)$ can be determined by means of Hankel's integral theorem[4] in such a way that for $z = z_0$ (for example, $z_0 = 0$) the potential will be $V(r) = A/(a^2 + r^2)$. We get

$$\varphi(r,z) = -\frac{iA^2}{2a}\int_0^\infty J_0(irk)\,K_1(iak)\cos kz\,.\,k^2dk, \qquad (6)$$

where $J(irk)$ is the Bessel function of the order zero, and $K_1(iak)$ the so-called Macdonald function of the



first order (see, for example, G. N. Watson, l.c, p. 78). Since one finds,

$$\int_0^\infty J_0\,(ikr)\,K_1\,(ika)\,k^2dk \;=\; \frac{2ia}{(q^2+r^2)^2}, \qquad (7)$$

it can be easily shown that (6) is indeed that solution of $\Delta\varphi = 0$, which has for $z = 0$ the form (3). The shape of the electrodes might be calculated from $\varphi(r,z) = \text{const.}$

But more important than these formulæ of the potentials required is development in series, by means of which we are able to calculate them numerically. One finds for the general form of the potential having the required distribution in the plane $z = 0$ the expression

$$\varphi(0,r) \;=\; V(r) \qquad (8)$$

$$\varphi(r,z) = \sum_{\nu=0}^{\infty}\,(-1)^\nu\,\frac{(\nu\,!)^2\,2^{2\nu}}{(2\nu)\,!}\,z^{2\nu}\,\sum_{\mu=0}^{\nu}\,\frac{V^{(\nu+\mu)}_{(r^2)}}{(\mu\,!)^2\,(\nu-\mu)}r^{2\mu}, \qquad (9)$$

and this becomes in our case (3)

$$\varphi(r,z) = \frac{1}{(1+r^2)^2}\,\sum_{\nu=0}^{\infty}\,(-1)^\nu\,b_{2\nu}\left(\frac{2z}{(1+r_2)}\right)^{2\nu}, \qquad (10)$$

in which the $b_{2\nu}$ are the following polynomials

$$b_{2\nu} \;=\; \frac{(\nu\,!)^2\,(\nu+1)}{(2\nu)\,!}\,\sum_{k=0}^{\nu}{}'\,(-1)^k\binom{\nu}{k}\binom{\nu+1}{k}r^{2k}. \qquad (11)$$

Since for (9), $\left(\frac{\partial\varphi}{\partial z}\right)_{z=0} = 0$, the force on the electron perpendicular to the plane $z=0$ vanishes, that is, the electron having the initial velocity in the plane $z=0$ stays in this plane. My collaborator, H. Robl, has worked out these formulæ, and the surfaces $\varphi(r,z) = \text{const.}$ are represented in the accompanying graph. It is imagined to be rotated about the z-axis. It is only necessary to imitate two of the equipotential surfaces at the top and below and on the sides by metallic electrodes in order to have the required potential distribution in the plane $z = 0$, where all (circular) trajectories from a point are exactly focused to an image point. It is possible to show by means of Larmor's theorem that a uniform magnetic field can also be combined with the electric field. Such a perfect cylindrical lens might be especially useful for a velocity-spectrometer, since only particles of the same velocity are focused to the same point; and perhaps (combined with a magnetic field) it might also be applied in mass-spectrography. In order to improve the stability of the electron trajectories in the plane $z = 0$ it will be necessary to investigate also the other potentials of the type (4) found by Lenz, for a suitable exponent p.

A discussion of this subject will be given shortly in the *Acta Physica Austriaca.*

WALTER GLASER

Institut for Theoretical Physics,
University, Vienna.

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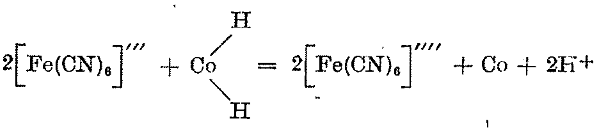
Source of the Hydrogen Ions in Gastric Juice

A FLOW of water from the oxyntic cells through a membrane permeable to chlorine ions and limited in its cation permeability to hydrogen ions should result in a secretion of hydrochloric acid in accordance with the view of Hollander[1]. It can be shown, however, that under such conditions the concentration of hydrogen and chlorine ions in the secretion would be of the order of 10^{-3}–$10^{-4}\,N$, and unless we add further hypotheses, including relatively very large water reabsorption, it would seem necessary to suppose a primary concentrating of hydrogen ions within the cell. It would appear that the simplest manner in which this could be achieved is by way of an organic acid produced metabolically or in relation to metabolic activities, hydrolysis of esters and the like. From the data of Davies *et al.*[4] showing that under their conditions Q_{HCl} can be greater than Q_{O_2}, the view was entertained that the organic acid might be cyclically reformed or restored[3].

From our studies with yeast[5] and the high acidic formation resulting from exchanges of potassium and hydrogen ions, a further stepping up of the hydrogen ion concentration could occur by exchange of hydrogen ion for an inorganic cation.

It may be pointed out that one of the catalysts involved in the passage of metabolic hydrogen to oxygen could conceivably function as such an acid, and the purpose of the present communication is merely to indicate such a possibility, which further exemplifies our previous hypothesis in which phosphoglyceric acid was used as an illustration.

It may be noted that in the metabolism of 1 molecule of glucose, 24 hydrogen atoms pass to oxygen, 12 from the original carbohydrate molecule and 12 from water incorporated at various stages. The metabolic hydrogens can be regarded as converted at some stage into electrons and free hydrogen ions. This does not happen at the stage of the pyridine nucleotides, but appears to happen at or before the stage of the cytochromes. It is of interest to note that Quastel[6] has used the reaction:



$$2\left[\text{Fe(CN)}_6\right]''' + \text{Co}\begin{matrix}\diagup \text{H}\\ \diagdown \text{H}\end{matrix} = 2\left[\text{Fe(CN)}_6\right]'''' + \text{Co} + 2\text{H}^+$$

to determine the concentration of cozymase, by measuring the acidity produced, through its effect on bicarbonate.

If all the metabolic hydrogens were utilized to supply the hydrogen ions of the gastric juice, the upper limit of the ratio $Q_{\text{HCl}}/Q_{\text{O}_2}$, from this source alone, would be 4.

When the electrons pass to oxygen, hydrogen ions are in turn withdrawn from the cell. Ordinarily the addition and withdrawal quantitatively balance without alteration of pH from such exchanges; but it may be possible that the stage of hydrogen ion formation can be effectively separated in the oxyntic cell from the stage of withdrawal. Such might occur, for example, if the donation of hydrogen atoms and conversion to hydrogen ions and electrons took place at a surface with fixed enzyme units of the donator and free diffusion back, through the cell, of the electron carriers.

Such amplifications of our earlier view had been entertained here prior to the appearance of a communication to the Biochemical Society (April 1948) of Davies and co-workers, in which they refer to a hypothesis of Crane, Davies and Longmuir (to be published), and which "requires that H atom transport by dehydrogenating enzymes is part of the mechanism by which H ions are secreted".

Upon inquiry, it would appear that this hypothesis does not include the supposition that the metabolic hydrogen atoms supply directly the hydrogen ions of the gastric juice in the manner indicated above, and which is an extension of a possible mechanism we had previously put forward[3]. Such would largely simulate the production by the yeast cell of a pH as low as 1·5 in the suspending fluid, and due to free hydrochloric acid.

EDWARD J. CONWAY
THOMAS G. BRADY

Department of Biochemistry,
University College,
Dublin.
April 26.

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[2] Conway, E. J., FitzGerald, O., and Walls, D., *Nature*, **156**, 477 (1945).
[3] Conway, E. J., and Brady, T. G., *Nature*, **159**, 137 (1947).
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[5] Conway, E. J., and O'Malley, E., *Biochem. J.*, **40**, 59 (1946).
[6] Quastel, J. H., and Wheatley, A. H. M., *Biochem. J.*, **32**, 936 (1938).

An Antigen Related to the *ABO* System

WE have studied a serum containing an agglutinin, provisionally named 'anti-Ken' after the patient's name. This agglutinin was formed by a Polish patient, aged twenty-four, in response to pregnancies: the first ended in a stillborn macerated fœtus at term, the second was successfully interrupted by Cæsarean section during the thirty-seventh week. The patient was group A_2 *M CDe CDe Ken-* and her husband *B MN cDE cDE* (or *cDE cde*); we could not distinguish between these genotypes owing to the lack of anti-*d* and anti-*e* sera. The baby proved to be group *O MN CDe cDE Ken+*.

During the second pregnancy, as there were many possibilities of immunization, abnormal anti-*B*, *N*,*c*(*Hr'*), *d*(*Hr*) or *E*(*Rh''*) antibodies were searched thoroughly. The characters of the anti-*B* agglutinin remained normal: titre, 1 : 512, thermal optimum at 4° C., no exaltation by human serum or 30 per cent bovine albumin. At the thirty-second week an agglutinin was found active at 37° C. on certain *O* and *A* cells. It did not correspond to one of the *Rh* antigens mentioned above, nor to the *N* antigen.

Ten days after delivery a suitable amount of serum was obtained. It reacted strongly with the baby's cells and certain *A* and *O* bloods, giving a visual agglutination up to 1 : 4 and a final titre of 1 : 32 (in saline) at 37° C. Its activity was markedly increased when 30 per cent bovine albumin was used as diluent.

Testing with *A* and *O* cells of known *D* (*Rh*) type gave the following results:

Reaction with anti-*Ken*		+	—
248 unselected *A* and *O* bloods	*A* cells	46	45
	O cells	102	55
	D+ cells	132	83
	D− cells	16	17

There is at first sight an evident discrepancy in the distribution of *Ken*+ and *Ken*− cells among *A* and *O* groups, and, in a minor way, among *D*+ and *D*− cells. The latter does not appear to be significant whereas the former indicates a true difference between the *A* and *O* cell-groups. The χ^2 and p values are given in the following table. Owing to the small number of samples, the Yates adjustment was applied.

	χ^2	p
A–O distribution	4·396	0·036
D+ *D*− distribution	1·4814	0·224

The observed difference would appear by chance in only 1 in 30 trials for the *A–O* distribution and about 1 in 5 for the *D* distribution. Therefore the *Ken* antigen is found with a significantly higher frequency in the *O* group and is probably related to the *ABO* system. Its genetical transmission is being studied and will be described later.

We are indebted to Pr. Olbrechts and Mrs. Olbrechts-Tyteca for advice in the statistical work, to Drs. R. R. Race and A. E. Mourant for the sera used in genotype determinations, and to J. Snoeck for permission to publish the case.

PIERRE O. HUBINONT

Laboratoire de Bactériologie et
Laboratoire d'Hygiène,
Université Libre de Bruxelles.
May 7.

Error in Counting Reticulocytes

WHEN immature mammalian red cells, or reticulocytes, are stained with brilliant Cresyl Blue they may be differentiated from adult red cells and enumerated in a sample as a percentage. If these cells were scattered according to chance, reticulocyte counts would be expected to follow the binomial distribution. In a recent paper, however, Jacobsen, Plum and Rasch[1] have shown that, in their laboratory, reticulocytes appear to be more regularly arranged than this when present in a proportion greater than 10 per cent. They are therefore able to make counts on one sample with remarkably close agreement. Much of the important work on reticulocyte maturation carried out in their laboratory depends on the great accuracy with which this technique is used. It was therefore thought that an independent attempt to confirm this deviation from the binomial distribution would be of interest.

Replicate counts were made on a human case of pernicious anæmia with 13 per cent and on an anæmic rabbit with 20 per cent of reticulocytes. In all, 66,000 red cells were counted. In the human case the counts corresponded fairly well with the binomial distribution; but in the rabbit the counts were less regular.

These results differ markedly from those of Jacobsen, Plum and Rasch, who record increasing accuracy with the higher counts. The discrepancy may have been due to inferior skill both in making the preparations and in counting, for clearly a laboratory worker whose whole time is occupied in counting reticulocytes will attain an unusual ability. On the other hand, this technique gives great scope for unconscious bias. Reticulocytes cannot be distinguished from adult red cells as black from white. The maturation of a red cell is a gradual process, and reticulocytes merge imperceptibly into mature red cells. The difficulty is demonstrated in the photographs from which some of the counts made by Jacobsen, Plum and Rasch were taken. In the two examples published in their paper are six cells which we would consider mature reticulocytes, but only one of these is so classed by them.

In the simple enumeration of red cells, it is the highly skilled worker who can obtain closer agreement between replicate counts than the Poisson distribution will allow. Similarly, in counting reticulocytes, the highly skilled technician might be liable to bias in favour of excessive accuracy. Despite the care taken to avoid bias, it is therefore possible that the extreme accuracy of these authors may be due to the unconscious adjustment of counts by the inclusion or exclusion of the more mature reticulocytes. This possible source of bias could be eliminated if counts were made by a number of competent and independent hæmatologists from unmarked and unselected photographs made by Jacobsen, Plum and Rasch.

ROSEMARY BIGGS

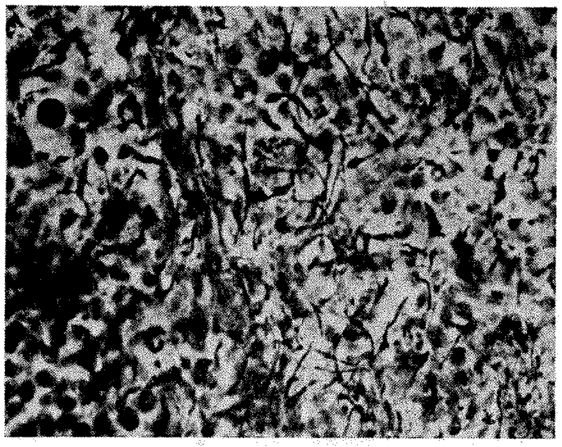
Department of Pathology,
Radcliffe Infirmary,
Oxford.

[1] Jacobsen, E., Plum, C. M., and Rasch, G., *Acta Path. Microbiol. Scand.*, **24**, 554 (1947).

Innervation of the Adenohypophysis

THERE is strong evidence that the nervous system controls the pituitary gland and its secretions; but the exact nature of the control is undecided. General agreement exists about the importance of the nerve connexions for the normal functioning of the pars nervosa of the posterior lobe. The influence of the nerve supply on the adenohypophysis is, however, still under discussion and has been denied altogether. Experimental sections of the hypophyseal stalk and related hypothalamic structures have produced conflicting results; but no alternative way of nerve supply has been established, and the stalk is still considered the most probable link between the pituitary body and the central nervous system.

The morphological descriptions of the gland provide many references to the presence of nerve fibres in the glandular hypophysis; but few complete and detailed descriptions of the origin and endings of such fibres. Perhaps for this reason the evidence in favour of the abundant nerve supply of the gland has been usually under-estimated.



In a study of the rabbit's pituitary gland, using Cajal's method on frozen sections, I have been able to show the rich innervation of the glandular parts (intermedia, tuberalis and distalis). The nerve fibres come from the hypothalamic-hypophyseal tract. They appear mostly as isolated elements, passing directly from the stalk and from the pars nervosa (infundibular process) to the pars tuberalis and intermedia. They are particularly abundant at the junction of the pars tuberalis and pars distalis, a region named the 'zona tuberalis', which Harris[1] has recently studied. Individually or in small bundles, these fibres follow the general direction of the portal vessels and thus reach the pars distalis. Other fibres reach the pars distalis after crossing the pars intermedia, especially at its caudal end, where they are very numerous. In some cases the fibres leaving the hypothalamic-hypophyseal tract form a thick bundle which, before entering the zona tuberalis, runs along the stalk for a short distance quite separate from the main tract directed to the pars nervosa. This is particularly clear in new-born and very young animals.

The nerve fibres of the adenohypophysis seem to have an almost uniform type of ending as small clubs or knob-like formations applied to the cells. From the relative numbers of endings and cellular nuclei visible, there seems to be only one of these formations for each cell. Even when the fibres remain unstained, it is often possible to see clearly the nerve endings as black knobs or disks in almost equal numbers to the nuclei.

The accompanying reproduction shows some fibres in the pars distalis of the adult rabbit, and the small club-like endings are also visible in parts of the field. This type of nerve-ending was described and illustrated by Croll[2] also in the adenohypophysis of the rabbit, and by several authors in other species.

A full description of this work will be published elsewhere.

E. VAZQUEZ-LOPEZ

Laboratories of the Imperial Cancer
Research Fund,
London, N.W.7.
May 24.

[1] Harris, G. W., *J. Anatomy*, **81**, 341 (1947).

[2] Croll, M., *J. Physiol.*, **66**, 316 (1928).

Occurrence of Thin Membranes in the Structure of Wool

WOOL keratin is considered to be completely soluble in sodium sulphide. 30 ml. of 0·3 *M* sodium sulphide was added to 1 gm. carefully purified wool, and this mixture was allowed to stand for about a month. After this time a light green solution was obtained, but the solution showed a slight opalescence. The particles causing this opalescence (estimated to be not more than 0·1 per cent of the wool) could be separated from the solution by centrifuging. After separating and washing with water, the solid matter was examined under the electron microscope. The specimen was mounted on collodion and observed directly. The solids proved to consist mainly of thin membranes, mostly rolled or folded, as is seen in Fig. 1. In order to determine the thickness of the membrane itself a collodion replica was made and gold-shadowed at a declination of 1 : 10. Fig. 2 shows how the thin membranes are rolled and the rolls flattened, probably by the surface tension during the drying. From the length of the shadows the thickness is calculated to be something between 50 and 100 A. Fig. 3 is a shadow-cast replica, where part of the wool membrane has stuck to the collodion. In part it shows both the membrane and the corresponding impression and is in that way interesting purely from the electron-micrograph point of view.

As these thin membranes are resistant to sodium sulphide, we think it justified to assume them to have a chemical composition different from the ordinary wool keratin.

It would be of great interest, of course, to know where the membranes are located in the wool fibre. It is also essential to know the chemical structure of the membranes and their behaviour towards chemical agents and enzymes. A chemical analysis is being carried out.

A sample of wool was strongly chlorinated and the excess chlorine afterwards removed by a solution of sodium bisulphite. The sample was then repeatedly treated by supersonics and the water dispersion from each treatment was examined under the electron-microscope. In the first suspension there were numerous fragments from membranes similar to those mentioned above. In the second and following suspensions the occurrence of the membranes was more and more rare, but the wool still had the fibre character and even partly a scale structure. This can be taken as an indication that the membranes are located in the surface layer of the wool. Further investigations are necessary before more definite conclusions can be drawn.

If it be a fact that these membranes are located at the surface or in the outer layers of the wool and do not dissolve in an alkaline and reducing agent like sodium sulphide, it may have an important bearing on surface phenomena such as the frictional properties of the fibres and the diffusion of dyes into the fibres.

JOEL LINDBERG
BO PHILIP
NILS GRALÉN

Swedish Institute for Textile Research,
Gothenburg. May 14.

Action of Streptomycin on Plant Tumours

In previous reports on the effect of streptomycin on plant tumours produced by *Phytomonas tumefaciens*, it was stated that this antibiotic substance would 'cure' a variety of plants of crown-gall[1], and that it killed tumour tissue in these galls without influencing normal cells[2]. To obtain more information about the action of this agent, experiments were performed using *in vitro* methods which made possible more exact control of dosage and closer observation of effects.

Cylinders of sterile carrot tissue 10 mm. diameter × 6 mm. high were placed on sucrose mineral agar. The upper surface of these fragments was covered with a suspension of fully virulent crown-gall organisms. About 15×10^8 viable organisms were applied to each fragment in this way. After 1, 2, 6 and 8 days, the fragments were transferred to sucrose mineral agar containing $50\,\gamma$ per ml. streptomycin, and their upper surfaces were covered with 0·06 ml. of a solution containing $500\,\gamma$ per ml. streptomycin. One group was left on streptomycin-free agar as a control.

After three weeks incubation in light at 25° C., the distribution of tumours in the variously treated groups was found to be as shown in the table :

Frequency of tumour formation in fragments of carrot tissue treated with streptomycin

Interval between inoculation and streptomycin treatment	Number of fragments showing tumours (out of 10)
1 day	1
2 days	3
6 days	10
8 days	10
Untreated control	10

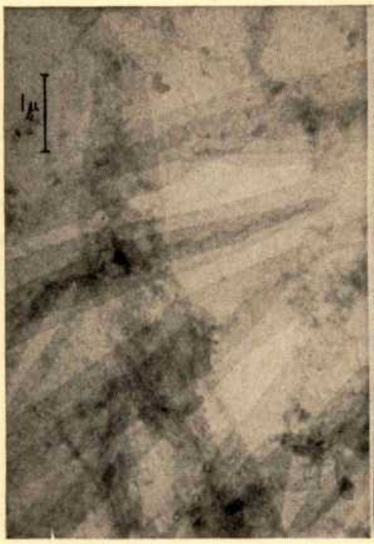


Fig. 1

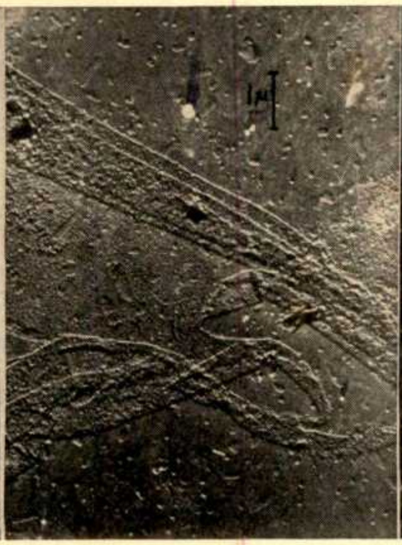


Fig. 2

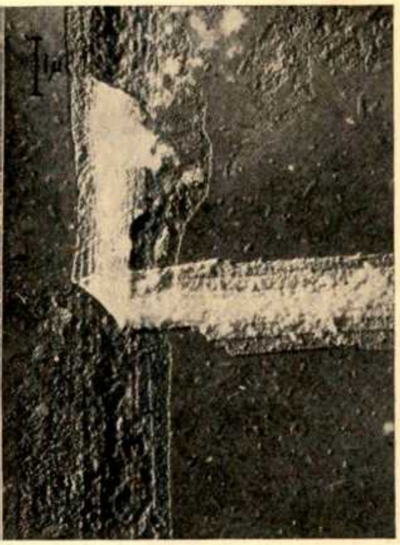
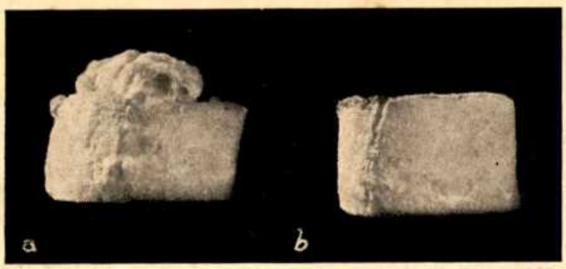


Fig. 3

Fig. 1. Electron micrograph of membranes from wool. Fig. 2. Collodion replica of the membranes on glass ; gold-shadowed. Fig. 3. Collodion replica as Fig. 2 ; part of the membrane has stuck to the collodion



(*a*) Cylinder of carrot tissue treated with crown-gall bacteria and cultured for 3 weeks *in vitro*. A large green tumour has formed on the upper surface. (*b*) Cylinder of tissue treated as (*a*) but with 0·03 ml. of a solution of 500 γ per ml. streptomycin applied to the upper surface one day after inoculation. No trace of tumour formation was visible on this fragment

Where streptomycin was applied one or two days after inoculation, almost complete inhibition of tumour formation occurred. The tumours which did develop were very small. At six days, tumefaction had already started. Application of streptomycin at this time slightly reduced the growth of the tumours and changed their appearance, untreated tumours being green, treated ones white. The accompanying reproduction shows the difference in appearance between a fragment of carrot tissue on which the tumour developed and one on which it was inhibited by streptomycin.

When bacteria-free sunflower tumour tissue was cultured on sucrose agar containing 50 γ per ml. streptomycin, growth was only 65 per cent of that made by tissue on streptomycin-free agar. It was also found that 50 γ per ml. of streptomycin would completely inhibit the growth of roots on sunflower stem fragments treated with indole acetic acid, though it did not inhibit their initiation. It seems more probable that streptomycin is a general inhibitor of the growth of embryonic plant tissue than a specific inhibitor of tumour tissue. Its inhibiting effect on tumour formation is probably due to its action on the bacterial inciting agent.

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R. S. DE ROPP

New York Botanical Garden,
New York 58. May 5.

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Antigenic Components of *Psittacosis* Virus

THERE is much evidence that viruses of the *Psittacosis-Lymphogranuloma* group are antigenically related. Some of the most active reagents for use in diagnosis by the complement-fixation reaction are virus suspensions which have been boiled[1]. It has also been found that treatment of egg-grown *Lymphogranuloma* by phenol and boiling, by urea or by extraction with ether yield products of enhanced activity which, however, will react with antibodies evoked by the heterologous as well as the homologous species[2,3]. Many observations, recently reviewed by Cox[4], indicate the frequency of serological cross-reactions between various members of this group, and the production of specifically reacting antigens is clearly of importance.

Complement-fixation studies with hyper-immune guinea pig sera absorbed with unheated or boiled *Psittacosis* suspensions have led to the conclusion that this virus possesses at least two antigens, one destroyed by heat, the other resistant[5]. Evidence, not yet published, that specificity is a property of the labile antigen has also been obtained[6].

In other instances the serological activity of a specific antigen has been demonstrated, and the toxin neutralization experiments of Rake and Jones[7] suggest that this may be identified with the specific toxic factor which they describe. Mammalian sera may often be relatively deficient in specific antibody and there is evidence from infection neutralization[8] and complement-fixation tests[9] that avian sera are more potent in this respect. Virus agglutination methods may also be of value in detecting specific reactions[10].

In the course of an investigation into the antigenic properties of *Psittacosis* and related viruses, two types of antisera were prepared in the guinea pig: one designated 'complete' by the injection of *Psittacosis* in the fresh state, the other designated 'group' against the virus heated in a boiling water-bath. These suspensions were made from yolk-sac material, and the sera were tested by complement fixation against similar antigens from mouse spleen.

It was found that unheated antigens, rich in virus, gave variable results in that they might fail altogether to fix complement in the presence of either antiserum, but more often preparations of this sort gave good fixation with the 'complete' serum and very much less or no fixation with comparable dilutions of the 'group' serum. Regardless of its initial behaviour in the fresh state, heating the suspension consistently altered it, so that it reacted fully with both types of serum. The same effect was produced by treatment with papain or with dilute mineral acid.

As was expected, after absorption with the heated virus, the 'complete' serum retained reactivity only with the unheated preparation: similar treatment of the 'group' serum removed its fixing powers with the heated antigen as well as the small degree of reaction sometimes apparent with the unheated material. These findings confirm Bedson's previous observations on the complex antigenic nature of *Psittacosis*, and suggest that, in the living virus, the heat-stable factor is largely or, less commonly, entirely masked by one or more heat-sensitive components.

Attempts were made to improve the specificity of active, unheated suspensions with various reagents which might preserve and enhance the combining power of the labile antigen or suppress that of the group antigen. At the same time it was hoped that the effects of such treatment might yield further information about the composition of the virus particle.

The heat stability of one factor is very marked, and it was found to resist autoclaving for thirty minutes at 135° C. This property and its lack of sensitivity to a proteolytic enzyme suggest that it may be composed largely or entirely of carbohydrate. Conversely, the other reactive fraction might well be protein in nature.

The serological activity of heated *Psittacosis* was destroyed by 0·001 molar potassium periodate in thirty minutes at 37° C.; the minimal exposure required has yet to be determined. Unheated antigens treated in a similar manner with 0·002 molar solution reacted well with the 'complete' serum; to obtain this effect an increased concentration of virus was required in the test but, even at this strength, no reaction took place between the treated material and the 'group' serum. It would thus appear to have acquired a uniformly specific character.

It has been shown recently[11] that, in addition to its effect on carbohydrates, periodate may alter or inactivate biologically active proteins. Nevertheless, it seems likely that critical dilutions of this reagent may be helpful in the identification of some carbohydrate substrates. The inactivation of the heat-stable *Psittacosis* antigen by periodate is regarded as confirmatory evidence that the group component is, at any rate in part, carbohydrate.

A report giving full details of these and other observations bearing on the antigenic behaviour of *Psittacosis* is being prepared.

C. F. BARWELL

Department of Bacteriology,
London Hospital Medical College,
London, E.1. July 29.

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[9] Eddie, B., and Francis, T., *Proc. Soc. Exp. Biol. Med.*, **50**, 291 (1942).

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Æcidia of Barley Rust in Britain

THE æcidium on *Ornithogalum* species in Europe has an interesting nomenclatorial history. At first attributed to *Puccinia liliacearum* Duby, it was recognized by Bubak[1] as belonging to a separate heterœcious rust and named by him *Æcidium ornithogaleum*. Then, in 1914, Tranzschel[2] demonstrated in both directions its connexion with the common brown rust of barley, *Puccinia hordei* Otth. (syn. *P. anomala* Rostr.). This connexion has been confirmed by Mains and Jackson[3] in the United States of America; but, so far as we are aware, the æcidium has not hitherto been found in Britain. According to Sydow[4], it is known to occur in Germany, Austria and Hungary. D'Oliveira[5], who repeated Tranzschel's experiments and produced æcidia on *Ornithogalum* by inoculation from barley, was unable to find the æcidia in the field in England and concluded that barley rust survives the English winter in the uredo state on barley tillers and seedlings.

On March 14, 1948, one of us (N. Y. S.) collected spermogonia on a leaf of *Ornithogalum pyrenaicum* L. in Inwood Copse near Ham Spray, below Inkpen Beacon, on the borders of Berkshire and Wiltshire within the last-named county. These may have belonged to *P. hordei* or to *P. liliacearum*; but their occurrence stimulated our interest and led to our asking Mrs. F. Partridge, who lives at Ham Spray House and was present when the leaf was collected, to keep a watch for æcidia. Two æcidia were found on April 2, and on April 15 we received from her a consignment of thirty-two infected leaves. Twenty-seven of these bore spermogonia associated with teleutosori of *P. liliacearum*, five bore spermogonia and æcidia but no teleutospores. From the latter, inoculations were made at once to seedlings of common barley (unnamed hybrid seed); and on April 23, uredo pustules were visible on the inoculated leaves. They became erumpent on the following day.

Subsequent careful search of the copse at Ham Spray has shown that *O. pyrenaicum* occurs there in two distinct patches. One adjoins the corner of an arable field which carried barley in 1947; the other lies between fields which carried wheat and oats respectively. The æcidia were found only in the former patch; *P. liliacearum* occurred in both, but mainly in the latter.

While it appears probable that persistence of the uredo stage is the chief method by which barley rust overwinters in Britain, the æcidia may be important in two ways. In the first place, *O. pyrenaicum* is locally abundant (with a discontinuous distribution) in certain parts of the south and west of England and may be responsible for initiating local outbreaks of brown rust. The plant occurs in north Somerset, west Gloucestershire, Wiltshire, Berkshire, Bedfordshire, Norfolk and Sussex. Secondly, presence of the æcidial stage affords opportunity for hybridization between existing physiological races of barley rust and for the production of new ones. D'Oliveira was able to distinguish five races of this rust in England. We suggest that it may be desirable to survey the known stations of *O. pyrenaicum* next April to ascertain to what extent æcidia are normally produced in Britain. Other species of *Ornithogalum*, especially *O. umbellatum* L., should also be examined for this purpose.

We are indebted to Dr. G. R. Bisby for help with the inoculations, and to Mrs. Partridge for her observations and for sending us material.

R. W. G. DENNIS
N. Y. SANDWITH

Royal Botanic Gardens, Kew.
May 26.

[1] Bubak, Fr., *Annal. Mycol.*, **3**, 223 (1905).

[2] Tranzschel, W., *Mycol. Centbl.*, **4**, 70 (1914).

[3] Mains, E. B., and Jackson, H. S., *J. Agric. Res.*, **28**, 1119 (1924).

[4] Sydow, P. and H., "Monographia Uredinearum", **4**, 287 (1924).

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Velocity of Photons

MR. H. FLETCHER MOULTON'S paradox[1] is ingenious, but easily resolved. The energies of two photons emitted at the same place are *not* equal if each energy is measured in the co-ordinate system of the moving body at which it is absorbed. Each observer measures wave-length and velocity in his own co-ordinate system, and deduces the frequency and energy to correspond. The same remark elucidates the 'mystery' of the Doppler effect; but it must be remembered here that each photon does not show this effect. If one single photon could be received, it would presumably show no Doppler effect (or, indeed, wave-length at all—this is the classical deduction from photo-electric phenomena); the wave decides the probability of the photon being found at any given point, or the distribution of the photons if they are present in sufficient numbers.

J. H. AWBERY

11 Carlisle Road, Hampton, Middx.

[1] *Nature*, **162**, 303 (1948).

DR. GEORGE NOVELLO COPLEY, City Technical College, Liverpool, states that answers to Mr. Fletcher Moulton's questions are given in "A Textbook of Physics", by E. Grimsehl, vol. 5, "Physics of the Atom", p. 240 (Blackie, 1945), where the corpuscular interpretation of the Doppler effect is seen to be analogous to that of the Compton effect.

A NEW INTENSE SOURCE OF RADIO-FREQUENCY RADIATION IN THE CONSTELLATION OF CASSIOPEIA

By M. RYLE and F. G. SMITH
Cavendish Laboratory, Cambridge

THE discovery by Hey, Parsons and Phillips[1,2] of a variable source of radio-frequency radiation in the constellation of Cygnus suggested that at least part of the galactic radiation was due to very intense discrete sources. Afterwards a detailed study of this region was made by Bolton and Stanley[3], using an interference system of greater resolving power; their results showed that the angular diameter of the source was smaller than the resolving power of their apparatus (8 minutes of arc), and the more precise determination of its position enabled them to show that the source does not coincide with any outstanding star. In a more recent note Bolton[4] describes the extension of this work and the discovery of other discrete sources.

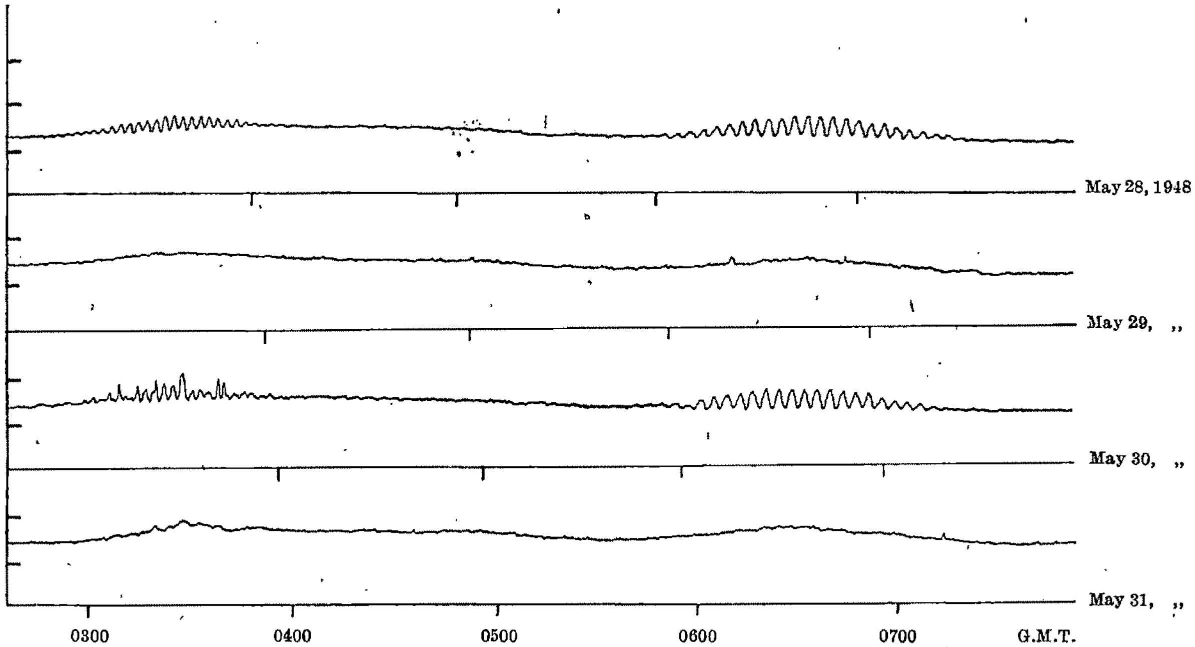
The similarity between the fluctuations observed from the source in Cygnus and from the disturbed sun has suggested to both teams that the mechanism for the emission of intense radiation from discrete galactic sources is likely to be the same as that of sunspot emission. The results obtained by many workers have shown that sunspot radiation is circularly polarized, and it is therefore of importance to measure the polarization of the radiation emitted by discrete galactic sources.

Recently we have carried out a series of experiments on a frequency of 80 Mc./s. to determine the polarization of the radiation from the source in Cygnus. During the course of this work we have found a new and more intense source situated in the constellation of Cassiopeia, as well as several minor sources having a smaller intensity than Cygnus.

In our experiments we have used the radio version of Michelson's stellar interferometer which we have previously described[5,6]. When making observations with a large resolving power, this type of interferometer has advantages over the method used by Bolton and Stanley, since no corrections are necessary for refraction in the troposphere or ionosphere. In order to identify the central maximum on the record we have limited the total width of the interference pattern by using two aerials of considerable directivity. By noting the times of the adjacent minima it is then possible to determine the Right Ascension of the source.

It can be shown that the periodicity of the interference pattern produced on the record by such a system depends on the declination (δ) of the source, and is given by $t_0 \sec \delta$, where t_0 represents the period of the central interference pattern for a source in the equatorial plane. It may therefore be seen that by measuring the period of the interference pattern the declination of the source may be found from the same record, without the need for an aerial system having a large resolving power in a north-south plane.

If the two halves of the aerial system are now mounted with mutually perpendicular planes of polarization, the system may be used to determine the polarization of the radiation from a galactic source. For a wave which is circularly polarized, the amplitude of the interference pattern produced will be the same as with the aerials parallel, but the phase of the pattern will be displaced by a quarter period. If the radiation is only partially polarized, the amplitude of the interference pattern will be reduced, and by comparing the amplitudes obtained with the two aerials parallel and perpendicular to one another, it is possible to determine the degree of polarization. (The full analysis of a complex wave is possible by this method, as has already been mentioned[6].)



Records of galactic radiation using the spaced aerial system (units of intensity are 5×10^{-23} watts/m.^{2}/(c./s.)). May 28, aerials parallel; (2) May 29, aerials mutually perpendicular; (3) May 30, aerials parallel; (4) May 31, aerials mutually perpendicular

We have used an aerial spacing of about 0·5 km. at a frequency of 80 Mc./s. An accuracy in Right Ascension of ± 10 sec. should be possible with this system for sources as intense as that in Cygnus, although our accuracy has been limited by the accuracy of time calibration to ± 20 sec. The determination of declination (δ) becomes inaccurate for small values of δ, but for δ greater than 30° an accuracy of ± 20′ becomes possible.

Observations have been made between declinations of 0° and + 75°. In addition to the source in Cygnus, a more intense source was located in Cassiopeia, the radiation from which has been notable for showing considerably smaller fluctuations than that from the source in Cygnus.

Some typical records are shown in the accompanying figure (curves 1 and 3), in which the interference patterns produced by the sources in Cygnus (0335) and Cassiopeia (0640) can be seen.

The source in Cassiopeia has been found from these records to have a Right Ascension of 23 hr. 17 min. 50 sec. and a declination of 58° 0′ (1948 co-ordinates). The total intensity (twice the value obtained with aerials which accept only one component of polarization) has been found to be 23×10^{-23} watts/m.^{2}/(c./s.), with 'bursts' of radiation having an intensity of up to 6×10^{-23} watts/m.^{2}/(c./s.). The intensity of the source in Cygnus has been found to be 14×10^{-23} watts/m.^{2}/(c./s.) with 'bursts' of intensity up to 20×10^{-23} watts/m.^{2}/(c./s.). The aerial system has not yet been fully calibrated, but although the absolute values of intensity may be in error by as much as ± 30 per cent, the relative values are reliable.

A less intense but more variable source in Ursa Major (R.A. 12 hr. 20 min., declination 58°) has been found to give a maximum intensity of 5×10^{-23} watts/m.^{2}/(c./s.).

The angular diameters of all the sources which have so far been observed are less than the resolving power of the apparatus (about 6 minutes of arc for the two intense sources). The observation of 'bursts' of duration less than 20 sec. coming from the source in Cygnus has shown that the linear dimensions of the source of the variable component cannot greatly exceed the distance travelled by electromagnetic waves in 20 sec. If a source of this diameter (about 10^7 km.) is situated at the distance of the nearest fixed star, the observed intensity would correspond to radiation from a black-body source at a temperature greater than 10^{14} °K.

Observations made with the two halves of the aerial system mutually perpendicular have given records in which the amplitude of the interference pattern is less than 5 per cent of that with the aerials parallel. Some typical records are shown in curves 2 and 4. The results show that, within the limits of experimental error, the steady component of the radiation from both sources is randomly polarized. The determination of the polarization of the variable component of the radiation (see curve 4) is difficult, since the 'bursts' last for a time comparable with the period of the interference pattern, but a study of such records suggests that this component is also randomly polarized.

The detection of intense radiation from discrete galactic bodies has suggested that the radiation is due to processes similar to those occurring in sunspots. The observation that the radiation is not circularly polarized, however, suggests that the mechanism is somewhat different, and may not involve an appreciable magnetic field in the emitting region. The mechanism may possibly be more nearly analogous to the radiation from the undisturbed sun.

[1] Hey, Phillips and Parsons, *Nature*, **158**, 234 (1946).
[2] Hey, Parsons and Phillips, *Proc. Roy. Soc.*, A, **192**, 425 (1948).
[3] Bolton and Stanley, *Nature*, **161**, 312 (1948).
[4] Bolton, *Nature*, **162**, 141 (1948).
[5] Ryle and Vonberg, *Nature*, **158**, 339 (1946).
[6] Ryle and Vonberg, *Proc. Roy. Soc.*, A, **193**, 98 (1948).

VARIATION IN MORPHOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF ANAEROBIC BUTYRIC ACID BACTERIA

By DR. OTTO RICHARD

Department of Agricultural Bacteriology and Fermentation Biology, Swiss Federal Institute of Technology, Zurich

IN attempts to identify the butyric acid bacilli not liquefying gelatin present in silage-fodder, cow fæces, milk and cheese, we generally found it very difficult or even impossible to determine the exact species of the organisms isolated. In most cases our freshly isolated pure cultures differed, in morphological and biochemical properties, from the species described in literature. Furthermore, one and the same strain, when repeatedly examined, frequently showed great variations with time; a certain strain, which behaved as a representative of the species *a* at one time, later showed the characteristics of the species *b*.

In order to get an idea of the variability of butyric acid bacteria, a great number of strains were isolated from various biotopes and investigated repeatedly. The 260 pure cultures thus examined were isolated from soil, green plants, silage-fodder, fæces of cow and sheep, spoiled process cheese, green cheese of Glaris, Emmentaler cheese, potato-, corn-, rye-, chestnut-mash, and polluted water. Direct isolations by means of smear-cultures on glucose – yeast extract – meat infusion – agar and glucose – yeast water – agar of various hydrogen-ion concentrations were made. In addition, enrichment media were employed, namely skim milk, glucose – skim milk, Winogradsky's solution, glucose – meat – peptone-broth, corn-broth, corn-liver-broth, and pea-broth.

So far the isolated strains have been examined for the following properties: (i) macroscopical appearance of the colonies on the agar media mentioned above; (ii) shape and size of cells and spores grown in various substrates; (iii) Gram-staining and formation of iodophilic substance; (iv) growth and liquefying power on gelatin medium; (v) changes brought about in litmus-skim milk with and without glucose; (vi) ability to ferment sodium lactate; (vii) formation of gas and acid from different carbon sources, namely glycerol, sorbitol, mannitol, xylose, arabinose, rhamnose, fructose, glucose, mannose, galactose, sucrose, maltose, lactose, raffinose, inulin, dextrin, starch, and salicin; (viii) changes brought about in corn-broth; (ix) fixation of atmospheric nitrogen. The results of the present investigation are summarized below.

In young cultures grown under strictly anaerobic conditions several types of colonies can be distinguished. There are colonies with entire margin and those with crenated margin. Frequently root- and hair-shaped projections are formed. Some colonies belong to the flat type, other colonies to the raised type. The colonies of young cultures are generally milky to dirty white, those of old cultures often yellowish or violet. Of special interest is the observation that the ability to form slimy colonies is of erratic nature. On the whole, the variability appearing within one and the same strain in characteristics of the colonies is striking.

Inconstancy also appears in the shape of cells and spores. Thus the different colonies of a strain may contain unswollen as well as more or less distinct *Clostridium*- or *Plectridium*-like rods. Even within one and the same colony, these more or less pronounced types of cells may be found in varying numbers. Young organisms always show motility. The spores are always oval and may have a central to subterminal location, the latter being predominant. In several strains free spores with a brush-like capsule as described by Winogradsky[1] for *Clostridium pasteurianum* were observed in the phase-contrast microscope. Spores possessing such appendages are, however, developed also by strains which have nothing to do with Winogradsky's organism. Special attention may be directed to the fact that the differences observed in appearance of colonies, cells and spores between various strains are not greater than those found, on repeated examination, within one and the same strain.

Young cells are throughout Gram-positive.

According to Svartz[2], the formation of iodophilic substance by butyric acid bacteria under certain conditions is to be considered a property of taxonomical value. The results of the present investigation do not support this view, the appearance of iodophilic substance in the cells being of the same irregularity as that observed in the properties described above. Two strains of *Clostridium butyricum iodophilum* Svartz kindly supplied by him could not be identified by means of the iodine reaction after having been mixed with our freshly isolated strains. Moreover, it was impossible to identify the two strains as a species on the basis of the properties dealt with in the present communication.

All strains show excellent growth but no liquefying power on gelatin medium. The same was the case with a strain of *Clostridium pasteurianum* Winogradsky kindly supplied by Prof. Kluyver, Delft (Holland).

All strains reduced litmus added to glucose – skim milk, generally within 24 hours. At the same time or a little later, a turbulent fermentation, that is, production of acid and gas, started in all cultures. In skim milk without addition of glucose, however, quite different results were obtained. The results of a typical test are seen in Table 1.

Table 1. Effects produced upon skim milk by freshly isolated strains of butyric acid bacilli

Number of strains	Effects
119	Turbulent gas evolution and strong acid production (coagulation)
10	Slight production of gas and acid (no coagulation)
12	Only slight production of acid
27	Slight production of gas without change of acidity
92	No change

Of particular interest is the fact that the activity shown by the butyric acid bacteria in skim milk is very inconstant, the results obtained with one and the same strain at different times, and even with one and the same cell suspension under identical conditions, varying considerably. Further, it is worth noting that there exists no obligate parallelism between the ability of the pure cultures to ferment lactose in milk and the ability to attack this carbohydrate in peptone – meat-broth. On this point our results do not agree with those obtained by van Beynum and Pette[3], who state that strains incapable of producing fermentation in milk do not attack lactose. The same authors state that the butyric acid bacilli may be divided into two distinct groups on the basis of their different ability to ferment lactose and lactate. Thus *Clostridium tyrobutyricum* van Beynum et Pette includes the strains capable of fermenting lactate but incapable of attacking lactose, whereas *Clostridium saccharobutyricum* Beijerinck is supposed to ferment lactose but not lactate. In view of the fact that lactate fermentation is of great importance in cheese- and silage-making, it seemed of interest to test our 260 strains for lactose- and lactate-fermenting power. The method employed was that introduced by van Beynum and Pette[3]. The results may be seen in Table 2.

Table 2. Fermentation of lactose and sodium lactate by butyric acid bacilli

Total number of strains tested	Number of strains fermenting				Total number of strains attacking lactate
	Lactate, not lactose	Lactate and lactose	Lactose, not lactate	Not lactose, not lactate	
260	48 (18·5%)	195 (75·0%)	15 (5·8%)	2 (0·8%)	243 (93·4%)

From the results given in Table 2 it is evident that most strains of butyric acid bacilli ferment lactate as well as lactose. A rather small number of the pure cultures examined attack only lactate, and a very small number only lactose, the former strains thus belonging to *Cl. tyrobutyricum* van Beynum et Pette, and the latter strains to *Cl. saccharobutyricum* Beijerinck. On further investigation, however, it was found that the specificity for lactate and lactose, respectively, is a highly variable property. Thus it could be demonstrated that strains, apparently attacking only lactate, in reality possess a latent power to dissimilate also lactose, and vice versa. Obviously there is no reason for maintaining the species *Cl. tyrobutyricum* van Beynum et Pette. This statement was further confirmed on examining two pure cultures of this organism and two pure cultures of *Cl. saccharobutyricum* Beijerinck kindly supplied by Prof. van Beynum, Hoorn (Holland). Of the former, one strain showed specificity for lactate. The other strain, however, was found to cause a vigorous fermentation of lactose as well as lactate. Both strains of *Cl. saccharobutyricum* attacked lactate.

As mentioned above, the ability of the isolated strains to ferment carbohydrates, higher alcohols, etc., has been studied, this ability often being supposed to be of great importance for the classification of butyric acid bacilli. The results of these tests are shown in Table 3.

It appears that, of the compounds tested, only fructose and glucose are fermented by all strains with simultaneous production of acid and gas. In the medium containing mannose, only one strain failed to induce fermentation. As to the ability to attack the other carbon sources examined, the strains showed great variation, some pure cultures attacking all or most of the compounds, other strains attacking only a few of them. Furthermore, it was found, on repeated investigation, that most of the strains, as regards fermenting power, showed an irregularity of

Table 3. Fermentation of various carbohydrates, alcohols and glucosides by butyric acid bacilli

Carbon source	Number of strains forming	
	Acid	Gas
Glycerol	121	120
Sorbitol	179	187
Mannitol	235	230
Xylose	212	195
Arabinose	221	186
Rhamnose	97	58
Fructose	260	260
Glucose	260	260
Mannose	259	259
Galactose	241	228
Sucrose	224	215
Maltose	229	202
Lactose	211	186
Raffinose	197	195
Inulin	179	173
Dextrin	185	205
Starch	166	172
Salicin	197	163

the same type and the same extent as that found for the other properties examined. For example, one and the same strain on repeated examination of one and the same carbon source may show no attack, attack with production of acid only, attack with evolution of gas only, and finally, attack with formation of both acid and gas.

We therefore agree with McCoy *et al.*[4], that it is impossible to use the fermenting power for the classification of butyric acid bacteria not liquefying gelatin.

According to McCoy *et al.*[4] the butyric acid bacilli not liquefying gelatin may be divided into two groups, called *Bacillus saccharobutyricus*-type and *Clostridium pasteurianum*-type, respectively. Strains belonging to the former group liquefy the starch gel of corn-broth, whereas those of the latter group do not. The results obtained in examining our 260 freshly isolated strains by means of the method described by the authors mentioned may be summarized as follows. Between absolutely inactive strains on one side, and strongly active strains on the other side, there are intermediate types attacking the gel only partially. No obligate parallelism could be demonstrated between starch dissimilation in corn-broth and the breakdown of this polysaccharide in peptone-meat-broth. Furthermore, the power of attacking starch showed the same variability as that observed in the other properties of the strains examined. Thus our results do not support a classification of the butyric acid bacteria not liquefying gelatin on the basis of the changes brought about in corn-broth.

On examination for nitrogen-fixing power in Winogradsky's solution, our pure cultures were found to vary considerably, qualitatively as well as quantitatively. A large number of strains which in their properties, for example, growth on gelatin medium, fermentation of carbohydrates, higher alcohols, etc., are not identical with Winogradsky's organism, induce a turbulent fermentation in the solution without nitrogen compounds.

From the results discussed above the conclusion may be drawn that it is impossible to base a reasonable classification of the butyric acid bacilli not liquefying gelatin on differences in the properties dealt with in the present investigation.

[1] Winogradsky, S., *Cbl. Bakt.*, II. Abt., 9, 43 (1902).

[2] Svartz, Nanna, *J. Inf. Dis.*, 47, 138 (1930).

[3] van Beynum, J., and Pette, J. W., *Cbl. Bakt.*, II. Abt., 93, 198 (1935–36).

[4] McCoy, Elizabeth, Fred, E. B., Peterson, W. H., and Hastings, E. G., *J. Inf. Dis.*, 46, 118 (1930).

RADIO COMMUNICATION AND THE IONOSPHERE

THE great strides made in the development of long-distance radio communication and broadcasting in the past ten years or so have involved the combined efforts of a large number of scientific workers, engineers and operators. These and older students of the subject have become aware of the fact that the transmission of radio waves to distances beyond the horizon and even right round the earth is only possible because of the existence of the ionosphere, which is that portion of the earth's atmosphere which becomes electrically conducting by ionization chiefly under the influence of ultra-violet radiation from the sun. But while this conducting region reflects radio waves and so returns them to the earth at a distant point, it does not behave as a simple metallic reflecting sheet in the same position at all times and seasons. It is rather in the nature of a series of partially conducting layers, one above the other, each varying in height and conductivity with time, and the lower ones sometimes shielding the upper ones from radio waves transmitted upwards from the earth's surface.

On account of the somewhat complicated nature of this subject, it was found necessary during the War to provide, in a suitable booklet, a background knowledge of the fundamental principles of the transmission of radio waves through the ionosphere for those interested in short-wave communication. Such a book was written by Mr. G. Millington of the Marconi Wireless Telegraph Company on behalf of the Inter-service Ionosphere Bureau and at the suggestion of the Admiralty. It was extensively used by Service Departments during the War, and it seemed to the Admiralty and the Department of Scientific and Industrial Research that the information it contained should be made more widely available for radio technical workers and students. It has therefore now been reprinted with only slight modification as "Radio Research Special Report No. 17—Fundamental Principles of Ionospheric Transmission" (published for the Department of Scientific and Industrial Research by H.M. Stationery Office, 1*s.* 6*d.* (U.S.A., 55 cents), by post 1*s.* 8*d.*).

This report describes the main properties of the ionosphere as a medium in which radio waves from a transmitting station are bent or reflected back to a distant receiving station. The effect of the angle at which the waves are projected from the earth toward the ionosphere is described, together with the influence of sunlight on the transmission, with its resulting possibilities for communication. The text is of a descriptive theoretical nature, and the use of mathematics has been kept to a minimum so that the treatment can be followed by as wide a circle as possible of those interested in this subject.

The book is primarily meant for those who can supplement the reading of it by attending a training course, and perhaps even more for those whose task it is in these days to conduct such courses, and who until now have been handicapped by the lack of any book of the scope of the present one. No reference is made to actual experimental results, such as the values of the heights and critical frequencies of the ionospheric layers, and the diurnal and seasonal variations of these values. The publication admirably fulfils, however, its intended purpose of providing a basis for appreciating and understanding the practical results that can be found elsewhere.

SOCIAL MEDICINE OF OLD AGE

THE Trustees of the Nuffield Foundation have published a report on the social medicine of old age prepared by Dr. J. H. Sheldon in a survey of a random sample of 477 old people*. His object was "to discover the medical and mental condition of old people living at home, and the stresses and strains to which both they and the younger people caring for them may be subject". The survey forms an appendix to the report entitled "Old Age", published by a Survey Committee under the chairmanship of Mr. Seebohm Rowntree. Wolverhampton was one of the towns covered by the Rowntree Report, and the same sample of people has provided the material for the new survey. The town, which has a population of 150,000, was selected because it was large enough to ensure a fair mixture of all income classes and sufficiently compact to enable the compiler to undertake the amount of visiting involved. Old age for the purposes of the survey has been taken to begin at sixty for women and sixty-five for men. The sample was obtained from the register of ration cards, every thirtieth name in the selected age group being included in the survey.

The earlier chapters of the report deal with what the author describes as the natural history of old age, and cover an assessment of the old person's health, ability to move about, the nature and extent of any illness, susceptibility to loneliness, extent of dependence on others for nursing care, shopping, housework and cooking, difficulties in climbing stairs, queueing, moving among traffic or in the dark and liability to fall. The analysis of the physical state of the subjects was based on a case-history supplied by the subjects themselves and by relatives, or in some cases by their general practitioners. No clinical examination of the subjects was possible, and for this reason the data permit no very accurate estimate of the nature of any existing disability. In particular, no precise evaluation can be made of the diseases and functional impairments which are specific to old age, or of the contributory factors involved in the phenomenon of senescence. The remainder of the report makes a valuable analysis of the ecology of old age; that is, its relation with the rest of the community, and the mutual stresses and strains set up.

One of the important points which emerges is the fundamental importance of the family in the social biology of old age. The problems of old people in the mass are domestic rather than institutional. The author favours the provision of temporary hostel accommodation which would enable those normally responsible for their care to obtain occasional relief. Another aspect which is referred to is the provision of old people's dwellings specially designed and carefully sited in building schemes of the future. The possibility of living in the environment to which they are accustomed, of having something to do, and of being still able to feel necessary to the world are of the greatest importance to old people, and may help to explain why the mental level of old people living in their homes appears to be so much better than that of those living in institutions. The sense of loneliness of old people and the disabilities which are inherent in old age are most successfully mitigated where children or relatives live in close proximity. This mode of life seems most satisfactory to both generations since it enables the old people to preserve their independence and the married children to live a separate life, while at the same time ensuring that help is at hand in time of need. There is, however, a darker side to the picture. Many old people, especially women, were found to be carrying a burden in the management of the home, and in some cases in the nursing of a sick husband, which was clearly beyond their capacity. In other cases the care of aged parents imposes a strain on the younger generation which is almost intolerable.

The findings of the report are not necessarily applicable to other towns, and no final conclusions can be drawn from the data which have been obtained. Nevertheless, the report is of value in directing attention to the kind of problems which besets old age and in indicating some of the ways in which these problems can be met. In a population such as that of Great Britain, where the age distribution is moving upwards, there is a clear need for further study of old age.

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* The Social Medicine of Old Age: Report of an Inquiry in Wolverhampton. By Dr. J. H. Sheldon. (Survey Committee on the Problems of Ageing and the Care of Old People: Medical Sub-Committee on the Causes and Results of Ageing.) (Published for the Trustees of the Nuffield Foundation.) Pp. x+240. (London: Oxford University Press, 1948.) 5s. net.

RECENT RESEARCHES ON FOOD

THE first report of the Food Investigation Board since 1938 has only recently appeared*; but readers of scientific journals have been able to follow the work that has been done through the publication of separate papers on particular aspects of the work. The public in general has had a close acquaintance with the results of the work—if not of the work itself—in the war-time dehydrated foods and the special packagings that were adopted. Probably, however, few of those who complained about their dried egg and their household milk realized the amount of work that had gone into making it possible for us to have these foods at all. Here now is a chance for them to learn something of what was done on their behalf, for the successful application of the research findings was the result of close co-operation between the Board and the Ministry of Food.

The present report includes a summary of the work done during the years 1940–45 and a more detailed report for 1946, when the urgency of the war years had lessened and it was possible to resume "a more balanced and diversified programme of research which includes a fair proportion of longer range and more fundamental studies". This year also saw the reopening of the two 'market' laboratories, at Smithfield and at Covent Garden. The Torry Fisheries Research Station had been active throughout.

During the war years problems connected with the dehydration of foodstuffs and their subsequent use took first place—of necessity, since smallness of bulk was of particular importance in transport and storage. Now, however, there is opportunity once again to study such matters as the ripening and storage of fresh fruit and vegetables, the smoking and salting of fresh fish, freezing techniques and the composition of fresh carcases.

The work of the Food Investigation Board covers a multitude of problems arising from the processing, packaging, transport and storage of foodstuffs. Already we are a far cry from the primitive producer-consumer community whose diet is subject to very marked seasonal variations and shortages. All the work described in this report exemplifies man's increasing control over his environment and heralds a time when all foods will be available at all times and always in their most palatable and nutritional forms. (It will make life easy for the dietitians, but I wonder if it may not prove a little dull !)

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* Food Investigation, 1940–46. Department of Scientific and Industrial Research. Pp. 42. (London: H.M.S.O., 1948.)

However, that time is not yet, and meanwhile much of importance is being discovered. It is only to be expected, in view of the variety of problems that have to be tackled, that progress towards their solution is sometimes held up by lack of data on some fundamental issue. But a glance over the titles of the papers which have been published shows that even under war-time conditions these additional problems were tackled as they came, and in many cases a considerable advance was made in our understanding of the chemistry and physics of biological processes.

One of the most interesting points of advance—and the one which seems to have attracted most attention from other workers—was "the discovery of the reversible formation of starch from glucose-1-phosphate". A preliminary report on this work appeared in *Nature* of March 23, 1940, p. 451. No less important, however, are the contributions in other fields : the study of mucoproteins, of the chemical changes accompanying the development of rigor mortis, the general problem of the denaturation of proteins, the characterization of the components of connective tissue, the cause and cure of the lessening in biological value of milk powder stored with too high a moisture content.

None of this work is reported in full in this publication. For details the reader must refer to individual papers published in various scientific journals (references are given in full). This report is merely the outline picture ; but worthy of attention at that. It is a good example of science applied for the benefit of mankind and of the value of close co-operation between the scientific worker in the laboratory and the trader and administrator in the field. This co-operation was largely brought about by the urgent needs imposed by war-time conditions ; it is to be hoped that it may still be maintained now that the need is less obvious than it was.

M. W. Grant

WORLD ECONOMIC SURVEY

THE broadsheet "World Economic Survey", issued as No. 283 by Political and Economic Planning, gives a very useful and concise summary of two large and valuable reports produced by the Department of Economic Affairs of the United Nations Organisation. This Department is carrying on the essential functions of the Economic, Financial and Transit Department of the League of Nations, which issued almost as its swan song the "World Economic Survey, 1942–44". The comprehensive picture which that report gave of the world economic situation on the eve of victory was supplemented by two other reports, "Commercial Policy in the Post-war World" and "The Cause and Control of Inflation", the former reviewing the problem of post-war trade policies and trade relationships and the latter monetary experience in Europe after the First World War, which especially for their review of the inter-war years are almost equally valuable in providing the background for the discussions of the Economic and Social Council and the Economic Commission for Europe, which it is the prime purpose of the two new reports to provide. These reports, "Economic Report : Salient Features of the World Economic Situation 1945–1947", with a subsequent supplement, and "A Survey of the Economic Situation and Prospects of Europe", are also intended to find their way into the universities and libraries, and the summary provided by P.E.P. will indicate to the industrialist the extent of the assistance they can give them as well as the economist and research worker.

The European survey provides the more precise and detailed body of information ; the most notable feature of the industrial progress of the European countries is the extent to which recovery was retarded in 1947. Agricultural recovery since 1945 has been less satisfactory than in the corresponding period after the First World War, and the volume of food imports into Europe was running in 1947 at about 10 per cent below the pre-war level. The scanty evidence available suggests that, in Europe as a whole, industrial output per man-hour was lower than before the War. The foreign trade of European countries expanded only moderately in 1947 after a rapid recovery in 1946, and an unsatisfactory feature was the sharp decline in intra-European exchanges of food, coal and other essential goods, while trade in luxury products increased. Little hope is entertained that imports of foodstuffs and raw materials can be reduced below pre-war levels, and restoration of equilibrium in Europe's external balance of payments will require a concentrated effort over a period of years. Success depends on the conquest of open or suppressed inflation, the restoration of trade within Europe to pre-war levels and a further expansion of production of the right kind of goods. The survey concludes that, given the continuation of the present high levels of employment, the prospects of attaining the existing production targets for the early 1950's are not unpromising, provided that intra-European trade and credit arrangements can be developed sufficiently to permit a more rational utilization of European resources, and that financial difficulties do not interrupt the flow of overseas supplies.

As regards the rest of the world, while the population is almost 10 per cent greater than ten years ago, food production is still well below pre-war levels, and even if the high hopes for harvests in 1948 are realized, serious deficiencies will remain. Reduction in livestock population is adversely affecting soil fertility and crop yields. Latin-American countries have all suffered from inflation, and the high prices of foodstuffs have lowered the standards of living of many of the inhabitants. Prospects for output and exports of primary commodities other than food in Asia and the Far East are still not very bright, and production, transport and administration will have to be improved greatly before Far Eastern foreign trade is likely to meet the needs of the situation. Areas of Africa which suffered heavily during the War have made marked recoveries, although agricultural output has tended to lag behind the increases in population. Apart from cereal shortages, Africa's most serious problem is the shortage of textiles. The level of industrial production in Australia and New Zealand has been high, but both countries are suffering from shortage of dollars. Both are anxious to continue industrialization, but to do this must promote a high level of immigration. The survey also throws a little light on the disruption of Soviet economy by the War, and the extent of its recovery.

FORTHCOMING EVENTS

Tuesday, September 21—Thursday, September 23

Institution of Civil Engineers (at Great George Street, London, S.W.1).—Conference on "Biology and Civil Engineering".

Institute of Petroleum (joint meeting with the Institute of Fuel, at the University, Edgbaston, Birmingham).—Conference on "Modern Applications of Liquid Fuels".

Tuesday, September 21—Friday, September 24

Institution of Naval Architects (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2).—London Autumn Meeting.

Thursday, September 23

Royal Institute of Chemistry (at the Technical Institute, Darnley Road, Gravesend), at 8 p.m.—Dr. T. W. Parker: "Estimation of Durability of Building Materials".

Thursday, September 23—Saturday, September 25

Faraday Society (at Ashorne Hill, near Leamington Spa).—General Discussion on "The Physical Chemistry of Process Metallurgy".

Friday, September 24

Department of Scientific and Industrial Research, Road Research Laboratory (in association with the Glasgow and District Association of the Institution of Civil Engineers, the Scottish Branches of the Institution of Municipal Engineers and the County Surveyors' Society, and the Scottish Accident Prevention Council, at the Royal Technical College, Glasgow), at 10 a.m.—Conference on "Road Research".

Biochemical Society (in the Department of Biochemistry, The University, Sheffield), at 11.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturers (2) in Engineering—The Registrar, The University, Manchester 13 (September 24).

Senior Technician in the Department of Pathology—The Secretary, Marischal College, Aberdeen (September 30).

Assistant to the Chief Officer of the Official Seed Testing Station for England and Wales, and a Crop Recorder—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge (September 30).

Chair of Pathology in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (September 30).

Principal Scientific Officer or Senior Scientific Officer (Mathematician) in the Department of Atomic Energy, Risley, Lancs.—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting A.312/48A (September 30).

Assistant Lecturer in Biochemistry—The Registrar, King's College, Strand, London, W.C.2 (September 30).

Lecturer in Biochemistry in the Technical Education Branch of the Department of Public Instruction of New South Wales—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (September 30).

Senior Lecturer in Physics in the Leeds College of Technology—The Director of Education, Education Department, Leeds 1 (October 2).

Senior Scientific Officers (with sound knowledge of emission spectroscopy or electronics, or radiation chemistry), and Senior Experimental Officers (well experienced in spectro-chemical or other modern methods of analysis), in the Chemical Inspectorate (Atomic Energy), Ministry of Supply, for analytical work involving modern physico-chemical methods—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, S.W.1, quoting No. 2281 (October 7).

Senior Organic Chemist, Junior Research Chemists (3), and a Chemical Engineer, for the British West Indies Sugar Research Scheme—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (October 9).

Lecturer in Agricultural Bacteriology, and a Lecturer in Agricultural Zoology—The Secretary, Seale-Hayne Agricultural College, Newton Abbot, Devon (October 16).

Psychologist (non-medical)—The Establishment Officer, Prison Commission, Horseferry House, Dean Ryle Street, London, S.W.1 (October 16).

Chair of Zoology, the Chair of Botany, and a Lectureship in Physics, at Raffles College, Singapore (University of Malaya)—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (October 30).

Senior Lecturer in Botany at the New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (October 31).

Readership in Chemistry at the Royal Cancer Hospital—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 3).

Tutor in Social Case Work in the Department of Social Studies, University of Sydney—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (November 30).

Chair of Natural History in the United College, St. Andrews—The Secretary, The University, St. Andrews (January 31).

Graduate (young, preferably with honours in chemistry) to join a small research team working on an industrial problem—The Registrar, Loughborough College, Loughborough.

Analyst to take charge of analytical laboratory—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

Glassblower–Instrument Maker as technical research assistant in physical chemical laboratories, and a Bacteriological Technician for biological section of department of chemistry—The Steward, Chemistry Department, The University, Edgbaston, Birmingham 15.

Research Physicist or Engineer experienced in vacuum and high voltage work, to rebuild and operate a 400-kv. neutron generator and co-operate in biophysical research—The Secretary and House Governor, Mount Vernon Hospital and the Radium Institute, Northwood, Middx.

Geologists and Geophysicists in the Australian Bureau of Mineral Resources, Geology and Geophysics—The Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2.

Research Chemist for biochemical work on fundamental problems related to the nervous system—The Director, Neuro-Psychiatric Research Centre, Whitchurch Hospital, Cardiff.

Nutritional Adviser for service with the Control Commission in Germany—The London Appointments Officer, 1–6 Tavistock Square, London, W.C.1, quoting F.B.76.

Lecturer in Agriculture—The Secretary, Seale-Hayne Agricultural College, Newton Abbot, Devon.

Associate Professor of Electrical Engineering—The Electrical Engineering Department, College of Engineering, University of Tennessee, Knoxville, 16, Tenn., U.S.A.

Lecturer or Assistant Lecturer in Botany, with special qualifications in Cytology—The Registrar, University College, Exeter.

Assistant Government Chemist in Nigeria, for duties in connexion with water supply investigation—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Contemporary Issues. (Quarterly.) Vol. 1, No. 1, Summer 1948. Pp. 80. (London: Contemporary Press, 1948.) 2*s.*; 8*s.* per annum. [157

R.G.S. Research Series. No. 1: Glaciological Research on the North Atlantic Coasts. By Prof. Hans W:son Ahlmann. Pp. iii+83. (London: Royal Geographical Society, and John Murray, 1948.) 7*s.* 6*d.* [157

United Nations Economic and Social Council: Economic and Employment Commission, Sub-Commission on Economic Development, Second Session. A Survey of the Technical Assistance available for Economic Development in the United Nations and the Specialized Agencies. (Prepared by the Secretariat.) Pp. 62. (London: United Nations Information Centre, 1948.) [157

Personal Recollections of the Nobel Laureation Festival of 1947. By Dr. R. E. G. Armattoe. Pp. 62. (Londonderry: Lomeshie Research Centre, 1948.) 8*s.* 6*d.* [157

B.I.O.S. Overall Report No. 3: The Timber Industry in Germany during the Period 1939–1945. Pp. 16. (London: H.M. Stationery Office, 1948.) 6*d.* net. [157

British Standard 904:1948. Dimensions of Instrument Jewels. Pp. 12. (London: British Standards Institution, 1948.) 2*s.* net. [157

Other Countries

List of Scientific Papers published in the Middle-East. Pp. 37. (Cairo: UNESCO Science Co-operation Office, 1948.) [286

Proceedings of the Zoological Society of Bengal. Vol. 1, No. 1, March 1948. Pp. 78. (Calcutta: Zoological Society of Bengal, 1948.) 5 rupees (10*s.*); 10 rupees (20*s.*) per Vol. [286

Annals of the New York Academy of Sciences. Vol. 50, Art. 2: The Chemotherapy of Filariasis. By L. L. Ashburn, F. C. Bartter, R. N. Bieter, F. J. Brady, L. M. Brancone, T. Brey, L. G. S. Brooker, H. W. Brown, E. Bueding, T. A. Burch, M. C. Clark, L. T. Coggeshall, D. B. Cowie, A. C. Cuckler, J. T. Culbertson, R. W. Cunningham, E. M. Cranston, J. J. Denton, S. Halliday, B. K. Harned, R. I. Hewitt, S. Kushner, J. T. Litchfield, Jr., W. L. McEwen, T. H. Maren, J. Oliver-Gonzalez, G. F. Otto, L. Peters, H. M. Rose, D. Santiago-Stevenson, H. W. Stewart, Y. SubbaRow, R. J. Turner, R. E. Vessey, W. S. Wallace, D. E. White, H. N. Wright and N. N. Yuda. Pp. 19–170. 2.50 dollars. Vol. 50, Art. 3: The Inhibition of Malarial Relapses by Toxoid of *Clostridium tetani*. By Eusebio Y. Garcia. Pp. 171–186. 75 cents. (New York: New York Academy of Sciences, 1948.) [296

Columbia-Presbyterian Medical Center. The Department of Medicine, 1921–1947. By Prof. Walter W. Palmer. Pp. ii + 30. (New York: Columbia-Presbyterian Medical Center, 1948.) [296

Catalogues

Books on Archaeology and Folklore, Arts and Crafts, Atlases and Maps, Bibliography, Costume, History, etc. (Catalogue No. 690.) Pp. 116. (London: Francis Edwards, Ltd., 1948.)

Air-spaced Articulated Co-Ax Cables for Radio Frequencies. (Publication No. 27.) Pp. 8. (London: Transradio, Ltd., 1948.)

A Selection of Interest Books on a Great Variety of Subjects. (No. 657.) Pp. 80. (London: Bernard Quaritch, Ltd., 1948.)

Gas Carburising with Prepared Town's Gas. (GC. 648.) Pp. 8. (Watford: Wild-Barfield Electric Furnaces, Ltd., 1948.)

Microscopical Preparations. (Catalogue 'A'.) Ninth edition. Section L: Collections of Slides in Botany, Zoology, General Biology, Cytology, Geology, etc. Pp. 40. (Manchester: Flatters and Garnett, Ltd., 1948.)

Meteorological and Scientific Instruments. (Catalogue No. 684.) Pp. 144. (London: C. F. Casella and Co., Ltd., 1948.)

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SCIENTIFIC AND TECHNICAL MAN-POWER IN BRITAIN

AMONG the specific issues of policy on which the Advisory Council on Scientific Policy was asked to make recommendations shortly after its first meeting in March 1947 were the arrangements for securing an adequate flow of scientific man-power to meet the needs both of Government and of industry. One section of the Advisory Council's first annual report deals with this problem in some detail, and may well be regarded as the most important section of the report. Since the Barlow Committee recommended in May 1946 that the output of scientific workers should be doubled so as to provide about five thousand every year, it has become apparent that attainment of this expansion within the immediate future is improbable, if not impracticable under present conditions. Furthermore, while on one hand the desirability of an expansion at the recommended rate has been challenged on the ground of the probability of the supply exceeding demand, on the other, fears have been expressed that too large a proportion of the available new scientific talent is being attracted to the Government services and that industry is not obtaining the recruits it requires.

In dealing with this task of keeping under review the probable demand for scientific man-power and the measures being taken to meet it, the Advisory Council on Scientific Policy investigated four primary questions: the number of scientific workers and technologists already available; whether the prospective supply of such men and women in the coming decade is likely to meet the expected demand, and, if not, what further steps should be taken to increase the output; and whether the present distribution of scientific man-power between defence and civil requirements is satisfactory. The last of these is clearly the most important question at the present time; but the answer we give to it must depend partly on the situation revealed by the examination of the first three questions. In regard to the first of these, the Advisory Council has discussed with the Ministry of Labour and National Service the possibility of arriving at a more accurate estimate of the existing number of qualified men of science and technologists than the rough calculation of 55,000 given by the Barlow Committee in 1946. The Ministry doubts whether the Central (Technical and Scientific) Register ever included more than about 85 per cent of the qualified scientific man-power in Great Britain, and the Advisory Council accordingly asked the Ministry to make a new survey with the view of ascertaining the numbers available at the present time.

A large number of replies have now been received to the questionnaire issued at the end of October 1947, and analysis of the results is expected to provide a very useful picture of the scientific man-power now available in Great Britain, with full details of the experience, qualifications and occupations of those covered. Further detailed reviews of the man-power position in particular fields of science are being carried out by the Ministry of Labour, and these reviews should also contribute to the more difficult question of estimating the prospective demand for scientific workers. Some of the recent inquiries, such as that carried out by the Industrial Research Committee of the Federation of British Industries, are admittedly inadequate, and the figure of 70,000 given by the Barlow Committee as the minimum demand for scientific men in the United Kingdom and in the Colonial Service has since been questioned, as well as the further estimate that the effect of raising the school-leaving age and the increasing need for qualified workers in Government service and industry would raise this figure to 90,000 by 1955.

The Barlow Committee estimated that unless the output of newly qualified scientific workers was raised from its pre-war level of about 2,500 per annum to 5,000 we could not expect more than 64,000 to be available by 1955. According to the Advisory Council, the latest figures which have been obtained from the universities indicate that this level has almost been reached and that the present output, if maintained, is therefore likely to meet the anticipated demand. Against this view, it has been stated that the Universities of Oxford and Cambridge will only be able to admit about one in twelve of the student applicants for the academic year beginning this autumn. The Vice-Chancellor of the University of Manchester, Sir John Stopford, has spoken of intolerable overcrowding there, and has told the University Court that the number of students, at present 5,460, might reach 6,000 in October, but after that would have to be kept appreciably below 5,000 until the building programme was under way.

The shortage of accommodation, which has existed since the end of the War, for entrants from school has been due essentially to the policy of giving preference to ex-Service men; but the procedure has naturally reacted harshly on members of the younger generation too young to be called up for several years service in the Armed Forces. The waiting list of ex-Service men with a claim for preference is not yet exhausted, and the majority of those already admitted have still to complete their courses. While this position obtains, even if the standard of acceptances from school reaches a much more satisfactory level than one in twelve, not only must many young aspirants to a university education be disappointed, but also, and equally important for the assumptions of the Barlow Report, the age structure of the intake of scientific workers will be affected adversely, and a longer time will be required before the level is stabilized at whatever figure, whether double or treble the pre-war, for example, may be deemed desirable.

This factor may, however, prove of minor importance compared with the others, such as building extensions and the assembling and training of the teaching and research staff to deal with the increased number of students, which are involved in implementing such a long-term policy as that recommended in the Barlow Report. A Committee appointed by Nuffield College, in its report "The Problem facing British Universities"*, is of the firm opinion that, until additional financial resources can be translated into buildings and equipment, and additional staff collected, the doubling of the university population contemplated by the Barlow Committee is not possible, and even the present increase of a half over pre-war figures is excessive. The provision which the universities can make for other needs—extra-mural teaching, intra-mural part-time teaching, advanced research, and the wide range of advisory work exacted by the Government from university staffs to-day—is stretched to the utmost.

The Nuffield Committee statement casts a very critical eye over the demands for university expansion, and although the Committee appears to be sceptical as to the justification for doubling or trebling the university population, it is unfair to suggest that it is opposed to expansion. It is concerned rather with the best way of dealing with an increased demand in the immediate future, and with the dangers which may result from allowing limited and sectional pressures to distort the balance and scale of university provision. It casts few doubts on the employability of more graduates in the national life; but it is concerned as to the maintenance of the sanctity of university life.

The significant factors with reference to the report of the Advisory Council on Scientific Policy which are stressed by the Nuffield Committee are that the present demands for university expansion represent many conflicting and unco-ordinated pressures. In the aggregate, the estimated requirements of the professions, Government departments and industry for graduates represent a 60 per cent increase on the 1938 numbers. What does not appear to have been considered is how all these demands can be met without fundamentally altering the character and purposes of university education, particularly during the next ten years, when the shortage of teaching staffs is the most critical factor.

It is with this danger in university expansion that the Nuffield statement is fundamentally concerned. It admits the need for expansion, although it reserves judgment as to the magnitude required. It calls for better planning of existing resources, and for more thought about the aims and fruits of a university education. It suggests that before deciding when and how to meet some of the sectional demands for expansion, we should first consider those demands in the light of the fundamental purpose of the university. We may need a re-statement of the principles that should govern the life and work of a university if the demand for training for a career is not to be allowed to distort both the development and the functions of the universities.

The Nuffield statement puts these questions; but it does not attempt to indicate the answers. Its constructive suggestions are designed rather to ease the immediate pressure on the teaching staffs, and two of these are open to serious objection. The proposal to push back to the secondary schools a good deal of the instruction which is at present given in universities runs counter to a fairly general complaint that the schools are already giving much specialized instruction that should properly be given in the university. Certainly any increase in the influence of the university on the content of the school curriculum cannot be viewed without some concern that it may be detrimental to the interests of the many scholars who do not proceed to a university at all.

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* Nuffield College. The Problem facing British Universities. Pp. 131. (London: Oxford University Press, 1948.) 5s. net.

The second proposal is that universities in Britain should leave to the specialized institutions and technical colleges a good deal of the higher professional training that in the United States is undertaken by the universities. The Nuffield College Committee has in mind particularly the development of advanced schools for the study and teaching of engineering and other technological subjects and for the professional preparation of teachers, clergy and possibly others. The development in the United States as well as in Germany and some other European countries of such specialized institutions for advanced study and research is *prima facie* evidence that the suggestion deserves to be examined carefully. The Massachusetts and California Institutes of Technology and the *Handelshochschulen* of Berlin and Stockholm have assembled staffs and made contributions to research and teaching which few universities surpass. What chiefly distinguishes a university from them is a wider range of studies and a less specialized purpose.

Nevertheless, the separation of the study of engineering and other technological subjects from the universities and concentration in special schools, however closely located to the universities or friendly the association with them, has real dangers. In the first place, segregation of engineering and technological students in this way deprives them of the great benefit of a life shared with students in other fields, and may well encourage the narrowness of outlook so often condemned in the specialist. Conversely, not only have the students of engineering and other branches of technology a contribution to make to the corporate life of the university, sometimes out of proportion to their numbers, but also the teacher and investigator in these fields would, by such segregation, be deprived of the fertilizing and stimulating influence of close contact with colleagues working in such fields as mathematics, physics, chemistry and geology.

The first need, as the Nuffield College Committee rightly points out, is to define the specific function of the university and relate it to the functions of other institutions. In this matter of technical training, too, we need not only to be clear as to the justification for university facilities for any particular branch of professional or technological training, but also we need to recognize much more frankly that most occupations involve so restricted a range of theoretical or scientific knowledge that their technique can be acquired just as effectively and much more economically in the occupation than in a university. That is a consideration which bears closely on the correct distribution of scientific man-power, with which the Advisory Council on Scientific Policy is concerned.

A second conclusion reached by the Nuffield College Committee also touches that problem. Whatever the demands made on the universities, there is no possibility of meeting them unless the universities can draw from the schools a sufficient supply of undergraduates to be trained in accordance with those demands. Earlier in its report, the Committee endorses the view of the Barlow Report that in the present phase of expansion the universities must, so far as they are able, give the first priority to increasing the supply of university teachers and research workers. It then points out in this connexion that the fulfilment of even the sectional professional demands that are being pressed depends on the maintenance or improvement and extension of the general education given in secondary schools, and in particular that the universities must do all in their power to ensure that the schools can secure a regular supply of mathematicians, graduates in English and other languages, the classics and in science.

Complaints have been voiced that just as an excessive proportion of our scientific man-power is entering Government service rather than productive industry, so the staffing of schools with honours graduates in science of high ability is becoming increasingly difficult because of the more attractive and remunerative conditions in industry.

That is clearly a matter to which the Advisory Council cannot be altogether indifferent, although in its present report it merely considers the distribution of scientific man-power between defence and civil requirements. The question of higher technological training has been reserved for discussion in a separate report, and the survey of higher technical and other specialized institutions included in the Nuffield statement should prove a useful contribution to that discussion. The Advisory Council takes up the query raised by the Select Committee on Estimates as to the justification for the present distribution of Government research funds between civil research and defence research, and gives the estimate of about 13,700 scientific workers engaged in civil research as against 5,500 in defence research. The former figure includes 10,000 in industry, 2,500 in civil Departments of State and 1,200 in the research associations. The Advisory Council comments that much defence research and development is carried out by industry, while many scientific workers employed by the Government are concerned with subjects such as aeronautics and radar which have important civil applications, even when research and development are undertaken purely for defence purposes. The comparatively high Government expenditure on defence research as compared with civil research is due partly to the fact that the Government has to undertake directly or by contract all research or development for defence, whereas the main effort on the civil side comes from industry, and partly to the high cost of provision for development, design and prototype production in the defence field.

The Advisory Council has thus only touched the fringe of the general problem of scientific man-power, and in particular the question of distribution deserves rather fuller examination. The estimates of distribution in themselves merit analysis: on the figures quoted, qualified scientific workers employed by the research associations represented roughly some ten per cent of those engaged in Great Britain's total research effort, a proportion sufficiently high to warrant some examination of the question whether it yields a sufficient return in comparison with other forms of research effort. The whole question has a close bearing on the prospective supply, and it may well be found that the promised report on higher technological training will provide the occasion for a more adequate discussion of some of these issues, which require to be resolved before the form of university expansion over the next few decades is finally moulded.

CHRISTIAN HUYGENS

Christian Huygens and the Development of Science in the Seventeenth Century

By Dr. A. E. Bell. Pp. 220 + 7 plates. (London: Edward Arnold and Co., 1947.) 18s. net.

FOR many the most fascinating period in the history of science is the second half of the seventeenth century, the time when the foundations for the vast structures of to-day were laid with extraordinary sureness, solidity and speed. Newton, of course, was the supreme figure, a genius whose pre-eminence has been emphatically avowed by all men of science who have closely studied his achievement. The age was, however, rich in figures of outstanding gifts and accomplishment, and among them Christian Huygens holds a foremost place. He was, incidentally, one of the few to whom Newton paid generous tribute. Pemberton records: "But Sir Isaac Newton has several times particularly recommended to me Huygens's stile and manner. He thought him the most elegant of any mathematical writer of modern times, and the most just imitator of the antients . . .", the "antients" for whom Newton always expressed the greatest admiration. In the "Principia" he refers to "Sir Christopher Wren, Dr. Wallis and Mr. Huygens, the greatest Geometers of our time", and, acknowledging the gift of a copy of the "Horologium Oscillatorium", he writes ". . . Mr. Huygens's kind present, which I viewed with great satisfaction, finding it full of very subtle and useful speculations very worthy of the author. I am glad, that we are to expect another discourse of the Vis Centrifuga." Dr. A. E. Bell, whose book is before us, quotes the familiar "What Mr. Huygens has published since about centrifugal force I suppose he had before me", and adds "wrote Newton with some chagrin", which seems to be a quite unjustifiable comment.

That Newton had a just appreciation of the work of Huygens and fully understood it is significant, because Huygens signally failed to comprehend Newton's full achievement, although he realized Newton's greatness as a mathematician and as an experimenter. He criticized Newton's fundamental work on colour because it did not explain the ultimate nature of colour—"Besides, if it should be true that the rays of light, in their original state, were some red, others blue, etc., there would still remain the great difficulty of explaining, by mechanical principles, in what consists this diversity of colours". He did not understand Newton's "But to examine how Colors may be explained hypothetically is beyond my purpose". Huygens himself wrote little about colour, since the problem as he conceived it, to find a mechanical explanation, seemed to him intractable: "I do not think", he wrote, "that it would be easy to show what makes red or blue colours, nor am I much impressed in this matter by the Cartesian proofs. Certainly it has little or nothing to do with the geometrical method of reasoning."* He may not have been impressed by Descartes' particular views on colour, but nevertheless he himself was seeking a Cartesian type of 'explanation'. Again, he could not accept Newton's gravitating forces acting at a distance; but, although he rejected Descartes' particular way of explaining gravity by swarms of subtle particles, he himself published as late as 1690 a scheme which accounted for terrestrial gravity by a shell of particles round the earth behaving in a somewhat different way from that devised by Descartes. He never, apparently, really understood the essential nature of the advance made by Newton in his great hypothesis of universal gravitation.

To say this is not to disparage Huygens, whose fundamental achievements make a formidable list. His pendulum clock was the first accurate timepiece, and was based upon a thorough mathematical study of the compound pendulum and of oscillations in general; his discussion of centrifugal force constituted a fundamental advance in mechanics; his discovery of the rings of Saturn, a brilliant piece of observation, was conditioned by the great advance which he made in the construction of the telescope; his construction for the wave front by what is known as Huygens' principle is fundamental to physical optics and his treatment of double refraction showed the way for subsequent advances in crystal optics. This, which is only part of his record, is a sufficient performance, without crediting him with the wave theory of light, for which, in the ordinary sense, he can scarcely be held responsible. He is one of the really great figures in physics, and it is quite time that there was a book on him in English.

Dr. Bell's book is divided into two roughly equal parts, the first dealing with Huygens' life and the second specifically with his scientific work. This arrangement has the disadvantage that it leads to a certain amount of repetition, which even extends to a double use of the same phrases and quotations. The biography is simply set down, with a good discussion of the Cartesian influence, which, in spite of the fact that Huygens often disagreed with Descartes on mechanistic details, always remained strong. There is the usual denigration of Hooke: it is, of course, perfectly clear and just that Hooke was incapable of the beautiful mathematical development in which Huygens excelled; but it is not correct to say, as the author does, that Huygens showed as wide a range of activity. I can only suppose that he has forgotten Hooke's work in geology, physiology and architecture, as well as the extraordinary scope of his invention.

The matter of aerial, or tubeless, telescopes is not very clearly handled: the original suggestion came from Auzout, and, so far as I know, no successful use was ever made of them, as anybody who has tried to set up even a model can readily understand. Huygens presented to the Royal Society in 1691 an object glass of 121 ft. focal length, with eyepiece and subsidiary equipment for an aerial telescope. Somewhere about 1844 Admiral Smyth thought of trying to erect it; "the trouble, however, promised to be so much greater than the object appeared to justify that I laid the project aside". The impracticability of the device is not made clear in the book: a plate of the proposed instrument would have helped, and might have replaced, say, that of the Sebastian le Clerc engraving showing Louis XIV visiting the Académie des Sciences, of which the small half-tone reproduction gives little notion. Huygens' philosophical outlook receives some attention. There are many points, such as Huygens' visits to England, on which one would have liked a little more information; but naturally not much detail is possible in the hundred-odd pages devoted to general biography.

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* "Colores autem quid puniceos faciat aut ceruleos non facile ostendi posse existimo; neque hic multum Cartesianis demonstrationibus permoveor. Certe ad Geometricas rationes minime pertinet."

The chapter that introduces the treatment of Huygens' scientific work contains the remarkable statement: "The history of this mathematical treatment of phenomena is usually somewhat briefly dismissed, as if it all resulted from the insight of Galileo and Newton—and all the rest were fools". I wonder what writers Dr. Bell had in mind when he wrote this and the sentence ". . . it is simply not true that the dawn of the seventeenth century brought a universal belief in the operation of physical law and a discredit of magic and mystical agents". Did anybody ever suggest that it did? Huygens' work on impact is well summarized in one chapter. Very properly, a relatively considerable space is devoted to the "Horologium Oscillatorium", a book which contains, besides a detailed description of the pendulum clock, the fundamental work on oscillation in a cycloidal arc, on evolutes—which stresses the interest of the cycloid—and on the compound pendulum, the researches that established the centres of oscillation and of percussion. As Dr. Bell justly says, the fact that Huygens used geometrical methods instead of calculus for finding the moment of inertia makes this troublesome matter for the average reader of to-day. Incidentally, it has been suggested of Huygens, as it has of Newton, that he himself used analytical methods and afterwards threw the work into geometrical form, as being the gentlemanly way to do things. "Quoiqu'elle y soit exposée en grande partie suivant le style de l'ancienne Géométrie, on ne peut douter que l'analyse de *Descartes* ne soit le principal instrument dont il s'est servi", says Montucla. Dr. Bell also directs attention to Huygens' proposal to use the length of the seconds pendulum as a standard of length. It is not, of course, suitable, depending as it does on g, but it is the first indication of a search for a not completely arbitrary unit. The "Traité de la Lumière" is well handled in a chapter headed "The Wave Theory of Light", although the author properly points out that it is not really a wave theory in the modern sense but rather a pulse theory and that the conception of periodicity is nowhere introduced. The construction for the wave front and the wonderful treatment of double refraction are the fundamental advances made by Huygens. The work on geometrical optics that enabled Huygens to make good—and short, manageable—telescopes is briefly described, as are the Saturnian discoveries and the attempts to 'explain' the earth's gravitational field. A separate chapter is devoted to the posthumous publication, "Cosmotheoros", in which Huygens argued that the planets are probably inhabited. This little book achieved some popularity; it appeared in several languages and an edition of the English translation was published as late as 1757. It is, however, strange that Dr. Bell says nothing of "De Ratiociniis in Ludo Aleæ", a little work on probability of which Todhunter records, "This treatise of Huygens continued to form the best account of the subject until it was superseded by the more elaborate works of James Bernoulli, Montmort and De Moivre", nor of the work on coronæ and parhelia. They are surely worthy of mention, at least.

It is, of course, poor criticism to reproach an author for not having done what he has not attempted, and to many criticisms that might be made Dr. Bell would probably reply that he had not written a book for experienced students of the history of science, but for average readers. This, for example, would excuse the omission of any attempt at a bibliography of Huygens' books. It is, however, scarcely an excuse for the almost complete lack of references to sources or, still more, for the great carelessness shown as to names and dates. In the preface Thomas Power is cited when Henry Power is meant; the letter quoted on p. 45 was written by Sprat and not by Bishop Wren; on a single page the titles of two books by Kepler and one by Bartholinus are misspelt. These are but examples. Every author knows that a certain number of typographical errors are unavoidable, and there is no point in citing the number that this book contains. There are, however, too many bibliographical errors—Schott's "Mechanica Hydraulico Pneumatica" is not mainly about perpetual motion; at one place we are told "In 1674 appeared Hook's *Micrographia* with its astonishing mixture of skilful observation, pregnant intuition and mathematical insufficiency", although the correct date, 1665, is given elsewhere; the date cited for Kepler's "Epitome Astronomiæ Copernicæ" (1635) would make it a posthumous work, the true date of the first edition being round about 1620, and so on. These points are not mentioned in a carping spirit, but as indicating that the serious reader must be careful in taking facts from this book without verification. There is much, in fact, to indicate that Dr. Bell has not spent too much time with the books with which a writer on Huygens should be familiar. The "Short Bibliography" given at the end of the book "limited to comparatively modern publications" is also disturbing. It makes no mention of Bosscha's book on Huygens; the German history of physics that it quotes is one of the oldest and least informative; there are no references given for Huygens' mathematical work; if Delambre's history of astronomy is allowed in as a "comparatively modern" work, then Montucla's history of mathematics undoubtedly earns a place. Incidentally, the issue of Newton's "Principia" quoted as "English translation by F. Cajori 1934" was a re-issue of Motte's translation of 1729, although anyone might be pardoned for overlooking the fact. Complaints about the index are a failing of reviewers; but the index here is really deficient. I have noted well over fifty names that are mentioned in the text, many of them more than once, that are not indexed, and under the names indexed only about half the references that actually occur in the book are cited. Subjects are treated in the same perfunctory manner.

The reviewer would not be thought ungracious. He is grateful to Dr. Bell for having produced a book on Huygens and for having sent him for many hours back to the original sources. The book will be useful as giving a brief and readable account of the work of that great pioneer, and, no doubt, widely read. It does, however, require a thorough revision, however modest its aim may be, and it is to be hoped that, by the time that a second edition is called for, the author will have extended his researches.

E. N. DA C. ANDRADE

SPOT TESTS

Qualitative Analysis by Spot Tests, Inorganic and Organic Applications

By Dr. Fritz Feigl. Third completely revised English edition, translated by Prof. Ralph E. Oesper. Pp. xvi + 574. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1947.) 43*s*. net.

ONE of the most striking features of recent developments in qualitative and quantitative analysis has been the increasing use made of micro- or semimicro-methods. This is not, indeed, a modern branch of analysis; some of the old masters worked with very small quantities of materials. Wollaston's laboratory, we are told, consisted at one time of a tray containing watch-glasses, a blowpipe, and similar unimpressive objects, and when he had occasion to need a little calcium phosphate for a blowpipe test, he supplied it by scrapings of an ivory paper-knife. Berzelius created nearly all the chemistry of vanadium with a few grams of material. The so-called spot test, with which the present treatise deals, is also an old friend to most chemists; the use of test-papers and of an external indicator in titrations are examples of its early use.

There comes a time in the history of most branches of science, however, when some enthusiast sees the possibility of large extensions of a method, and by devoted and single-purposed work enlarges the field of some modest plot of knowledge until it becomes an imposing park, stocked with the most bewildering variety of forms. This task has been well performed for the spot test by Prof. Feigl, formerly of the University of Vienna and now in the Ministry of Agriculture Laboratory, Rio de Janeiro, who is well known to all chemists as the leading authority in this branch of analysis.

The book is a complete monograph. It deals with apparatus and technique, with methods, reagents, the exact details of procedure, and the results which may be expected. The field of application embraces metals, acid radicals, free elements, mixtures, organic compounds, and technical materials and minerals. In all cases, the most careful attention to detail is given, so that no user of the book who wishes to carry out any test described in it can have any doubt as to what he must do. Very full references to the literature are given (very few after 1939, and these mostly to the author's own papers), and there is a tabular summary and full indexes.

The reviewer looked up several examples of what might be expected to be found in the book, and was disappointed only once (salicylic acid). In his opinion, the book will find a welcome in all chemical laboratories. The use of spot tests in teaching is a matter on which divergent views will be held, and the reviewer does not think the present book is suitable for general use by students. A separate book, "Laboratory Manual of Spot Tests" (New York, 1943), has been written by Prof. Feigl for this purpose. A feature which struck the reviewer is the extending use which can be made of spot tests in organic analysis; according to the author, this branch of the subject dates only from 1928, and the extensive use of organic reagents in inorganic chemical analysis is also a newer development. Although the remark is not relevant to the present book, the reviewer would like to suggest that more attention should be given in teaching to the reduction in the quantities of materials used in organic preparations by students. There is little point in the teacher in the inorganic laboratory training a student to work with very small amounts of material and with small apparatus when the student, on entering on his training in organic chemistry, is encouraged to work with hundreds of grams and with large bolt-head flasks, as is too often the case because the laboratory manuals specify these quantities. Not only is unnecessary expense incurred, but also the student grows up with an increasing inability to work with the small amounts of material he will normally have available in research work. It has been the reviewer's experience that much of what the student has been taught in the course of quantitative inorganic analysis is undone in subsequent work in the organic chemistry laboratory, where the dirty bench and abundance of material are too often the rule. A short course of work on the lines of Prof. Feigl's manual would do much to restore a sense of proportion.

J. R. PARTINGTON

'HILLBILLY' FOLK-LORE

Ozark Superstitions

By Vance Randolph. Pp. ix + 367. (New York: Columbia University Press; London: Oxford University Press, 1947.) 21*s*. net.

THE Ozark country, or Ozarkland as it is sometimes called, covers some fifty or sixty thousand square miles and extends over the southern half of Missouri, the north-west of Arkansas and a few counties in Oklahoma. Although it is often considered to be a mountainous country, the hills are scarcely more than about two thousand feet, and the country consists of wooded land, gorges and ravines.

The name was first applied to this region by French-Canadian trappers, and the origin of the word is still in dispute, some maintaining that it is derived from Aux Arcs (*bois aux arcs*, wood for bows) and others thinking that it is connected with Azoic Arc. However that may be, the highland country was first settled early in the nineteenth century, and since then, largely owing to the bad soil and poor communications, the region has been to a certain extent isolated, and so has preserved many of the old folk beliefs and customs.

In the present volume Mr. Vance Randolph, who has already written a study of the Ozarks in which he deals with what he calls an "American survival of primitive society", has collected a number of the popular beliefs and practices which are still to be found by the field worker in this region. He attributes the survival of many of these beliefs to the fact that the people made little contact with the outside world since the pioneers came west from the Southern Appalachians. Although many Americans regard these 'hillbilly' people almost as foreigners, the fact is that many of them are of British stock and have been in America since colonial days.

In his discussion of Ozark folk-lore, Mr. Randolph has divided his material into subjects, and the book is really a collection of articles in which the beliefs and superstitious practices of the people are merely assembled without any analysis. In effect, the volume is little more than a catalogue in narrative form, and as such is certainly a useful compilation in view of the well-arranged index. Passing from beliefs on weather signs, the author goes on to discuss matters connected with crops, domestic management and water finders. These water witches or 'witch wigglers' are clearly ordinary water diviners or dowsers, although Mr. Randolph gives no indication that he is aware of these widespread beliefs. Moreover, it is a little difficult to understand why, when seeing one of these dowsers at work, the author should have "shivered" and felt as if the hair was rising on the back of his neck, a fact which he himself explains by maintaining that there was something "uncanny and obscene" about the divining rod.

Much of the folk-medicine and folk-beliefs concerning pregnancy and childbirth could be paralleled elsewhere, and it would be an interesting study to see how far these could be traced to early British sources. Although from what Mr. Randolph has said it would seem that Ozark superstitions are commonly held and of great variety, it would be a mistake to suppose that similar collections could not be made for other regions in which the population has not been cut off to the same extent as those living in Ozarkland. It is true that the superstitions of these less isolated communities would differ radically from those held in the Ozark highlands, but anyone who receives the lavishly produced catalogues of talismans, amulets and charms which circulate in the United States and who reads the advertisements in the newspapers of California and the Middle-West, will conclude that a study of these superstitions would be as entertaining and informative as those of the Ozark country here so assiduously collected by Mr. Randolph.

E. J. Dingwall

RECLAMATION OF THE LAND

Land Reclamation

By P. J. O. Trist. Pp. 178 + 15 plates. (London: Faber and Faber, Ltd., 1948.) 15*s.* net.

THIS book gives an excellent account of problems facing the officers of the war agricultural executive committees in their task of increasing food production during the War. It was essential national policy that as much food as possible should be grown at home, and that so far as possible every acre of potentially good land should be cultivated. But several decades of agricultural depression had left their mark in thousands of acres of land being abandoned or being so badly farmed that in 1939 they made no worthwhile contribution to the national larder. Much of this land was potentially fertile; it was merely costly and difficult to keep in good heart and in many areas it had broken most of the farmers who were trying to get a living off it.

Mr. Trist confines himself to the problems facing the Essex Committee, of which he was first a district officer and then the cultivations officer, in deciding which under-farmed or derelict areas should be reclaimed, and the method of reclamation to be used. The soils involved were mainly heavy clays, either in derelict pasture or thorn scrub, and the work involved included clearing hedges, cleaning out ditches, seeing to the drainage system, and discovering the best methods of doing the critical cultivations before a crop was sown on most of the land. On some, however, the far more difficult problems of bush and scrub clearing had to be undertaken. All the multitude of problems arising from lack of experience, shortage of the proper tools and of suitable foremen for the large unskilled and often unwilling labour force that had to be drafted on to the land are dealt with clearly and at sufficient length for the intelligent general reader to appreciate the difficulties that had to be overcome in successfully carrying out these reclamations.

The book has also a great historical value, for it gives a very good account of the workings of many war organisations, such as the set-up of the county war committees, the difficulties of employing and limitations in using the various types of labour that had to be drafted on to the land, and many other of the day-to-day problems that arise when a great effort is needed to increase food production. Let us hope that the agricultural policy of Great Britain will continue to encourage the farming community to keep all their land at a high level of productivity, so that the lessons learnt during the War will not have to be slowly re-learnt if a future emergency arises.

E. W. Russell

EGG-LAYING BATTERY MANAGEMENT

Eggs from Every Cage

Describing Laying Battery Management. By H. E. Swepstone. Pp. 83. (Worcester: Littlebury and Co., Ltd., n.d.) 7*s.* 6*d.* net.

MR. SWEPSTONE has written a book on laying batteries which should be of great value to the large number of beginners who are interested in this latest system of commercial egg production. The battery system is equally suitable for the domestic poultry-keeper with half-a-dozen birds, the commercial poultry-keeper and the general farmer, so that this useful little book should have a very wide reading public. The author has had twenty years experience of poultry-keeping, and after trying several methods he states that the best of all is the single hen laying battery. In fact, he would rather give up than attempt commercial egg production on any other lines. Surely this is ample testimony of the efficiency of this system.

This book is written by a practical man who has made a success of the battery system, and it provides all the information that the beginner is likely to require. There are excellent chapters and diagrams on the construction of houses and cages, the best way to start and the right management to get satisfactory results. The arguments in favour of starting with day-old pullets, or partly grown birds, are fully explored, and the man wishing to rear his own replacement stock will find the chapter on intensive rearing very helpful.

The method of accounting is well explained; but the figures of costs and returns would be very much more helpful to the beginner if they could have been converted to present-day values rather than pre-war. In his foreword, Mr. Swepstone asks the reader to substitute current prices for those given, and although this may present no difficulty to the experienced poultry-keeper familiar with the trend of prices, it is not so easy for the beginner, to whom the book will have the greatest appeal. Nevertheless, this handy little volume is well written in practical language and should be on the bookshelf of every poultry-keeper.

T. E. Whittle

SOME BIOLOGICAL ASPECTS OF COLONIAL DEVELOPMENT*

By SIR FRANK STOCKDALE, G.C.M.G., C.B.E.
Colonial Development Corporation

CONSIDERABLE interest is being taken by the people of Britain in Colonial development at the present time, and great importance is attached to the further development of Colonial territories in the interests of their inhabitants, the Commonwealth and the world.

In some quarters, extravagant views have been expressed as to the extent and the speed at which deficiencies of foodstuffs and raw materials in Europe can be met from the Colonies; but such views display ignorance of Colonial food requirements, social customs and habits, the poverty of their soils, the vagaries of rainfall, and the hazards from pests and diseases of crops, animals and men. Many of the Colonial peoples themselves are anxious to see the execution of projects which will develop the natural resources and provide them with a wider field of occupation and standards of living; but the road to achievement will only be traversed successfully if there is careful and sympathetic planning and persistent efforts to overcome difficulties.

Government Policy

Government policy is designed to improve and extend the public services and encourage economic progress so far as natural conditions and resources permit. Twenty years ago, a Colonial territory could only obtain financial assistance for active development through a guaranteed loan, but the Colonial Development Act of 1929 and the subsequent Colonial Development and Welfare Acts of 1940 and 1945 provided increasing State help for Colonial territories for post-war plans and centrally administered schemes of research, education and training, and these plans were designed to lead to better nutrition, water supplies, housing and communications, and in turn to better methods of production and higher standards of life.

To secure expanded economic development, the Overseas Resources Development Act was passed in 1948 establishing the Colonial Development Corporation with a capital limit of £110 million, and the Overseas Food Corporation, capital £55 million. The latter is charged with the execution of the East African Groundnut Scheme, and the former is to undertake projects to aid Colonial development generally, its activities covering agricultural, fishing, forestry and mining enterprises as well as industrial, processing and manufacturing undertakings. All projects must be financially sound, and it is the Corporation's intention to supplement, not supplant, private enterprise. It has already a considerable number of projects under consideration, and several have been investigated on the spot. It will start some projects this year, although shortages of basic materials must involve some delays.

Biological Factors

Biological factors have to be taken into account in Colonial development—particularly in Africa.

Population Issues. The increasing populations, their irregular distribution and the drift to the urban areas, emphasize the need for increased production of foodstuffs for local use; and greater occupational diversification is necessary in order to secure a more balanced economy.

Tsetse. Several species of tsetse flies occur on the African Continent and are responsible for the transmission of diseases to man, game, and domestic stock—accounting to some extent for the uneven distribution of populations and domestic animals. The area in which tsetse occurs is estimated to be seventy-five times the size of the United Kingdom. Tsetse flies are found in more than two-thirds of Tanganyika, and outbreaks of trypanosomiasis still occur. Whereas trypanosomiasis is under better control, thanks to increased knowledge and the production of better organic compounds with prophylactic and curative properties, the movement and resettlement of villages is still necessary. Tsetse research work of the past twenty years, including the study of the bionomics of the species and the ecological factors governing their control, has gradually built up a mass of information of the greatest value. It has been established that tsetse flies are susceptible to changes in environment brought about by clearing or thinning the bush, and successful reclamations of areas from tsetse have been achieved by bush clearing, provided that the subsequent tree-growths in the areas so dealt with have been kept in check. Progress, however, is slow, and large-scale clearing operations, such as those being undertaken by the East African Groundnut Scheme, may show the way to bring tsetse-infested country more rapidly into economic production; but no one can be satisfied about the present position. This is recognized by the authorities. Steps have recently been taken to place tsetse research under central direction, and international collaboration is also being secured on trypanosomiasis. Plans are also well advanced for insecticide dissemination by aircraft and helicopters, though the wholesale use of the new insecticides is not without danger, as many useful insects may be eliminated.

Livestock Diseases. In many parts of Africa these remain a factor which controls the development of animal industries and more satisfactory systems of agricultural husbandry. Rinderpest, the most serious of cattle diseases, still occurs in several territories; and although it had been hoped that in East Africa a check had been made on the disease, there have been recent outbreaks in Tanganyika, all the more serious because of the small number of veterinarians at work in the field.

Locusts. Crop losses of considerable magnitude have been experienced in the past in Africa from swarming locusts; but the extensive campaigns for the control of the desert locust in East Africa, and the successful control of the red locust in Tanganyika, have established the fact that locust plagues can be checked before they assume dangerous proportions provided the outbreak areas are supervised and timely action taken against incipient swarms. Spraying from aircraft can be applied effectively, and it has been clearly established that the results of the patient research work of the last twenty years, which are now being applied, are paying dividends.

Termites. Termites still remain unchecked and cause heavy unrecorded losses throughout the Colonial Empire. There is no British authority in the United Kingdom who has specialized in termites and their control, and it does seem high time to provide for a survey of the termite position in

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* Substance of a paper read before Section D (Zoology) of the British Association on September 10.

Colonial territories and for planned research. The establishment of a post at the British Museum (Natural History) for the specialized study of termites has been recommended; but a team for the scientific study of termites and the evolution of satisfactory control measures is warranted. A considerable amount of local knowledge is available in the Colonies about termite damage and the resistance of certain hard-wood timbers to attack. This knowledge requires to be collated and expanded by scientific research, and control measures need to be more generally adopted.

Pests and Diseases. Pests and diseases of plants and animals are also factors which have to be kept in mind. In addition to rinderpest, I need only mention certain virus and fungus diseases, such as the 'swollen shoot' of cacao in the Gold Coast, the 'sudden death' of cloves in Zanzibar and Pemba, the witches' broom disease of cacao in Trinidad, the Panama and leaf-spot disease of bananas, and then pass on to the pests of cotton.

The need for increased supplies of cotton from within the sterling area is great, especially at the present time. Owing to the research work of the Empire Cotton Growing Corporation and other specialists, many new types of cotton suitable to different areas and resistant to some pests and diseases have been evolved. Crop losses from jassids and other pests and certain virus diseases have been checked by breeding new resistant types. 'Stainers' are troublesome but not limiting; but the red boll worm (*Diparopsis castanea*) is the most limiting, and definitely controls expansion of cotton growing in large areas of Central, East and West Africa where the climatic regime consists of a single rainy season followed by a long severe dry period. Effective agronomic methods have been devised; but the use of insecticides may be necessary before cultivation can be expanded without undue risks in large sections of the continent.

Importance of Food Supplies

We in Britain are well aware of the shortages of food supplies; and in certain Colonial territories the people have not enough for satisfactory nutrition. Insufficiency of the B-vitamins, hungry periods between the seasons, serious shortages when the rains fail, definite protein starvation—particularly in the southern parts of the West African territories—all exist. Throughout the Colonial Empire there is a great need for wider variety in diet and a much greater consumption of protein foods if extra effort is to be expected in developmental projects. In Africa, it is probable that the growing populations will absorb the bulk of meat supplies available in the near future, and Colonial Governments must give the highest priority to the food needs of their people and to the stimulation of increased local production of crop and animal products.

Fishing. The fishery resources in the waters of Colonial territories have been neglected too long, and a wide field is open for development by the application of modern technology. The first stage is to establish a measure of the availability of fish in terms of the yield per unit of human and material effort expended in their capture and distribution, and then determine the level to which exploitation can safely be developed. Practical tests are an urgent need.

At a later stage it will be necessary to build up a body of basic scientific knowledge of the fisheries so that the level to which exploitation can safely be developed can be determined.

An ambitious programme of research has been planned, including the development of freshwater fisheries and the establishment of fish farming in several areas. There are obviously vast possibilities of increasing fish supplies by fish farming, and a Government training and research centre is to be established in Malaya.

The whaling industry has been developed largely as the result of the whale fishery investigations of the "Discovery" Committee of the Colonial Office. This industry is an example of complete dependence on fundamental oceanography and marine biology. Through this work the vast biological productivity of the southern oceans is made available for human needs, with a reasonable assurance of a maximum sustained production.

Mechanical Aids to Colonial Agriculture

Colonial agriculture is dependent largely upon peasant producers—many of whom grow their crops on small areas for subsistence purposes. In the main, their husbandry methods and animal industries can be greatly improved, though with the existing tools and the methods in vogue increased productivity is difficult to achieve. The requirements at present are to secure better organisation of farming operations and to test the value of fertilizers and mechanical aids. The effects of the introduction of mechanical implements on the farming economy and the social organisation of the people will require careful study and investigation, as their introduction will necessitate farming units of a larger size, whether cultivated individually or communally. The possibilities of increased soil erosion and dangers from pests and diseases must not be overlooked. Useful lessons will doubtless be learned from the East African Groundnut Scheme.

The East African Groundnut Scheme

There is no doubt that the world shortage of edible oils made it essential that this project should be undertaken. It will have an important influence on the agriculture of Tanganyika and on Colonial development generally. I have recently had an opportunity of paying a short visit to the Kongwa area, where the speed at which equipment could be assembled for bush clearing, cultivation and harvesting has been much slower than had been anticipated. Much of the equipment had to be reconditioned or modified and some new implements evolved; but many of the technical difficulties on the mechanical side have now been overcome, and those responsible are to be congratulated on their achievements. Unforeseen difficulties had to be expected and allowed for—this is always the case in pioneering ventures—but the groundnuts and other crops this year have been free from any serious attacks from pests in the Kongwa area, except for damage to the sorghums in the experimental area. There has been some loss of certain groundnut varieties from wild pig; but no occurrence of the virus disease, rosette, which is capable of causing serious losses, has, so far, been detected. It is very necessary, however, that the research work undertaken by the scheme should be well in advance of requirements, so that outbreaks of rosette and of other pests and diseases can be met when they arise.

An extensive programme of field trials to investigate crop rotations, fertilizer needs, cultivation methods and groundnut varieties, as well as a large series of observation plots with a wide range of crops have been put into effect this year, and valuable lessons have already been learnt. This work has been given the highest priority, and steps have recently been taken to increase the scientific staff. It is to be hoped that arrangements will also be made for the testing of a wide range of groundnut varieties for resistance and immunity to rosette disease in an area of the territory where the disease occurs in some abundance, as in my view such work can only be regarded as a necessary insurance.

Conclusion

A considerable increase of basic knowledge is being built up as the result of Colonial research work; but there are still gaps in our knowledge. The application of the results of research work also leaves much to be desired. The strengthening of the staff of the British Museum (Natural History) appears to be desirable in the interests of Colonial biological research. Termites, in particular, require further study. It is also necessary that early steps be taken to enable Kew to produce a Flora of East Africa. Such a Flora is not at present available, and its production is essential for further ecological work in the East African territories and for the use of biologists working in these territories.

HIGHER EDUCATION IN THE COLONIES

IT was a graceful gesture by the Sixth Congress of the Universities of the British Commonwealth to devote its concluding session on July 23 at Oxford to a discussion of higher education in the Colonies, and thus to recognize and welcome the youngest members of the academic family.

The discussion, under the chairmanship of the vice-chancellor of the University of London, Prof. Hughes Parry, was opened by Sir Alexander Carr-Saunders with a sketch of the general plans for developing university institutions in the British Colonies and in the Sudan. In addition to the two existing Universities of Malta and Hong Kong, there will soon be, in Malaya, a third university if the proposals of the recent commission are adopted for the fusion of the King Edward VII College of Medicine and Raffles College. Five new university colleges are being established, two on the basis of existing institutions, Gordon Memorial College, Khartoum, and Makerere College, Kampala, serving the East African territories, and three as new foundations, University College, Ibadan in Nigeria, the University College of the Gold Coast, and the University College of the West Indies in Jamaica. These five university colleges are autonomous corporations, governed by councils the composition of which ensures that they are broadly representative of the interests concerned in their territories, including Government, and include an effective proportion of academic staff representatives. Control of all academic matters is vested in academic boards, composed wholly of members of the staff. The students at these colleges will sit for the degree examinations of the University of London, with which the colleges will be "in special relationship". By this arrangement, the University of London, while retaining complete control over the award and standards of its own degrees, is prepared to devise, in consultation with the colleges, syllabuses appropriate to the needs and opportunities of the territories and to associate the local staffs in the setting of papers and marking of scripts in the examinations. After gaining experience in constructing syllabuses for special degrees, in conducting local examinations and in establishing firm standards, the colleges will in due course seek degree-granting powers and become independent universities.

A sum of six million pounds from central funds administered on the advice of the Colonial University Grants Committee is available as a contribution towards the capital needs of this programme (excluding the developments in the Sudan). Grants for recurrent expenditure will have to come chiefly from the local governments, and arrangements are being made for such assistance to be given as block grants for quinquennial periods to ensure a proper degree of independence for the colleges. Academic assistance, technical advice, library services and co-operation in a variety of ways from the home universities is provided through the Inter-University Council for Higher Education in the Colonies. The critical need in the next phase of carrying through these plans for a new university and five new university colleges is for properly qualified staff. The conditions of service, the salaries, the academic freedom, the research opportunities, the responsibility of the work make service in these university institutions attractive, and every effort is being made by Inter-University Council visits and other means to overcome some of the disadvantages that formerly existed in Colonial work such as the relative isolation. Sir Alexander Carr-Saunders concluded by appealing to the Dominion universities to interest members of their staffs in serving in the Colonial institutions, either in permanent appointments or on temporary secondment.

In the discussion which followed the opening address, Mr. Lewis Wilcher, principal of Gordon Memorial College, and Dr. Kenneth Mellanby, principal of University College, Ibadan, paid tribute to the assistance given to their colleges by the Inter-University Council and by the University of London. Mr. Wilcher reported that Gordon College hoped to obtain independent university status within ten years, and emphasized the value of the services which higher education had to render to the Sudanese in their rapid progress towards self-government. Dr. Mellanby stated that University College, Ibadan, was beginning in temporary buildings near the permanent site of five square miles which the Nigerian Government had presented, in addition to making a contribution of £500,000 towards the recurrent expenditure of the College in the first quinquennium, and an initial grant of £250,000 to an endowment fund. The College would have two hundred students in residence for the session 1948–49, and expected an annual intake of a hundred. Local groups were springing up throughout Nigeria to collect funds to be placed at the disposal of the College for awarding scholarships.

Mr. H. R. Raikes, vice-chancellor of the University of the Witwatersrand, hoped that the Colonial medical schools would ensure that the students' training made full use of the special opportunities provided by the local clinical material and experience, and pleaded that dentistry should be treated as of equal importance and urgency as medicine; he suggested that external examiners going to the Witwatersrand from the

United Kingdom should be encouraged to visit the Colonial medical schools *en route*. Dr. E. G. Malherbe, principal, Natal University College, stressed the dangers of mass literacy campaigns and elementary education in Africa in exposing the peoples to irresponsible propaganda and to some of the less-desirable features of Western civilization if they were not accompanied by the parallel process of providing the enlightened leadership and critical interpretation which the Colonial university institutions would give.

Dr. J. W. Davidson (Wellington University College, New Zealand) directed attention to the danger of importing into the Colonies European standards and conceptions of university education insufficiently adapted to the conditions and interests of the local communities, and thus losing deeply rooted popular support for the new colleges. Prof. A. R. Humphreys, of Leicester, suggested that a practical step to remove one of the deterrents to recruitment, namely, fear that it would be difficult to return to home university posts, would be the prompt and systematic notification of appropriate vacancies to staffs serving overseas.

Principal H. J. Page described the activities of the Imperial College of Tropical Agriculture, Trinidad, the primary task of which is postgraduate training in tropical agriculture of students entering the Colonial agricultural services; a secondary function has been training students, chiefly from the West Indies, for a local diploma. The College hopes soon to co-operate with the University College of the West Indies in providing teaching for the London degree in agriculture. Mr. Bernard Williams, dean of the Medical School, described the plans for opening the Faculty of Medicine of the University College of the West Indies in October, the special problems created by the scattered territories of the West Indian Colonies, the assistance which the College had received not only from the Inter-University Council and University of London, but also from McGill University, and the methods by which it was hoped to overcome the technical difficulties in the secondment of clinical teachers.

Prof. W. E. Dyer, principal of Raffles College, Singapore, stressed the importance of the secondment of university teachers to the Colonial colleges as a means of reducing the isolation and fear of loss of academic status of the local staffs. Prof. F. L. Warren, Natal University College, considered that one reason why a greater number of French than British scholars had remained in service in Egypt was that staff seconded there from the Sorbonne or University of Paris were granted in two years the seniority which would accrue from three years service in France; he suggested that the overseas institutions would attract visiting specialists if they made it known that they could offer working facilities and cheap residential accommodation, such as were provided for visiting astronomers and marine biologists in Egypt.

Prof. Lillian Penson, of the University of London, in concluding the discussion, stated that every effort was made, through full consultation with local opinion and by other means, to harness the sympathy and support of the peoples to their university colleges, and that, far from any forcing of standards by the University of London or the Inter-University Council on the local communities, the demand for the highest standards and nothing less came from the peoples themselves. Secondment on temporary service to the Colonial colleges gave an opportunity of attractive work; from her knowledge of the quality of Sudanese students, she felt confident that staff need have no fear of lowering standards; and the risk of isolation or of being lost sight of was greatly diminished by the work of the Inter-University Council, particularly by its regular visits.

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON

By Dr. J. A. V. BUTLER

Many scientific workers will have heard, with regret and possibly incredulity, of the impending closing of the Princeton Laboratories of the Rockefeller Institute for Medical Research. The decision to close these Laboratories and to concentrate the work of the Institute in New York was reached in the spring of 1947. The Laboratories are to be closed by 1951; but if an acceptable offer for the site and plant is received before then it will be accepted. Any members of the staff who wish to do so may continue their work in the New York Laboratories.

It would be impertinent to question the reasons which have led to this decision; but friends of the Laboratory, as well as many who have been privileged to receive its hospitality, will be distressed that it should be necessary. The founding of the Princeton Laboratories was a logical consequence of the policy of the Rockefeller Trustees to provide facilities for the study of disease in all its manifestations, in animals and plants as well as in human beings. This policy was magnificently justified by the results achieved, and to an onlooker it seems a grievous and deplorable loss to science that it should be found necessary to reverse it.

The Rockefeller Institute began its work in a temporary building under Dr. Simon Flexner in 1904. The present New York buildings on a site overlooking the East River were begun in 1906 and have provided both a hospital for the study of special diseases and a wide range of laboratories covering all branches of biochemistry and physiology.

The policy of the Trustees to study disease in all its forms led to the establishment in 1914 of the Department of Animal Pathology with laboratories on a country site near Princeton, under Dr. Theobald Smith, who was succeeded in 1930 by Dr. Carl Ten Broeck. In 1931 the plan to provide, in one organisation, for the study of disease as it occurs in all the main orders of living things was completed by the addition to the Princeton establishment of a Laboratory of Plant Pathology. The Princeton Laboratories also housed a Laboratory of General Physiology, under Dr. J. H. Northrop, which has devoted itself to investigations of the nature of enzymes and other biologically active proteins of animal origin.

The world-wide reputation of the Princeton Laboratories was based in part on the isolation of a large number of crystalline enzymes and their precursors in Dr. Northrop's laboratory, and on Dr. W. M. Stanley's isolation of the tobacco mosaic virus and succeeding studies in the Department of Plant Pathology. Although the first isolation of a crystalline enzyme was achieved by Sumner in 1926, it is not too much to say that the work of Northrop and his colleagues, leading to the purification and crystallization of a long series of enzymes and related substances, has done more than that of any other group to open up the chemistry of enzymes; while, as is well known, Dr. Stanley's work decisively initiated the modern studies of virus particles. Numerous discoveries in animal pathology were also made within the laboratories, for example, Shope's rabbit papilloma, and many others, which the writer regrets he is unable to describe adequately.

It is most regrettable that the staff and equipment by which such results have been achieved should be dispersed. The main reason for the decision is apparently the contraction of the funds available and also a desire to concentrate the available resources on the Hospital and its auxiliary laboratories. It is understood that attempts made to enlist sufficient financial assistance to make possible the continuation of the Laboratories as a scientific unit were unsuccessful. Many of the younger members of the staff and some senior ones have already accepted posts elsewhere.

The result is the dispersion of a most valuable scientific establishment, which made a contribution to biological and medical research of unique importance. Situated a few miles from the university town of Princeton and within easy reach of New York, it was an ideal site for scientific work. The many British workers who enjoyed its hospitality will remember the efficient organisation of its well-equipped Laboratories and the friendly and agreeable atmosphere of its club-house, and will regret its passing acutely.

RADIATIONS AND HEALTH

A DOSE of radiation above the accepted tolerance limit of 0·5–1 roentgen per week presents hazards to the individual, notably those of sterility and cancer, and to his progeny—in the form of recessive mutations. The importance of the former effects has been recognized since the beginning of the century mainly as a result of the all too obvious injury to many of the early workers with radium and X-rays. The medical profession is therefore fully alive to these dangers. On the other hand, whereas the practitioner sees many examples of the effects of recessive mutations in man—the amaurotic familial idiot, the hæmophiliac, the alcaptonuric—he is seldom, if ever, able clearly to relate these to radiation effects. Thus the matter of genetic damage stands outside the field of practical medicine, and indeed so far has been largely a theoretical concern of eugenics.

Several new factors are at work which must ultimately alter this position. One is the recognition, now beyond dispute, that the genetic effects of radiation are cumulative. The increase in the mutation-rate is proportional to dose, no matter how long may be the period over which it is accumulated. It is estimated, for example, that a dose of 50 r. doubles the mutation-rate in man[1]. It will be noted that the tolerance dose, if regularly received over a reproduction life-time, represents approximately 750 r. It is in no sense a threshold value, and finds general acceptance only on the understanding that not more than 1 per cent of the population receives it regularly. In these circumstances the genetic effects are reckoned to be not more serious than other inevitable ones. The same effects would be produced by a dose of 75 r. incident on 10 per cent of the population. Another factor is a fuller realization of the high levels of radiation to which the population is being subjected as a result of the increasing popularity of X-rays and radium in a wide variety of uses. Especially is this true of the diagnostic and therapeutic uses. At one extreme, doses of the order of 10,000 r. are given in the deep X-ray treatment of malignancy, fortunately to sterile patients, and at the other a diagnostic screening after a barium meal accounts for 10–15 r. delivered directly to reproductive cells. Between the two stand a variety of conditions not in themselves fatal for which radiation is used; for example, ringworm and warts, and especially sterility in women, and on top of them come new treatments with radioactive isotopes. Finally, and most important of all, there stands in the background the sinister threat of an atomic war.

From the points of view of cancer and sterility, it is clearly in the interests of everyone to see that his accumulated radiation dosage both to tissue and reproductive cells is kept at the lowest possible level. He cannot know what the future has in store for him. From a national point of view, it is equally imperative that the level of peace-time radiation should be kept low. The people will be proportionately better able to tolerate the higher doses associated with preparation for, or the actuality of, an atomic war. The ultimate survival of a nation, if not indeed of the population of the world, may depend on just such a piece of elementary prudence as this. Peace-time levels cannot be ignored on the grounds that they are insignificant in relation to the radiation energy which may well be released in an atomic war. As Muller[2] has pointed out, much of the latter will not reach humans at all, and of the proportion which does, most of it will kill outright or sterilize. The insidious danger to the survival of the population lies in the breeding residuum, which will contribute a large number of recessive mutations to future generations. If these are already dangerously undermined in their genetic material by a wanton peace-time use of radiation by their forbears, the results will be serious.

These considerations require as a very minimum that public and scientific attention should be directed to the field of radiations and health in the broadest sense. In some measure, with this end in view, the Radiology Section of the British Medical Association at its Cambridge meeting held a symposium on the therapeutic applications of radioactive isotopes. The physical basis of the subject was presented in an opening paper by Prof. O. Frisch (Cavendish Laboratory), who dealt in particular with the various nuclear reactions which lead to the production of radioactive isotopes. Dr. A. S. McFarlane (National Institute for Medical Research) followed with a review of recent tracer applications, emphasizing the opinion that greater ultimate advantage will probably accrue from biochemical applications with the discovery of precise metabolic pathways in view, rather than from the more spectacular non-specific uses, as, for example, to measure blood-cell volumes or thyroid function.

The main contribution came from Prof. J. S. Mitchell, occupant of the newly created chair of radiotherapeutics in Cambridge. From his wide review covering all isotopes used therapeutically by external and internal administration, it is perhaps justifiable to refer in particular to his statements in relation to sodium-24, phosphorus-32, and iodine-131. These isotopes are usually administered internally, the first two being especially hazardous because, unlike most forms of therapeutic radiation, by virtue, of their widespread distribution, they affect both reproductive and somatic cells. Iodine, on the other hand, is localized to the extent of 80 per cent in the thyroid gland, and this enables doses of 5,000 r. to be given which are effective in destroying glandular tissue in hyperthyroidism. The method is not to be preferred to surgery; but has a useful field of application where other considerations preclude surgery, or in recurrences after surgery. There is a definite risk of late carcinogenesis which is generally worth taking. Few thyroid carcinomas take up useful amounts of iodine, so that isotope therapy is of little value in most malignant conditions of this gland.

Phosphorus-32 given as inorganic phosphate spreads widely throughout the body. Although it is an important constituent of nucleic acid, and practically all tumours are highly nucleated, the differential concentration never approaches that of iodine in the thyroid and generally is too low to be therapeutically useful. However, supplementary X-rays may be used. Prof. Mitchell stressed particularly the value of chemotherapeutic research directed to the synthesis of phosphorus compounds which will become localized in tumour cells. The concentration factor may be increased by local injection of the drug, and the biological half-life of the isotope may be prolonged. The latter incidentally is a composite function of the physical half-life and the excretion-rate. For phosphorus-32 it is estimated to be 11 days for body phosphorus and 6·3 days for thyroid iodine, which compares with physical half-lives of 14 and 8 days respectively.

Phosphorus finds its most effective application in generalized conditions, such as polycythæmia vera and the leukæmias. For the former it is now the treatment of choice, 6–8 millicuries being sometimes effective in a single dose. Generally, however, the disease is kept in control by repeated treatments. The isotope is easily given, the results are better than with external radiation and there are no toxic reactions. It is of interest to note from the hazard point of view that a single dose of 8 millicuries of phosphorus-32 equally distributed in a 70 kgm. adult delivers 70 r. The danger may be observed by the fact that 10 per cent of polycythæmia cases in any event develop into chronic leukæmias; but a few acute leukæmias have been observed after phosphorus treatment. Here again, in Prof. Mitchell's view, the general clinical picture usually justifies the risk.

The initial popularity which phosphorus-32 enjoyed in the treatment of myeloid leukæmia seems to be passing. The high doses used are associated with serious risk to reproductive organs, bone marrow and lymphoid tissue. Most of the isotope is ultimately excreted through the kidneys, and insufficient information is available about remote renal effects. Isotope treatment without supplementary X-rays is valueless in lymphadenoma (Hodgkin's disease), in acute leukæmias of any kind and in tumours. The same remarks apply to sodium-24.

A lively discussion followed, from which it was obvious that the audience much appreciated in particular Prof. Mitchell's survey and shared his cautious attitude in the present limited state of our knowledge. Among various hazards discussed was that arising from the inhalation of particulate radioactive matter. This is present, for example, in laboratories carrying out incinerations of carbon-14 compounds. A minute amount of isotope may ultimately exceed the carcinogenic dose at a point of focus in the lung, since the physical half-life is much longer than the life-span of the individual.

A. S. McFarlane

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[1] Ellis, F., *B.J. Radiol.*, 1, 21 (1948).

[2] Muller, H. J., *Bull. Atom. Scientists*, 267 (Sept. 1947).

OBITUARIES

Mr. P. J. Barraud

It is with deep regret that many of his friends and colleagues will have received the news of the death on August 9, after a long illness, of Mr. P. J. Barraud, at a nursing home at Bournemouth. I first came to know Mr. Barraud, as did a number of others in the Government of India Bacteriological Service, as entomologist attached to the Central Laboratory, Busra, during the latter part of the Mesopotamian campaign in the First World War; but he had earlier in the War done valuable work in the R.A.M.C. in Salonica and Palestine, where he received his commission as captain. Later, in 1922, Barraud was appointed entomologist on special duty under the Indian Research Fund and attached to the Central Research Institute, Kasauli, to carry out research and make a comprehensive survey of the culicine mosquitoes of India, a subject which at the time was very much in need of revision.

Between 1922 and 1932 Barraud published some forty papers describing systematically group after group of mosquitoes with descriptions of large numbers of new species, the final results being published in 1934 as the volume in the Fauna of India series, "Megarrhine and Culicine Mosquitoes of India", a work which was almost unique in its scope and clarity of treatment and which still remains the most comprehensive treatise on Oriental Culicidæ yet published. From at most a few score of recognized species Barraud's work resulted in the description of the adults and early stages of nearly 250 species. At one time he had some difficulty in finding names for all the new species he was describing, and at the present time, out of about 250 total species known from India, more than sixty will be found under Barraud's name as describer.

When in 1925–27 the Kala Azar Commission was formed to investigate the method of transmission of this disease, Barraud was selected as one of its members, and during the time that the Commission was at work he contributed many papers in his own name and jointly with that of other members relating to kala azar and the sandfly *Phlebotomus argentipes*. Besides his more purely laboratory work, Barraud took a great interest, and played an active part, in the training of officers and other staff in the malaria courses held at Delhi by the then Malaria Survey of India (now Malaria Institute of India), and in this connexion he was the author of a very helpful practical entomologist's course for students of malariology (Health Bulletin Series No. 18, published by the Government of India).

After his retirement at Colehill and until his health failed, Barraud played a very active part during the Second World War in local salvage and other local war activities, and was vice-chairman of Colehill Parish Council. He was not only very highly esteemed by his colleagues in India, but also remained the friend of many of them up to the time of his death. His unassuming kindness and interest in those he came in contact with made him a general favourite socially, and he was a very fresh and companionable friend. He entered with zest into the work and interests of those whom he knew and would take endless trouble to help where his services could be brought usefully to bear. S. R. CHRISTOPHERS

Prof. C. Perrier

NEWS has been received of the death of Prof. Carlo Perrier, professor of mineralogy in the University of Genoa, Italy. Prof. Perrier was born on July 7, 1886, in Turin. He studied in that city and obtained his doctorate in chemistry at the University of Turin. Shortly thereafter he worked for some time in the laboratory of Baur in Zurich on physical chemical problems. On his return to Italy his interest turned to mineralogy, and he joined the school of F. Zambonini.

In 1926 he became professor of mineralogy in the University of Messina, and later he moved to Palermo and finally to Genoa. His work was mostly on crystallochemistry, and he brought to it a remarkable analytical skill and a deep knowledge of crystallography.

Perrier had a wide range of interests and a versatile mind, and when the occasion arose, he was quick to apply his various skills to new problems. Noteworthy among these were the study of technetium carried out by radioactive methods in Palermo in 1936–37 and the investigation by radioactive tracers of some biological and chemical problems. His merits were recognized by membership of several Italian learned societies, including the Academy of the Lincei.

He was a loyal friend and a good teacher, and his untimely death will be deeply regretted by everyone interested in the future of science in Italy.

NEWS and VIEWS

St. Anthony's College, Oxford

AN anonymous Frenchman has given £1,250,000 to the University of Oxford for the foundation at once of a new residential college, with the ordinary status of an Oxford college. Its name is to be St. Anthony's; and its head is to be called the 'warden'. It will start with seven or eight fellows and about fifty graduate and undergraduate members. It will be governed at first by the warden and fellows in conjunction with a St. Anthony Foundation, called into existence recently to carry out the benefactor's wishes. It will be accommodated in the first large house with grounds that can be secured in the vicinity of the University, so that this generous new venture may become visible in the life-time of its founder. He himself has little connexion with England and none with Oxford. His name, if disclosed, would convey nothing to the academic world; but, like Cecil Rhodes, he has admired Oxford men in positions of responsibility all over the world, and has become convinced that the British system of education has promoted initiative and strengthened the moral qualities of students better than any other. Again, like Rhodes, he is anxious that men from overseas should go to Oxford. He has asked, therefore, that in the new St. Anthony's College a substantial proportion of the places available should be kept for qualified graduates from French universities. To encourage undergraduate members to come from France in far greater numbers in the future than they have done hitherto, he has offered a further £250,000 to be divided among any existing Oxford colleges that propose to build additional sets of rooms for their men, provided that in these new sets one third of the places are kept for Frenchmen.

The new proposal was welcomed in a hastily summoned Congregation at Oxford on September 15. St. Anthony's will have the uphill task of all new educational institutions at the present time; but if it contributes something fresh and vigorous to Oxford academic life, as have all the colleges founded in the past hundred years—the five women's colleges, Keble and Nuffield Colleges and St. Peter's Hall—it will do good work. It is a mistake to think that Oxford has all the colleges it needs and that benefactors would be wiser in giving their money to the University itself for furthering teaching and research than to the colleges to strengthen their tutorial system and collegiate activities. This is exactly the time when new colleges are wanted and when some of the existing colleges need further endowment if they are to retain to the full the tutorial system that is so excellent a part of Oxford life. Relative to even the richer colleges, the University in its role of promoter of teaching and research is very well off. It has its own endowments. It has a substantial income from the colleges (which contribute anything from a few hundreds to about £30,000 yearly, according to the college's capacity to pay) and a large one from Government through the University Grants Committee. Colleges, on the other hand, get nothing from the central body of the University and nothing directly from any Government source. They have their endowments; but the increases in their incomes from these sources have, in recent years, lagged behind those of their outgoings. It is on the colleges that the main burden of catering for the large increases in the numbers of men and women in recent years has fallen. It is good, therefore, that St. Anthony's College has been founded. It is hoped that its foundation may stimulate other benefactors to help other colleges as they go forward to their post-war tasks.

Administration and Anthropology

THE Frazer Lecture in Social Anthropology delivered before the University of Liverpool on October 23, 1946, by Dr. E. W. Smith, has now been published under the title "Plans and a People—A Dynamic Science of Men in the Service of Africa" (London: Lutterworth Press, 1948. 3*s*. 6*d*. net). Dr. Smith reviews first some developments in anthropology since 1908, stressing particularly that the study of acculturation in Africa is very largely the study of a disintegrating society and that our prime purpose in social anthropology is to study African society for its own sake, to understand how its component parts function, what changes are taking place in it and in what directions it tends to develop. Delay in publication has enabled Dr. Smith, in succeeding chapters on the new dynamic Colonial policy, advances in sociological research and the place of anthropology in planning, to take account of events since the address was given, and to assess how far the purpose of government is now not merely the maintenance of security and order but also the general social betterment of the people, and the extent to which the five-year and ten-year plans which Colonial governments have drawn up in broad outline meet his criteria for success. He points out that the recent review of the Colonial Empire, 1939–47, recognizes the importance of research into the nature of native society and its institutions, and he believes that the International African Institute has not only influenced the progress of social anthropology in Great Britain but also the British Government's decision to finance scientific research in Africa. He agrees that the value of social anthropology to the arts of politics and administration depends upon its theoretical advance, but holds that there is room for anthropological study which is at once scientific in method and directed towards the solution of practical problems. While we may differ as to ultimate values, there is much common ground, and in the spheres of nutrition, education, and the improvement of economic and social conditions the anthropologist may join his efforts with those of other scientific workers.

University and Research Section of the Library Association

The University and Research Section of the Library Association held its twelfth week-end conference during September 10–13 at the University of Birmingham. It was attended by ninety members, with Dr. Arundell Esdaile in the chair, and colleagues from Australia, Denmark, India, Sweden and Venezuela were present. The conference was welcomed to Birmingham by Dr. Wilfred Bonser, University librarian, who outlined the plans for the new University Library to be erected at Edgbaston. The chief speaker at the conference was Dr. S. R. Ranganathan, president of the Indian Library Association and formerly librarian of the University of Madras. Taking as his theme "The Challenge of the Field of Knowledge", Dr. Ranganathan pointed to the declaration made at the Royal Society Scientific Information Conference that in future librarians must be regarded as equal in standing to fellow men of science employed in research, industry and administration, and that they should receive comparable training facilities, rank and emoluments, as marking a definite advance. He showed how difficult it is for the librarian to satisfy the many needs of scholars—and especially of scientific workers—as the various fields of knowledge continually expand and overlap, particularly as seen from the point of view of library classification schemes. He demonstrated the principle and practice of the scheme known as Colon Classification, of which he is the author. During the week-end, visits were paid to the various sections of the University and other libraries at Birmingham, and the information departments of the Austin Motor Works and of Imperial Chemical Industries (Metals Division). The formal business of the annual general meeting of the Section on September 12 was followed by an account by Mr. C. C. Barnard, librarian of the London School of Hygiene and Tropical Medicine, of a visit to Hanover in May of this year as a representative of the Section at a conference of German librarians. The Medical Sub-Section held a meeting devoted to a symposium on cataloguing problems in medical publications, and also visited the Birmingham Medical Institute.

Elimination of Water from Wet Crude Oil

In a paper on the "Elimination of Water from Wet Crude Oil obtained from Bituminous Sand by the Hot Water Washing Process", by K. A. Clark and D. S. Pasternack of the Research Council of Alberta, University of Alberta, Edmonton (Reprinted from *Canadian Chemistry and Process Industries*, 1947), the authors deal with this problem from two angles, by continuous settling at atmospheric pressure and settling under pressure with evaporation; they have carried out much laboratory work towards its solution. In the first case, wet crude oil from the separation plant is mixed with a diluent (either 'topped' crude oil with S.G. 0·85 or kerosene with S.G. 0·82) and subjected to continuous settling in a suitable laboratory plant (illustrated). A ratio of diluent to crude oil of 0·7 and settling temperature 180° F. results in reduction of water content from 40 to 11·5 per cent. It is found that boiling and frothing of wet diluted crude oil before feeding to the continuous settler improves settling of water by causing coalescence of finely dispensed water, hence increase in volume of water ultimately settling out. The authors emphasize that continuous settling of diluted crude oil is not the complete answer to total elimination of water and that a subsequent operation is required to reduce the amount of finely dispersed water to limits acceptable to a refinery. Concerning mineral matter normally associated with the crude oil, it is pointed out that sand and silt readily settle out; but finely divided clay matter is carried within the finely dispersed water, possibly acting as a stabilizer, and this does not settle out, presumably because the emulsion will not break down under the conditions obtaining.

In an attempt to formulate the 'subsequent operation' above, experiments were carried out with continuous settling under pressure at an elevated temperature; but it was found that heating diluted oil up to 323° F. in this way did not cause finely dispersed water to coalesce. Further, water which does settle, does so as a gelatinous emulsion which will not flow to the discharge valve unaided by mechanical means. Hot oil and water, as is well known, make an unsatisfactory mixture at all times; but it is worse than ever with bituminous sand oil. The conclusion reached is that pressure settling is not practicable, that atmospheric settling of diluted crude oil is the first step, to be followed by evaporation in a heater and steam separator; in this way a practically dry oil can be obtained from bituminous sand, one which can then be more easily refined.

An Attempt to Detect the Magnetic Field of a White Dwarf

Dr. A. D. Thackeray has now published a description of his attempts to test Blackett's prediction on the magnetic field of massive rotating bodies (*Mon. Not. Roy. Astro. Soc.*, **107**, 5 and 6; 1947). Blackett pointed out that the ratio between the magnetic moment and the angular momentum of the earth and sun was approximately the square root of the gravitational constant divided by the velocity of light, and that this also applied to 78

Virginis (*Nature*, **159**, 658; 1947). He also dealt with the application of this formula to the white dwarfs and showed that in the case of Sirius B the equatorial field might be as much as 3×10^6 gauss. Such a field should lead to Paschen–Back splitting of the hydrogen lines of the order of 50 A., and Thackeray gives a full description of his work with the 36-inch Common reflector at the Solar Physics Observatory, Cambridge, to detect this effect. Unfortunately, there is not a very wide choice of white dwarfs suitable for the experiment, and Wolf 1346, magnitude 11·3, was selected as it was attainable with a 1-prism slitless spectrograph attached to the 36-in. reflector. It was shown that Paschen–Back splitting of $H\gamma$ is unlikely to exceed 8 A. in this star, corresponding to an upper limit of 10^6 gauss. It is emphasized that there is need for greater spectral purity in a discussion of an apparent structure in the lines, which is independent of the polarizing analyser. When 40 Erid. B became accessible in September 1947 a 2-in. $f/1$ aspherical singlet, figured and lent by Dr. C. R. Burch, was attached to the Newall 25-in. refractor for an attempt with the Wood aluminized grating spectrograph. An hour's exposure without 'Polaroid' was obtained on September 25, showing $H\gamma$ only, but exposures of one hour on September 25 and 3½ hours on September 27 through the analyser failed owing to the formation of thick haze during exposure.

Recession of Glaciers

THE Royal Geographical Society has inaugurated its new *Research Series* with a paper by Prof. H. W. Ahlmann on glaciological research on the North Atlantic coasts (London: Royal Geographical Society, 1948. 7*s*. 6*d*.). Prof. Ahlmann puts together his own and other observations on glaciers in Norway, Iceland, East Greenland and Spitsbergen. All data point the same way, to a general recession, and the same is true in many other parts of the world. The present rapid shrinkage seems to be the last stage in a recession that began about two hundred years ago when the glaciers reached their maximum extension in historical, and perhaps in post-glacial, times. This recession has resulted too in a rise of sea-level, as noted by J. Thorarinsson, F. Bergsten and others. The increasing intensity of the recession is also shown by recent changes in the extension of the Arctic pack-ice, notably in the Russian Arctic and around Spitsbergen, the northward migration of fish and certain birds and the improved cereal prospects in Iceland. The phenomenon is so widespread that it would appear to be associated with climatic fluctuations. The chief meteorological cause is held to be due to increased ablation. Radiation plays a part; but conduction is more important in the smaller icefields and at lower altitudes. On the other hand, it is stated that in the high interior of the Greenland ice there has been no increased ablation or reduced thickness of the ice. The low-pressure area of the North Atlantic apparently has moved to the north in recent years, thus favouring the flow of warm air to the Arctic.

Gresham's School Natural History Society

THE twenty-sixth report of Gresham's School Natural History Society (1948) has just been received. Membership of the Society totals well over a hundred—an eminently satisfactory number for a school. The Society is divided into Archæological, Astronomical, Botanical, Entomological, Meteorological and Ornithological Sections, all of which carry out valuable field work and present reports and papers to the Society. In the present report there are: (1) a survey of the flora of Holt and district, with an exhaustive list of plants observed; (2) an account of the surrounding insect fauna, together with lists of Lepidoptera and Orthoptera; (3) a descriptive account of the birds of the area, with a very comprehensive list and a detailed study of a fulmar colony. Extracts of papers submitted for the Holland-Martin Natural History Prizes (1944–47) are appended. The boys of Gresham's School are to be congratulated on their efficient and very valuable Natural History Society, which obviously encourages practical and field work to the utmost—a fitting basis for later work in natural history, and a great asset in their general education.

Dr. Franz Weidenreich on Human Evolution

A NUMBER of interesting papers by Dr. Franz Weidenreich are to hand. "The Trend of Human Evolution" is published in *Evolution* (1, No. 4; Dec., 1947), and "Some particulars of skull and brain of early hominids and their bearing on the problem of the relationship between Man and the Anthropoids" appears in the *American Journal of Physical Anthropology*, 5 (N.S.), No. 4 (Dec., 1947). In an article in the *American Anthropologist*, 45, No. 1 (Jan.–March, 1943), Dr. Weidenreich once again affirms his belief that Neanderthal man was the ancestor of *Homo sapiens*. The majority of physical anthropologists will probably not agree with the theories set forth in "The Neanderthal Man and the ancestors of *Homo sapiens*", but nevertheless Dr. Weidenreich can never be ignored with impunity. The last article comes from the *Transactions of the New York Academy of Sciences*, Series II, 4, No. 1 (Nov., 1941). It is a lecture on the site and technique of excavation of fossil man in Choukoutien, China. No anatomical details of the finds are given; but the student will find conveniently set out the story of the discovery and the excavation.

The Sondes Place Research Institute

THE Sondes Place Research Institute, Dorking, Surrey, of MacTaggart and Evans, Ltd., industrial consultants, is described briefly in an illustrated booklet which this firm has issued. There are fifteen laboratories, besides offices, stores, dark room, library and semi-scale building and workshops. The Analytical Laboratory and the Physical Testing and Cement Laboratories are service laboratories carrying out analysis and testing for the rest of the organisation and to some extent for clients. The Spectroscopy and Microscopy Laboratories and the dark room, as well as the X-ray Analysis Laboratory, function both as service departments and as research laboratories, but the main chemical laboratory is used exclusively for research and development. The Physical Laboratory is used mainly for physico-chemical research and for determining physical constants, while the Electronics Laboratory deals with the application of electronic methods and servo-mechanisms to industry. Work is carried out either for a fixed fee, on a time basis, or for a monthly or yearly retainer; during the past few years problems relating to abrasives, adhesives, bricks, cast iron, cement and concrete, detergents, fibre boards, gelatine and glue, gypsum, lime, linoleum substitute, mineral oils, paint, plastics, printing, synthetic organic chemicals, strip steel, etc., have been handled.

Applications of Electronics to Research and Industry

A symposium on the applications of electronics to research and industry is being arranged by the Electronics Section of the Scientific Instrument Manufacturers' Association, to be held in the Caxton Hall, Westminster, S.W.1, during November 18 and 19. The subjects for discussion are: measurement of displacement by electronic methods; frequency measurement; electronics in computing; measurement of ionizing radiation; high-vacuum gauges; the *radio sonde* and its applications; industrial applications of ultrasonics; metal detection; electronic control of batching; electronics in spectroscopy and spectrophotometry; dynamic recording of mechanical strains; and picture telegraphy. There will be an exhibition of British electronic instruments in the Caxton Hall during the period of the meeting. Particulars and tickets of admission can be obtained on application to the Secretary.

Conference on Dust in Industry

The Society of Chemical Industry is arranging a Conference on Dust in Industry, which will be held in the University of Leeds during September 28–30. The papers are being arranged in four groups, dealing with physical characteristics and estimation of dust (chairman, Prof. H. V. A. Briscoe), practical aspects of the dust problem (chairmen, Mr. Julian M. Leonard and Mr. A. V. Hussey), fire and explosion hazards (Sir Reginald Thomas), and health hazards (Prof. E. C. Dodds). Further particulars can be obtained from the General Secretary of the Society, 56 Victoria Street, London, S.W.1.

Colonial Services Appointments

The following appointments in the Colonial Services have been announced: R. B. Symington, agricultural officer, Northern Rhodesia; F. W. Champion, assistant conservator of forests, Tanganyika; P. A. Daley, assistant conservator of forests, Nigeria; D. G. Ellis, assistant conservator of forests, Nigeria; M. Gane, assistant conservator of forests, Tanganyika; G. S. MacPherson, assistant conservator of forests, Gold Coast; H. Sanders, assistant conservator of forests, Nigeria; J. R. T. Hazell, geologist, Nigeria; C. V. Cutting, analytical chemist, Tung Experimental Station, Nyasaland; D. A. Donald (agricultural officer, Fiji), senior agricultural officer, British Solomon Islands Protectorate; T. G. Strangeways (agricultural officer, Northern Rhodesia), senior agricultural officer, Hong Kong; W. O. Sunman (assistant to the Director of Agriculture, Kenya), assistant director of agriculture, Kenya; G. W. Chapman (assistant conservator of forests, Cyprus), senior assistant conservator of forests, Cyprus; N. Harris (geologist, Uganda), senior geologist, Uganda; W. G. Beaton (deputy director of veterinary services, Nigeria), director of veterinary services, Nigeria.

The Night Sky in October

New moon occurs on Oct. 2d. 19h. 42m., U.T., and full moon on Oct. 18d. 02h. 23m. The following conjunctions with the moon take place: Oct. 4d. 11h., Mercury 4° S.; Oct. 5d. 18h., Mars 1° N.; Oct. 8d. 02h., Jupiter 4° N.; Oct. 27d. 17h., Saturn 4° S.; Oct. 29d. 07h., Venus 2° S.; Oct. 31d. 00h., Mercury 0·5° N. In addition to these conjunctions with the moon, Venus is in conjunction with Regulus on Oct. 5d. 21h., Venus 0·4° S., and on Oct. 8d. 20h. Venus is in conjunction with Saturn, Venus 1·1° S. Mercury, in inferior conjunction on Oct. 20 and stationary on Oct. 28, is unfavourably placed for observation during the greater portion of the month. On Oct. 31 the planet rises 1h. 40m. before the sun and can be seen in the eastern sky. Venus rises at 2h., 2h. 40m. and 3h. 15m. at the beginning, middle and end of the month, respectively, and can be seen in the morning hours, stellar magnitude −3·6, the visible illuminated portion of disk varying between 0·64 and 0·74. Mars sets a little more than an hour after the sun during October and is not well placed for observation. Jupiter sets at 20h. 36m., 19h. 50m. and 18h. 57m. on Oct. 1, 15 and 31, respectively, and is visible in the western sky (stellar magnitude −1·6) for some time after sunset. Saturn rises at 2h. 30m. and 0h. 50m. at the beginning and end of the month, and can be seen in the morning hours, stellar magnitude 0·9. Occultations of stars brighter than magnitude 6 are as follow: Oct. 14d. 21h. 47·8m., ψ^3 Aquar. (*D*); Oct. 21d. 00h. 16·0m., 32 Taur. (*R*); Oct. 25d. 03h. 47·2m., ω Canc. (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the latitude of Greenwich is assumed. The Orionid meteors are due about October 16–24, but moonlight will partly interfere with observation of this shower.

Announcements

Prof. M. G. Evans, professor of inorganic and physical chemistry in the University of Leeds, has been appointed to the chair of physical chemistry in the University of Manchester.

Mr. W. T. Cooper, for the past five years scientific editor and head of the Publications Department of the British Coal Utilisation Research Association, has been appointed assistant secretary (editorial) of the Institute of Fuel.

The third Fleming Memorial Lecture of the Television Society will be delivered by Mr. Arthur Blok, who will give some personal recollections of Sir Ambrose Fleming. The Lecture will be given at the Royal Institution, London, W.1, on September 29, at 6.30 p.m.

It is announced that, owing to lack of funds, the International Office for Nature Protection cannot continue its work in Holland, and Dr. J. H. Westermann has resigned from the post of acting director. Following the decision of the General Council, the Bureau was recently transferred from Heerengracht 540, Amsterdam, to the Royal Natural History Museum, 31 rue Fautier, Brussels, where it will be under the supervision of Prof. V. van Straelen, vice-president of the Office.

Two courses in photoelasticity are being arranged at University College, London; one will consist of twenty-eight weekly lectures, with periods of laboratory work during the second and third terms of the session; the other, ten periods (lectures and demonstrations). Full particulars can be obtained from Col. H. T. Jessop, Photoelastic Laboratory, University College, London, W.C.1.

Erratum.—Referring to the communication entitled "A Simple Result in Quadrature" (*Nature*, August 7, p. 215), Sir K. S. Krishnan states that in the last entry of column 2 of the table, the numerator should read

$$(2\cos\tfrac{1}{2}v)^{\alpha+\beta-2}\exp\{-\tfrac{1}{2}iv(\alpha-\beta)\}.$$

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Lunar Tidal Oscillations in the Ionosphere

Using the well-known radio methods of upper atmospheric exploration, Appleton and Weekes[1] showed that the E-layer of the ionosphere is subject to an unexpectedly large lunar tide. The tide was found to be semi-diurnal in character, of the order of 1 km. in amplitude, the maximum heights being reached about ¾ hr. before the lunar transits.

More recently Martyn[2] has shown that the ionospheric observations made at the equatorial Huancayo station of the U.S. Department of Terrestrial Magnetism indicate a semi-diurnal lunar tide for the F_2-layer, also of very substantial magnitude, and has shown that this lunar oscillation can be observed in both the heights and critical frequencies of that layer.

Counting the magnitude and phase of the semi-diurnal tides in the E-layer as established for the location of south-east England, we have therefore examined F_2-layer ionospheric data for the same location in order to discover whether there is any variation of phase and amplitude with height. It was also considered of interest to find out whether the lunar tide in the F_2-layer could be detected for a station as far removed from the equator as latitude 51½° N.

As the material for analysis we have used the Slough hourly values of both the F_2-layer critical frequency and also of a quantity, h_m, the height of the maximum ionization level of the F_2-layer. Values of h_m were calculated by a method we have previously described[3]. Semi-diurnal lunar oscillations have been found in the values of both f_{F_2} and h_m. The amplitude of the oscillation in the case of f_{F_2} is about 0·05 Mc./s., the maximum being reached shortly before the time of lunar transit. The amplitude of the oscillations in the case of h_m is about 2 km.; but here the maximum is attained approximately mid-way between lunar transits. Thus the lunar tidal effects in f_{F_2} and in h_m are seen to be approximately out of phase, a result not unexpected from our previous study of F_2-layer phenomena generally. What is unexpected, however, is that the lunar diurnal *height* variations for the F_2-layer are found to be entirely different in phase from those previously observed for the lower level of the E-layer, indicating an alteration of phase of lunar height oscillation with change of ionospheric level. An investigation of corresponding effects in h'_{F_2} data, which relate to an intermediate level, indicate a phase maximum at a time intermediate between those found for the E-layer and for the level of h_m for the F_2-layer.

E. V. Appleton
Dept. of Scientific and Industrial Research,
London, S.W.7.

W. J. G. Beynon
University College,
Swansea.
Sept. 8.

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[1] Appleton, E. V., and Weekes, K., *Proc. Roy. Soc.*, 171, 171 (1939).

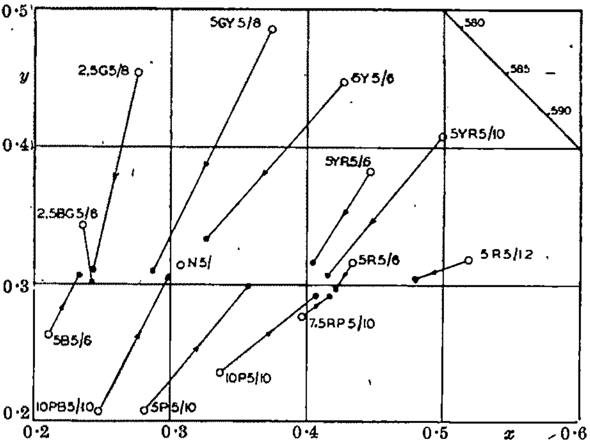
[2] Martyn, D. F., *Proc. Roy. Soc.*, 189, 241, 190, 273 (1947).

[3] Appleton, E. V., and Beynon, W. J. G., *Proc. Phys. Soc.*, 52, 518 (1940).

Apparent Colours of Surfaces of Small Subtense

The investigations of Hartridge[1] and others have substantiated the early conclusion of König[2] that the eye behaves as if tritanopic for coloured stimuli of small subtense, and it occurred to me that it would be of both theoretical and practical interest to determine the actual colours assumed under controlled conditions by small coloured surfaces. The first results are so striking a confirmation of König's conclusions that they are presented here as a preliminary report.

Small circular patches of a number of Munsell colours chosen from the 5-plane were presented against a black background (reflectance 2·6 per cent) singly and in random order to an observer seated at such a distance that they subtended 2 minutes of arc. The observer was provided with a chart having larger samples of all the Munsell colours in the 5-plane, systematically arranged, and a black mask with which any one colour could be isolated. The sample and the comparison chart were separately illuminated by 180 lumens m.$^{-2}$ of artificial daylight similar in colour to C.I.E. source 'C'. The observer was encouraged to be critical and to interpolate between the even values of chroma available; there was no possibility of interpolating between hues.



The figure is a portion of the C.I.E. mixture diagram showing the co-ordinates of the sample colours by open circles, and the mean location of the apparent colours at 2′ subtense by black dots. The (Munsell) neutral point is also indicated. Eight sets of observations by one observer are represented in the means.

Three main results will be noted: (1) the apparent displacements are in general directed towards or away from the short wave-length extremity of the spectrum locus ($x = 0·17$, $y = 0·01$); (2) the apparent colours lie closely about a line which if produced would cut the spectrum locus at about 491 and 630 mμ; (3) blue, green and blue-green are confused, as are also purple, red-purple, and orange; (4) yellowish-green, grey and purplish-blue are confused. The last two items, and indeed the entire picture, are in full accord with König's description of tritanopia. As an independent check of item (4), the Munsell colours lying near the straight line joining 5GY5/8 and 10PB5/10 were mounted side by side in order on the same piece of black card. At the experimental distance they appeared very nearly identical; though the extreme colours were just distinguishable. The three colours 2.5G5/8, 2.5BG5/6 and 5B5/6, similarly mounted, appeared identical.

A second observer, completely unacquainted with the Munsell colour system, obtained results similar to those shown in the figure, though with more scatter. Apparatus is being constructed to check these findings by methods less open to objection on psychophysical grounds; but of the general picture there seems no doubt.

W. E. KNOWLES MIDDLETON

National Research Council,
Ottawa. April 13.

[1] Hartridge, H., *Phil. Trans.*, B, 592, 519 (1947).

[2] König, A., "Physiologische Optik", 396 (Leipzig, 1903), quoted in Wright, W. D., "Researches on Normal and Defective Colour Vision", 333 (London, 1946).

Electronic Digital Computers

A SMALL electronic digital computing machine has been operating successfully for some weeks in the Royal Society Computing Machine Laboratory, which is at present housed in the Electrical Engineering Department of the University of Manchester. The machine is purely experimental, and is on too small a scale to be of mathematical value. It was built primarily to test the soundness of the storage principle employed and to permit experience to be gained with this type of machine before embarking on the design of a full-size machine. However, apart from its small size, the machine is, in principle, 'universal' in the sense that it can be used to solve any problem that can be reduced to a programme of elementary instructions; the programme can be changed without any mechanical or electro-mechanical circuit changes.

The essential parts of such a machine are: (1) a store for information and orders; (2) various arithmetical organs (for example, adders, multipliers); (3) a control unit[1].

The present machine contains the minimum set of facilities for a universal machine, namely: (*a*) If x is any number in the store, $-x$ can be written into a central 'accumulator' A; or x can be subtracted from what is in A. (*b*) The number A can be written in an assigned address in the store. (By means of (*a*) and (*b*) addition or direct writing into A can be programmed.) (*c*) The content of A can be tested for whether $x \geqslant 0$, or $x < 0$; if $x < 0$ the order standing next in the store is passed over. This gives the essential power of branching routines. (*d*) Control can be shifted to an assigned order in the table. (*e*) The machine can be ordered to stop.

The capacity of the store is at present only 32 'words', each of 31 binary digits, to hold instructions, data and working. Hence only simple arithmetic routines devised to test the machine can be run. Examples of problems that have been carried out are: (1) Long division by the standard process. (For $(2^{30} - 1)/31$, this took $1\frac{1}{2}$ seconds, the quotient being given to 39 significant binary figures of which the 13 least significant, to the left of the binary point, were zero, since 31 is a factor of $2^{30} - 1$.) (2) H.C.F. by the standard process. (For 314,159,265 and 271,828,183, which are co-prime, approximately 0·5 second.) (3) Factorizing an integer. For (3) the method was deliberately chosen to give a long run the result of which could be easily checked. Thus the highest proper factor of 2^{18} was found by trying in a single routine every integer from $2^{18} - 1$ downward, the necessary divisions being done not by long division, but by the primitive process of repeated subtraction of the divisor. Thus about 130,000 numbers were tested, involving some 3·5 million operations. The correct answer was obtained in a 52-minute run. The instruction table in the machine contained 17 entries.

It will, of course, be understood that it is intended to have other arithmetical facilities, as well as a much larger store, in a full-sized machine; and that even on the present machine quicker routines could have been used. At present routines are chosen with the sole object of testing the machine as thoroughly as possible.

The development of this machine has been very actively supported by the Telecommunications Research Establishment, Great Malvern.

F. C. WILLIAMS
T. KILBURN

Electrical Engineering Laboratories,
University, Manchester 13.
Aug. 3.

[1] For a fuller discussion see, for example, the Royal Society discussion on computing machines, summary in *Nature*, 161, 712 (1948).

Excitation Probability Functions of Atomic and Molecular Energy-Levels

IN the correlation of the electrical and spectroscopic properties of a glow discharge in a molecular or atomic gas, the need for a rough quantitative analysis of the kinetics of the excitation of the gas soon becomes apparent. In all but the simplest cases, no more than a rough analysis can be attempted with the present scanty experimental and theoretical knowledge of the interaction of slow electrons with atoms and molecules. It is the purpose of this communication to present an empirical form for the excitation probability functions of the atomic and molecular levels which seems to fit the few experimental curves fairly closely, and at least provides a basis for calculation where previously only generalized discussion was possible.

In principle, the excitation probability functions of atomic or molecular levels may be calculated from quantum mechanics. However, in actual fact, very few atoms and molecules have been considered[1]. In any event, serious theoretical difficulties exist in calculating the excitation probabilities for collisions with slow electrons—the interesting case from the point of view of glow discharge—where the Born approximation becomes invalid. Apart from these difficulties, it is necessary that the wave functions of the ground and excited states should be known. The wave functions of very few of the energy states of atoms and molecules have, in fact, been calculated. The quantum-mechanical method does not express the excitation probability function in a form which is readily applicable to discharge problems. Blackett[2] made an interesting semi-classical approach to the subject using the principles of conservation of energy and momentum. This, however, was limited and exploratory.

The shapes of excitation functions observed experimentally for singlet and triplet atomic levels from a singlet ground state are different[3]. The singlet excitation function rises from zero at the energy of the level concerned to a broad maximum somewhat above it, while the triplet excitation function rises from zero at the energy of the level concerned to a sharp maximum much closer to the level. The difference in shape is due to electron exchange being necessary for change of multiplicity.

An examination of the general shape of the experimental excitation functions suggests that they may be represented by:

$$s_1(V) = C(V - E_{AB})^{1/2}\exp[-L(V - E_{AB})], \quad (1)$$

where $s_1(V)$ is the excitation probability as a function of the energy V of the exciting electrons; E_{AB} is the energy separation of the ground (A) and the excited (B) states; L, an adjustable constant, controls the position and shape of the maximum ($s_{\max}$ occurs at $V = \frac{1}{2L}$); C is a scaling constant. Such a function has been fitted to the experimental curves for singlet and triplet excitation of atoms. The fit is comparable to that of the theoretical curves in cases where they have been calculated.

If (1) represents the excitation probability function for a first-kind collision between an atom and an electron, it can be applied in the relation of Klein and Rosseland[4], namely:

$$s_2(V - E_{AB}) = \frac{p_A}{p_B}\left[\frac{V}{V - E_{AB}}\right]^{1/2} s_1(V), \quad (2)$$

for the probability of the microscopically reversible case of a second-kind collision between an excited atom and an electron. p_A and p_B are the quantum weights of the states A and B respectively. From (1) and (2) we have:

$$s_2(V - E_{AB}) = C\frac{p_A}{p_B}V^{1/2}\exp[-L(V - E_{AB})]. \quad (3)$$

(1) and (3) predict the maxima of s_1 and s_2 to fall at energies which are greater by equal amounts than the energies of B and A respectively.

In the case of molecules, both experimental and theoretical knowledge is more scanty than in the case of atoms. The excitation functions of the nitrogen triplet *bands* have been investigated by numerous workers. These excitation functions are not necessarily the excitation functions of the upper levels concerned, however, as this assumes a direct excitation mechanism to these levels, and radiation as the only depopulating mechanism. As has been suggested previously[5], this assumption can by no means always be made, especially in the case of the triplet bands.

The excitations of both atomic lines and molecular band-systems are similar in that the orbital electrons in each case are the governing factor. We may therefore suppose the general shape of the excitation functions for molecular electronic levels to be the same as for atomic levels, and seek to apply the empirical function suggested above. In the molecular case, unfortunately, there are less experimental data of excitation functions (for molecular *levels*) to which the empirical equation may be fitted. Consequently, calculations must be of a more general nature than in the case of atoms. Study of the curves represented by (1) show that in cases where the experimental excitation functions are unknown, choice of $L \sim 1$ for triplet excitation functions and $L \sim 0{\cdot}1$ for singlet excitation functions enables first approximation analytical progress to be made. The postulation of a function such as (1) is necessary if any quantitative calculation is to be attempted on the excitation mechanisms in a molecular gas, when excited by electrons of an energy distribution $n(V)dV$, as exists, for example, in glow discharge. Such an analysis has been made of the excitation kinetics of nitrogen, the results of which are to be published shortly.

The choice of the suggested function has no theoretical basis. Its justification is in its fitting the experimental curves and of being of convenient analytical form. It enables some progress to be made in correlating electrical and spectroscopic data from discharge, in connexion with which this work has been done.

I should like to express my thanks to Prof. R. W. B. Pearse for valuable discussion.

R. W. NICHOLLS*

Department of Astrophysics,
Imperial College of Science and Technology,
London, S.W.7.
May 3.

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* Now at Department of Physics, University of Western Ontario, London, Canada.

[1] Mott and Massey, "Theory of Atomic Collisions", Chapters 11, 12. Massey and Mohr, *Proc. Roy. Soc.*, A, **132**, 605 (1931); **140**, 613 (1933). Penney, *Phys. Rev.*, **39**, 472 (1932).

[2] Blackett, *Proc. Camb. Phil. Soc.*, **22**, 56 (1924).

[3] Lees and Skinner, *Nature*, **123**, 836 (1929); *Proc. Roy. Soc.*, A, **137**, 173 (1932).

[4] Klein and Rosseland, *Z. Phys.*, **4**, 46 (1921).

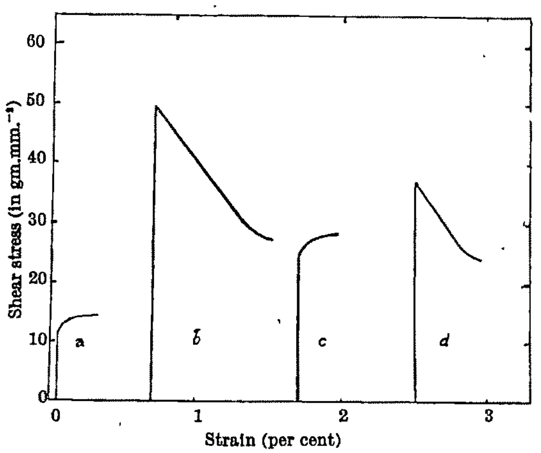
[5] Nicholls, *Nature* [**162**, 231 (1948)].

Thermal Hardening of Cadmium Crystals

BY annealing a crystal of chemically pure zinc in the temperature range 0–300° C. after a small plastic extension (~1 per cent) had been given, Orowan[1,2] found that the crystal could be made resistant to plastic deformation until a yield stress much higher than the previously determined 'normal' value was reached. The crystal would then suddenly yield and continue to extend plastically at the normal lower yield stress. On the other hand, a freshly strained crystal began to flow when retested as soon as the lower yield stress was reached. He termed the effect 'thermal hardening'. These effects remind one strongly of the yield phenomenon and strain ageing of iron, and the terms 'upper' and 'lower yield points', respectively, are suggested for the yield values belonging to the thermally hardened and freshly strained states.

Thermal hardening has been observed more recently by Smith[3] in spectroscopically pure cadmium crystals; however, whereas Orowan found the effect to be rare in zinc, Smith obtained it with every cadmium crystal he examined. We have found that cadmium crystals grown (by Andrade and Roscoe's fusion method[4]) in an atmosphere of pure argon give no sign of the effect; but marked thermal hardening could be produced consistently whenever the crystals were grown in nitrogen. It was also produced when argon contaminated by small amounts of nitrogen was used. Curve *a* shows a stress-strain curve from a crystal grown in pure argon and given a treatment designed to develop thermal hardening. The yield phenomenon, which is quite absent in this case, is clearly produced in a similarly treated crystal which has been grown in nitrogen (curve *b*); this second crystal produces the 'normal' type of curve, however, in which the yield phenomenon is absent, when it is tested in the freshly strained state (curve *c*).

Smith found that the value of the upper yield point varied markedly with λ, the angle between the axis of the applied tensile load and the glide direction, and a minimum was obtained in the range λ = 40–45°, where the upper yield point was only 5 per cent higher than the lower yield point. We have so far



Stress-strain curves of cadmium crystals. (*a*) Grown in argon; pre-strained 0·8 per cent; 40 min. at 200° C.; $\chi = 19°$, $\lambda = 30°$. (*b*) Grown in nitrogen; pre-strained 0·98 per cent; 50 min. at 200° C.; $\chi = 28°$, $\lambda = 40°$. (*c*) Immediately retested after (*b*). (*d*) Grown in nitrogen: no pre-strain; 90 min. at 200° C.; $\chi = \lambda = 56°$. (χ = angle between slip plane and tension axis.) (λ = angle between slip direction and tension axis)

failed to confirm this result; thus we have observed a difference of 70–80 per cent in the yield-points on crystals with $\lambda \sim 40°$, which is as high as can be obtained in other ranges of λ.

A difference between thermal hardening and the yield phenomenon in iron is that the characteristic yield point is produced at the first time of testing with iron, whereas with a cadmium crystal the first curve is of the type of curve *c* and the yield point type of curve is not obtained until a thermal hardening treatment has been given. The difference may be due to handling a soft crystal. To confirm this, a cadmium crystal was mounted in the testing machine and annealed *in situ* before testing. The characteristic upper yield point was developed by this treatment (curve *d*), which shows that the preliminary straining treatment is not essential and that the difference mentioned above between thermal hardening and the yielding of iron is trivial.

A subsidiary effect noticed is that, with successive annealing treatments, both the upper and lower yield points rise above their previously determined values (see table). This was found to be due to the formation of a surface film on the cadmium crystals during annealing. Roscoe[5] has shown that the presence of a thin oxide film can raise the critical shear stress of cadmium, and we have confirmed this on cadmium crystals free from nitrogen; a critical shear stress of 12 gm.mm.$^{-2}$ was obtained when the crystal surface was clean and, by a light oxidation treatment, this could be raised to 30 gm.mm.$^{-2}$.

Effect of successive annealing treatments on the yield points of a cadmium crystal ($\chi = \lambda = 56°$)

Treatment	Upper yield point, τ_1, measured as resolved shear stress in gm.mm.$^{-2}$	Lower yield point, τ_2, measured as resolved shear stress in gm.mm.$^{-2}$	$\frac{\tau_1 - \tau_2}{\tau_2} \times 100\%$
As grown	—	17·1	—
70 min. at 200° C.	33·4	20·2	65
Further 33 min. at 200° C.	32·8	20·6	59
Further 90 min. at 200° C.	41·0	21·8	88
Further 35 min. at 200° C.	42·8	23·3	83·5

A further similarity between thermal hardening and the yield phenomenon of iron is that nitrogen produces thermal hardening in cadmium, and the presence of small amounts of carbon or nitrogen in iron is associated with the yield phenomenon[6–8]. An explanation of the effects in iron, put forward recently by one of us[9], may thus be also applied to thermal hardening. It is considered that foreign atoms in solid solution migrate to dislocations, where they relieve stresses by altering locally the equilibrium lattice constants. A large force is then required to tear a dislocation from its cloud of solute atoms (upper yield point), and when a dislocation has in this way been freed it can migrate rapidly through the lattice under a smaller force (lower yield point). A freshly strained crystal contains free dislocations and shows no upper yield point; but, on annealing, the solute atoms can migrate to the free dislocations, anchoring them once more and causing the yield phenomenon to return.

We wish to thank Dr. C. L. Smith for helpful discussions, and Prof. D. Hanson and the Department of Scientific and Industrial Research for their interest and for providing facilities for this investigation.

A. H. COTTRELL
D. F. GIBBONS

Metallurgy Department,
University of Birmingham.
May 5.

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Limiting Diffusion Currents at Wire Electrodes

THE limiting current for an electrode reaction in aqueous solution, in which diffusion of the depolarizer to the electrode surface is the rate-determining factor, is generally treated[1] by assuming there to be present adjacent to the surface a diffusion layer of fixed thickness across which a linear concentration gradient is set up. On these assumptions, the limiting current is given by the expression:

$$I = \frac{ADnFC}{\delta} \times 10^{-3}, \qquad (1)$$

where I is the limiting current (amp.), A the area of the electrode surface (cm.^{2}), D the diffusion coefficient of the depolarizing ion (cm.^{2} sec.$^{-1}$), n the number of electrons involved in the electrode reaction, F the faraday, C the bulk concentration of the depolarizer (gm. ion per litre), and δ the thickness of the diffusion layer (cm.). This expression is found to hold satisfactorily for large electrodes, and δ has a substantially constant value for different depolarizers in unstirred solutions at constant temperature. The same relation has generally been considered to hold for wire electrodes, and since such electrodes are very convenient in practice and give well-defined limiting currents, they have been much used in voltammetric work.

During an investigation of the electrolytic oxidation of potassium ferrocyanide using small vertical wire anodes of constant diameter in unstirred solutions, we found that while the ratio I/AC was satisfactorily constant over a very wide variety of conditions, as required by equation (1), its actual value of *c.* 5 × 10^{-2} (at 20° C.) was very much higher than that

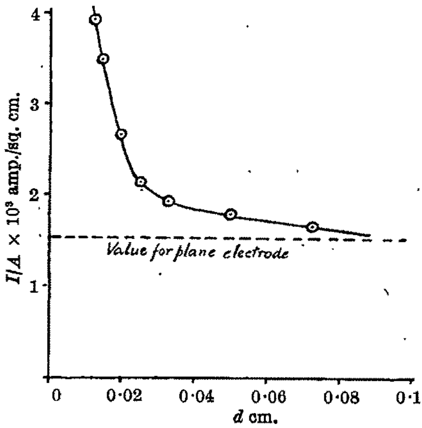

Fig. 1

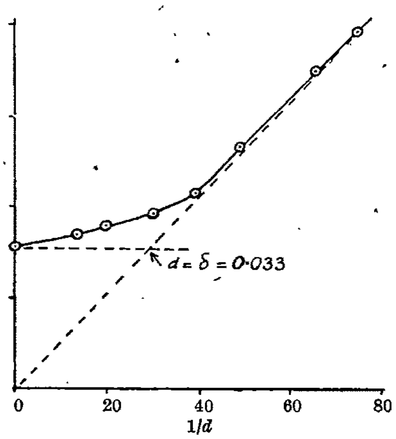

Fig. 2

of $2 \cdot 9 \times 10^{-2}$ (at 25° C.) found by Kolthoff and Laitinen[2] for the same system. In attempting to resolve this discrepancy, it was noted that these workers had used rather thicker wire electrodes than those employed in our investigation, and we have therefore made measurements with wire anodes of different diameters.

We have now found that the ratio I/AC increases rapidly with decreasing diameter when the wire becomes sufficiently thin. Some typical results are shown in Fig. 1 in which the limiting current density in amp./sq. cm. for the anodic oxidation of $0 \cdot 05M$ potassium ferrocyanide in phosphate buffer at 20° C. is plotted against the diameter d of the wire used. It may be noted that with the thickest wire used of diameter 0·0725 cm., the limiting current density is only slightly higher than that found for a plane electrode, but with decreasing diameter it increases, and below a diameter of 0·04 cm. the increase is very rapid indeed. In Fig. 2 the limiting current density is plotted against the reciprocal of the diameter, and it is seen that for very thin wires it becomes inversely proportional to the diameter; and it appears that:

$$I = \frac{ADnFC}{d} \times 10^{-3}. \qquad (2)$$

The intersection of the dotted lines representing the limiting cases (1) and (2) gives a value of δ of 0·033 cm. Other determinations of δ involve a knowledge of the diffusion coefficient of the depolarizing ion, about which there is usually considerable uncertainty. Early work[1] suggested a value of δ of about 0·05 cm., but Kolthoff and Laitinen[2] from a study of a number of reactions arrived at a value of 0·025 cm. Re-examination of their results, however, shows that their limiting current densities would be about 1·2 times the values for plane electrodes, owing to the diameter effect now reported; and if allowance is made for this, their results give a value of δ of 0·03 cm. (at 25° C.), which is in close agreement with that of 0·033 cm. (at 20° C.) obtained above.

The effect now reported appears to be a general one independent of the nature and concentration of the depolarizer used. In general, it is obvious that when the diameter of the wire approaches the thickness of the diffusion layer, equation (1) must fail, and indeed the diffusion must be of a cylindrical rather than a linear type. We have attempted to account for the experimental results by using the general equation for cylindrical diffusion (which does not of itself lead to any stationary state such as is experimentally observed) and inserting arbitrary boundary conditions; but these attempts have not led to any practically useful result. Empirically, a close fit to the experimental points can be obtained if equation (1) is formally retained and the diameter of the wire d replaced by $\sqrt{d^2 + \delta^2}$ in calculating the electrode area, and this may have some practical value for calculation purposes, although its physical significance is obscure.

The present results have two practical implications. First, in comparing results of limiting current measurements at wire electrodes, as is often done, the wires used must be fairly thick, or of the same diameter, or a correction factor must be introduced. Secondly, in designing electrodes to obtain very high limiting currents, as, for example, the platinum gauze electrodes used in electro-analysis, there is an obvious advantage in using the thinnest possible wire consistent with mechanical strength; our measurements show that the limiting current per unit length of wire becomes independent of diameter for very thin wires, and hence some saving of metal may be achieved by this procedure.

We are indebted to Mr. T. B. Grimley for much helpful discussion.

A. HICKLING
W. H. WILSON
Department of Inorganic and Physical Chemistry,
University of Liverpool.

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[1] See Glasstone and Hickling, "Electrolytic Oxidation and Reduction", chapter 3 (1935); Kolthoff and Lingane, "Polarography", chapter 32 (1941).

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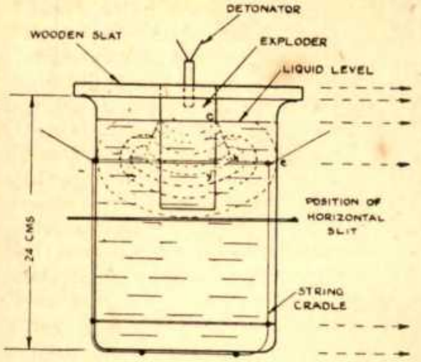
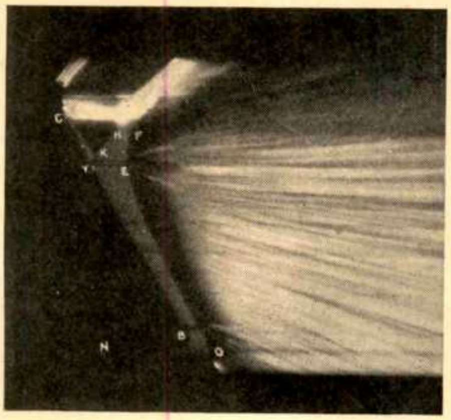
Detonation in Liquid Explosives

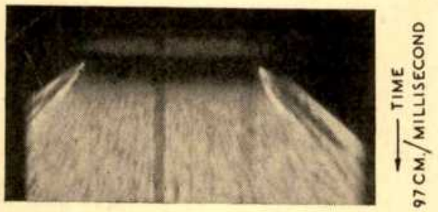
DURING the War a general investigation was commenced at the Road Research Laboratory, on the initiative of Dr. A. H. Davis, into the process of detonation in explosives, the programme including a photographic study of the detonation waves in transparent liquid explosives—the sensitivity of some of which can be varied by adjusting the constitution—and their relation to primers of different types and shapes. In the work, use was made of a new high-speed mirror camera to photograph the progress of the luminous detonation front inside transparent liquid explosives. A unique feature of the camera was the employment of two independent lens assemblies, each consisting of a telephoto field component focusing on to a spectrographic slit. The slits themselves were focused, via a four-sided rotating mirror, on to a photographic film located in cylindrical guides. The fields of the two slits were arranged to intersect at right angles in the object plane, approximately 30 ft. from the camera. Further, by means of a suitable arrangement of plane mirrors between the rear lenses and the film, images from the two slits were arranged to record on different areas





→ TIME : 97 CM/MILLISECOND

RECORD FROM VERTICAL SLIT



RECORD FOR HORIZONTAL SLIT

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of the same film. Use was made in this connexion of adjacent sides of the mirror block. In this manner it was possible to record simultaneously in two directions at right angles. The maximum recording speed was approximately 100 cm. per sec., with a time resolution of 1 microsecond.

A record obtained during the detonation of a 14-lb. charge of the transparent liquid explosive diglycol dinitrate, using a 12-oz. cylindrical tetryl primer, is reproduced herewith. The vertical slit was focused on the axis of the glass beaker used to contain the explosive, while the horizontal slit covered a section slightly below the bottom of the primer. To facilitate interpretation, the sketch of the charge is reproduced to the same linear scale as the records.

Referring to the record from the vertical slit, the flash from the detonator occurs first in time, followed by extensive luminosity from the section of the primer between the underside of the primer support and the level of the liquid. The flame front from this zone, travelling towards the camera, is later deflected upwards by the glass wall of the beaker. The boundary *CYB* on the record indicates the passage of the detonation front, first down the side of the primer and afterwards, with a slight decrease in velocity, down the axis of the beaker. During its passage from *c* to *y* along the primer, the detonation front has spread, to a limited extent only, into the liquid explosive, as sketched on the diagram. This encroachment is indicated by the boundary *CK* on the record.

On a circle concentric with the charge axis, and passing through the point *k*, a new detonation process has originated in the liquid. This has combined with the original wave to form a front of the shape sketched. The upward movement of this front is recorded as the boundary *KH*. When the detonation wave reaches the glass at *e*, luminosity ceases for a few microseconds, before the commencement of burning in air. This corresponds to point *E* on the record. As the expanding front shatters the glass, the boundary *FEG* is developed. From a mathematical analysis of this boundary the shape of the detonation wave can be derived. (The tail *NB* is due partly to reflexion from the convex base of the beaker, and partly to refraction at the curve in which the wall of the beaker meets the base.)

The horizontal slit records nothing until the detonation front in the liquid crosses its field. The curved boundary again gives a key to the shape of the wave, but in this case a correction must be made for refraction in the undetonated liquid. The record as it stands gives the impression that the detonation front has been temporarily contained by the glass !

Using this technique the critical primer/charge diameter ratio necessary to give complete detonation was investigated, and the effect of shaping the primer examined. The horizontal slit was found to be invaluable in the elucidation of the more complex detonation processes associated with shaped primers.

Some of the records obtained suggested that diglycol dinitrate has one or more low orders of detonation of the kind referred to recently by Jones and Mitchell[1]. Unfortunately, the luminosity associated with them was insufficient to record on the fastest film available, and the detonation process had to be reconstructed from the envelope of the after-burning, which was generally sufficiently luminous to record.

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D. CRONEY

Road Research Laboratory,
Dept. of Scientific and Industrial Research,
Harmondsworth,
West Drayton, Middlesex.

May 24.

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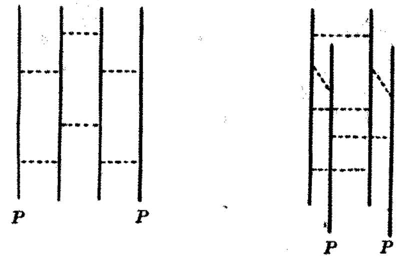
Some Peptides from Insulin

By oxidation with performic acid, the insulin molecule can be split into its separate polypeptide chains[1]. It has now been possible to prepare two fractions from the oxidized insulin : fraction *A* contains only glycine terminal residues and no arginine, histidine, lysine, phenylalanine or threonine ; fraction *B* contains 97 per cent phenylalanine terminal residues and all the amino-acids that are present in insulin. The yield of fraction *A* is more than 25 per cent of the original insulin, indicating that it represents more than one of the peptide chains of the insulin. The yield of fraction *B* is rather less.

The sulphur contents of the two fractions were kindly determined by Mr. M. W. Rees, who found



that fraction *A* contains four cysteic acid residues per molecule of molecular weight 2,900, and fraction *B* contains two per molecule of molecular weight 4,100. From these results it is possible to formulate a number of possible structures for the insulin sub-molecule. Thus, if we assume that it can be regarded as four parallel peptide chains, then only two structures are possible, as shown in the accompanying diagram, where the full lines represent the peptide chains and the broken lines the —S—S— bridges. The chains marked *G* have glycine terminal residues and those marked *P* phenylalanine terminal residues. It is assumed that the two glycyl chains have equal cysteic acid contents, which is probable from their similar properties. Other structures are possible if the chains cannot be regarded as parallel.

In order to carry further the investigation of the structure of these peptides, the products of the partial hydrolysis of their 2 : 4-dinitrophenyl-derivatives were studied. Using this method, it is possible to separate from a complex partial hydrolysate a relatively simple mixture of dinitrophenyl-peptides originating from the terminal peptides of the molecule. The isolation of a number of such peptides from an enzymic digest of insulin has already been reported by Woolley[2]. In the present work, acid hydrolysis has been used and the dinitrophenyl-peptides fractionated by partition chromatography on silica gel. The order of the amino-acids in them was determined by subsequent partial hydrolysis.

In a preliminary experiment with horse globin, the following peptides were isolated in a crystalline form and their structure determined: *H*1, 2 : 4-dinitrophenyl-valyl-leucine; *H*2, 2 : 4-dinitrophenyl-valyl-glutamyl-leucine; *H*3, the amide of *H*2.

This demonstrates that the six open peptide chains of horse globin[3] are not identical but consist of at least two different types, one with the terminal peptide valyl-leucine and one with the terminal peptide valyl-glutaminyl-leucine.

The method was then applied to the above fractions of oxidized insulin. From a partial hydrolysate of the dinitrophenyl-derivative of fraction *A* the following peptides were separated: *A*1, 2 : 4-dinitrophenyl-glycyl-isoleucine; *A*2, 2 : 4-dinitrophenyl-glycyl-isoleucyl-valine; *A*3, 2 : 4-dinitrophenyl-glycyl-isoleucyl-valyl-glutamic acid; *A*4, the peptide containing glutamic acid, leucine, serine and O-2 : 4-dinitrophenyl-tyrosine, which has been reported by Woolley[2]. Its structure has not yet been determined.

Fraction *A* thus consists of at least two separate chains with different terminal peptides. It is interesting to note that these chains, though not identical, are very similar in that they have no basic amino-acids, threonine or phenylalanine, are not easily separated from one another and have the same molecular weight and electrophoretic mobility.

Using fraction *B* the following peptides were detected: *B*1, 2 : 4-dinitrophenyl-phenylalanyl-valine; *B*2, 2 : 4-dinitrophenyl-phenylalanyl-valyl-aspartic acid; *B*3, 2 : 4-dinitrophenyl-phenylalanyl-valyl-aspartyl-glutamic acid; *B*4, ε-2 : 4-dinitrophenyl-lysyl-alanine; *B*5, threonyl-(ε-2 : 4-dinitrophenyl)-lysyl-alanine.

No evidence has yet been obtained of a second chain in this fraction.

The method of determining the structure of these peptides can be illustrated by considering the peptide *A*3. Using quantitative paper chromatography[4], it was shown that there was one molecule of isoleucine, valine and glutamic acid per molecule of 2 : 4-dinitrophenyl-glycine. While no great accuracy is claimed for this method as used here, it is sufficient to indicate without any doubt the number of residues present. On further partial hydrolysis of peptide *A*3, the peptides *A*1 and *A*2 and 2 : 4-dinitrophenyl-glycine were produced. From the composition of these peptides the order of the amino-acids could then be deduced, and it was confirmed by the identification of isoleucyl-valine in partial hydrolysate of peptide *A*2, by the method of Consden, Gordon and Martin[5].

In addition to peptide *A*4, Woolley has isolated from insulin a number of 2 : 4-dinitrophenyl-glycyl peptides in which threonine occurred not far from the terminal residue. We have not yet found evidence of these peptides in the present work in any of the main fractions of oxidized insulin; but it may be that they are not extracted under the procedure employed. It is possible, therefore, that there may be at least three different glycyl chains in insulin, though it is difficult to reconcile this with the present picture of the structure of insulin.

F. Sanger
(Beit Memorial Fellow)

Biochemical Laboratory,
Cambridge.
May 24.

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"17-Ketosteroid II" Isolated from Urine; its Reaction with Hydrochloric Acid

In an earlier communication[1] we announced the isolation of a new 17-ketosteroid in the urine of a girl with adenoma of the adrenal cortex. This compound, which we designated "17-ketosteroid II", is converted in presence of HCl into a mixture of $C_{19}H_{27}OCl$ and dehydro-*iso*-androsterone. We have now studied this reaction in more detail.

In the first place we were able to prove that the compound $C_{19}H_{27}OCl$ is identical with the 3-chloro-Δ^5-androstenone-17 isolated by Butenandt and Dannenbaum[2] from human male urine. This compound can be synthesized by the method of Wallis and Fernholz[3] by the action of phosphorus pentachloride on dehydro-*iso*-androsterone. We purified the product thus obtained by means of chromatographic analysis. The melting point was 153·5–155·5° C. (corr.).

We then added 5 per cent aqueous hydrochloric acid to a solution of pure 17-ketosteroid II in ethanol; under these conditions the latter reacts immediately even at room temperature. The reaction mixture consists of about 80 per cent of $C_{19}H_{27}OCl$

with 20 per cent of dehydro-*iso*-androsterone. The chloroketone prepared from 17-ketosteroid II had m.p. 153·5–155·5° C. The mixed melting point with synthetic 3-chloro-Δ^5-androstenone-17 showed no depression.

In view of the great readiness with which 17-ketosteroid II reacts with hydrochloric acid to form 3-chloro-Δ^5-androstenone-17 (unlike dehydro-*iso*-androsterone), we assume that the 3-chloro-Δ^5-androstenone-17 found in urine has been formed from 17-ketosteroid II and *not* from dehydro-*iso*-androsterone (though 17-ketosteroid II occurs in normal urine in small quantities only). Although everywhere in the literature it is assumed that the chloroketone is formed from dehydro-*iso*-androsterone, Butenandt and co-workers[2] in their original publication did actually point to the possibility of a different precursor.

When 17-ketosteroid II is subjected to the action of hydrochloric acid at 100° C., the product is chiefly dehydro-*iso*-androsterone. When hydrochloric acid is allowed to act for 10 min. on 3-chloro-Δ^5-androstenone-17 (at 100°) the reaction mixture contains about 65 per cent of dehydro-*iso*-androsterone, the remainder being unchanged 3-chloro-Δ^5-androstenone-17. The identity of the dehydro-*iso*-androsterone was proved by means of the mixed melting point with an authentic sample of dehydro-*iso*-androsterone, 140–141° C. (corr.), and the mixed melting point of the corresponding acetates, 170–171° C. (corr.).

These facts lead us to the conclusion that the dehydro-*iso*-androsterone found in relatively large amounts in the urine of patients with carcinoma of the adrenal cortex must be regarded, to some extent at any rate, as an artefact produced by the action of hydrochloric acid on 17-ketosteroid II at the boiling point.

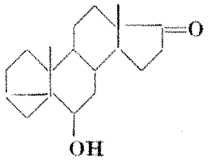
It also appears that the amount of dehydro-*iso*-androsterone thus formed is dependent on the duration of heating with hydrochloric acid. Boiling for 10 min. converts about 65 per cent of the 17-ketosteroid II to dehydro-*iso*-androsterone (see above). If, however, the urine is extracted with an organic solvent before hydrolysis, the 17-ketosteroid II present in the unconjugated form passes into the organic solvent. The result of such a method of extraction is that the amount of dehydro-*iso*-androsterone in the extract is much smaller than when the urine is boiled immediately with acid.

We think it worth while to direct attention to this in connexion with the estimation of dehydro-*iso*-androsterone in urine extracts for clinical purposes.

We have not yet succeeded in ascertaining whether 17-ketosteroid II can also exist in conjugated form in urine. In our previous communication[1] we stated that an acetate of this compound had been prepared (m.p. 109–111° C. (corr.)). Thus it contains an alcoholic hydroxyl group, so that it is by no means impossible that it may also be present in the esterified form in urine. The usual methods of hydrolysis will, however, convert these esters into dehydro-*iso*-androsterone.

Drs. Barton and Klyne (see following letter) kindly sent us a specimen of synthetic *i*-androsten-6-ol-17-one which proved to be identical with our 17-ketosteroid II; an identity that has already been considered in our previous paper. (We are glad to mention here that Dr. Beyerman, working at this Laboratory, suggested this identity for the first time, and we acknowledge with thanks this useful hint.) The identity of the compounds is established by mixed melting points and by identical adsorptive properties in chromatography.

The structure of 17-ketosteroid II is thus completely elucidated.



i-androstenolone

A grant was received for this study from Organon, Ltd., Oss.

ELIZABETH DINGEMANSE
LEONORA G. HUIS IN 'T VELD
S. LORE HARTOGH-KATZ
Pharmaco-therapeutic Laboratory,
University of Amsterdam.
July 12.

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[1] *Nature*, **161**, 848 (1948).

[2] *Z. physiol. Chem.*, **229**, 192 (1934).

[3] *J. Amer. Chem. Soc.*, **59**, 765 (1937).

Identification of "17-Ketosteroid II" as *i*-Androsten-6-ol-17-one

Dingemanse, Huis in 't Veld and Hartogh-Katz[1] recently described the isolation from human urine of a compound, "17-ketosteroid II", which they suggested was an androsten-3(α)-ol-17-one. Many of the reactions reported for this substance indicated that it might be *i*-androsten-6-ol-17-one, which has already been obtained by Butenandt and Suranyi[2] from the *p*-toluenesulphonate of dehydro-*iso*-androsterone. We have repeated the preparation of Butenandt and Suranyi, and have confirmed the properties recorded for this substance and for the corresponding diketone obtained on oxidation. The properties of "17-ketosteroid II" and *i*-androstenolone are compared in the accompanying table.

	17-Ketosteroid II	*i*-Androsten-6-ol-17-one
Melting point	140·5–141°	139–140°
$[\alpha]_D$ in alc.	+121°	+122°
Melting point of diketone obtained by oxidation	185°	184–185°

Our *i*-androstenolone showed no depression in melting point on admixture with "17-ketosteroid II" by Dr. Dingemanse, to whom we are most grateful for carrying out this comparison. The agreement in physical and chemical properties between the two compounds, together with this mixed melting point determination, proves that "17-ketosteroid II" and *i*-androsten-6-ol-17-one are identical.

The chloroketone, $C_{19}H_{27}OCl$, m.p. 151–152°, obtained by the Dutch workers by the action of hydrochloric acid on "17-ketosteroid II", must be 3(β)-chloroandrost-5-en-17-one, m.p. 155–157°, first isolated from urinary extracts by Butenandt and Dannenbaum[3].

So far as we are aware, this is the first report of the isolation of an *i*-steroid from urine or from any other natural source. Rosenheim[4] suggested that an *i*-steroid might be the precursor of the chloro-compound mentioned above. That *i*-steroids have not been detected previously in urine is doubtless due to the fact that the usual method of working up urine for its steroidal content (acid hydrolysis) must lead to the rearrangement of much or all of the *i*-steroids contained therein.

D. H. R. BARTON
Imperial College of Science and Technology,
London, S.W.7.

W. KLYNE
Postgraduate Medical School,
Ducane Road,
London, W.12.
June 29.

---

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Deodorization of Shark Liver Oil

SHARK liver oil, which is one of the cheapest and most plentiful sources of vitamin A in Nature, has a highly disagreeable odour which is very much more pronounced than that of cod liver oil. On account of its unpalatability it does not easily find favour with the consumers. The deodorization of the oil has to be effected in such a manner that the highly susceptible vitamin A is retained intact. Among the various methods that we have tried to achieve this result are: (i) steam-'distillation' of the oil under normal and reduced pressure in which the malodorous substances pass over with the steam; (ii) agitation of the oil with fermenting milk and toddy; and (iii) selective hydrogenation of the oil in the presence of a nickel catalyst.

Steam-treated oils are fairly free from odour when freshly prepared, but revert in the course of a few days to their original character. Oils, deodorized by agitation with fermenting milk or toddy, have been found to remain bland for several months. The accompanying data with regard to the chemical constants, potency and stability of oils deodorized with fermenting milk and toddy as compared with those of the original oil show that very little change in these vital characteristics is involved in the process.

Chemical characteristics

	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
Acid value	0·2	0·3	2·0	2·2
Saponification value	188	199	191	191
Iodine value	128	128	109	108

Vitamin A potency in international units per gram

Species of shark	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
Stegostoma tigrinum	1,200	1,100	3,800	3,800
Pristis cuspidatus	5,900	5,900		
Hammerhead	37,000	36,900		
Bulk sample	11,200	11,100	9,600	9,600

Stability of the oil

Time, days	Peroxide value			
	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
0	9·4	9·8	6·0	4·5
1	17·8	15·9		
2			21·4	23·6
3	47·8	46·4		
4	57·5	60·4	60·8	62·4
6	94·5	96·8	103·9	110·1
8	198·0	210·4		

Brocklesby[1] has indicated that hydrogenation of fish liver oils under carefully controlled conditions would eliminate the malodorous factors while the vitamin A itself may be kept unimpaired. Working with 0·1, 0·25, and 0·4 per cent concentrations of nickel catalysts prepared by the method of Adkins, Covert and Connor[2], we have obtained results which are quite promising. While 0·1 per cent of catalyst is not sufficient to effect complete deodorization (organoleptic test) within a temperature range of 100–180° C., 0·25 per cent of the catalyst effected fairly complete deodorization of the oil at 120° C. within 30–45 min. The percentage loss of vitamin A by this process is about 7, and stability studies have shown that the keeping quality of the oil has improved very considerably. 0·4 per cent of the catalyst caused increased destruction of the vitamin.

The accompanying table, giving results obtained with 0·25 per cent nickel catalyst at temperatures between 100° and 180° C. and reaction periods from 30 to 180 min., shows that the loss of vitamin increases progressively with increase in temperature and time of exposure.

	Time (min.)	Temperature (°C.)				
		100	120	140	160	180
Vitamin A*	30	97·1f†	84·0ff	93·0ff	89·0b	87·0
Vitamin A	60	92·9f	90·0b	85·5	74·8	71·2
Vitamin A	90	91·4ff	86·9b	76·4	68·0	56·9
Vitamin A	120	88·0b	80·2	70·7	56·7	43·0
Vitamin A	150	84·5b	74·3	64·3	48·0	31·3
Vitamin A	180	82·0b		57·0	42·1	20·2

* Percentage of original content.
† f = fishy; ff = faintly fishy; b = bland.

Further studies are in progress, and full details will be published as soon as they are completed. We are grateful to the University of Travancore for research scholarships awarded to two of us (P. K. M. and H. S.).

P. K. MATHEW
P. V. NAIR
T. A. RAMAKRISHNAN
H. SREEMULANATHAN
Department of Applied Chemistry,
University of Travancore,
Trivandrum, S. India.
May 26.

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Activities of Associating Solutes

THERE are comparatively few cases of binary mixtures in which the activity or fugacity of one component has been interpreted in terms of molecular properties. Well-known instances of such treatments are the Debye–Hückel theory of electrolytes and Hildebrand's theory of regular solutions. We have examined the case of a binary mixture where interaction between the two components is negligible, but where one of the components (the solute) has a tendency to form multiplets of any degree of complexity by means of association. Since interaction is assumed to be negligible, the non-ideality of the solute is attributable entirely to association, and each multiplet species (including the monomer) may be supposed to constitute an ideal sub-system. We propose to call mixtures of this type 'perfect associating mixtures'.

Since the solvent plays an entirely inactive part, a special case of this type is that of a gas, the ultimate molecules of which can associate to give multiplets. The second component (the solvent) is here replaced by the free space between the gaseous molecules. For sufficiently high temperatures and low pressures, each multiplet sub-species may be regarded as forming an ideal gas.

Examples of this type of system are certain solutions of polar solutes in non-polar solvents, and gaseous systems such as sulphur or iodine vapour at high temperatures.

The 'solute' will be considered as an equilibrium mixture of single molecules, doublets, triplets, etc. The total molarity (in terms of single molecules) of the solute will be denoted by n_s and the molarity of the various individual species (in terms of the appropriate multiplet molecules) by x_r. Here $r = 1$ for singlets, $r = 2$ for doublets, etc. If μ_r is the chemical potential of the r^{th} species, then

$$\mu_r = \mu_r^0 + RT \ln x_r. \qquad (1)$$

All species exist in equilibrium with one another, hence

$$r\mu_1 = \mu_r. \qquad (2)$$

If a definite volume of solution is considered (say 1 litre), x_r may be taken as the masses of the various species (expressed in moles). Hence if G_s is the Gibbs free energy of the solute as a whole

$$G_s = \sum_{r=1}^{\infty} x_r\mu_r = \mu_1 \sum_{r=1}^{\infty} rx_r. \qquad (3)$$

If μ_s is the chemical potential of the solute species as a whole

$$(\partial G_s/\partial n_s)_{T,P,n_l} = \mu_s, \qquad (4)$$

where n_l is the mass of the solvent in one litre of solution. For n_s, we can write

$$n_s = \sum_{r=1}^{\infty} rx_r. \qquad (5)$$

Equation (4) and subsequent equations derived from it would hold for solutions sufficiently dilute for n_l to be effectively constant, that is, for the volume of the solution to be approximately equal to the volume of the solvent. Thus, from equations (3), (4) and (5),

$$\mu_s = (\partial G_s/\partial \sum_r rx_r)_{T,P,n_l} = \mu_1. \qquad (6)$$

Writing the last equation fully,

$$\mu_s^0 + RT \ln a_s = \mu_1^0 + RT \ln x_1, \qquad (7)$$

where a_s is the activity (or the fugacity) of the 'solute' species as a whole. Since at infinite dilution n_s tends to x_1 and also to a_s, the standard chemical potentials μ_s^0 and μ_1^0 must be identical and hence

$$x_1 = a_s. \qquad (8)$$

For such mixtures, therefore, the activity of the solute (in molarity units) is identical with the molarity of the singlet species. For the conditions when this is valid (that is, volume of solution approximately equals volume of solvent), it is easily deduced that it is also true that the activity of the solute (in molality units) equals the molality of the singlet species. For the corresponding case for associating gases a similar treatment yields the result that the fugacity of the gas equals the partial pressure of the singlet species.

The application of this new relationship to certain gaseous and liquid systems will be discussed at greater length elsewhere.

A. F. H. WARD
L. TORDAI

Faculty of Technology,
University of Manchester.
May 25.

Autoradiography of the Thyroid Gland

AUTORADIOGRAPHY of the thyroid gland has been carried out by various methods: (1) mounting sections of tissues containing radioactive iodine on glass slides, applying these slides with pressure against the emulsion of a photographic plate[1]; (2) melting photographic emulsion and pouring it over a section[2]; (3) mounting the sections directly on the photographic emulsion[3]; and (4) a modification of (2), by removing from its base Ilford half-tone thin film, dry-stripping emulsion and mounting it on top of the slide-bearing sections[4].

The first method, although the stained slide and the developed photographic plate may be examined in conjunction, does not permit accurate localization. In the second method a heavy blackening of the emulsion may obscure the section, even though stained. Pelc[4] was unable to stain the section through the emulsion in the fourth method. The third is simple to use, and the section may be stained with ease, and precise histological localization of the blackening of the emulsion obtained. It is well suited for serial sections used in the present work.

In the present experiment, 25 micro-curies of radioactive iodine (I^{131}) was injected in the form of sodium iodide intraperitoneally into a normal adult male mouse. After two hours, the animal was killed with chloroform. The thyroid lobes were removed and fixed in aqueous formalin. Water-soluble iodine compounds are dissolved by aqueous fixatives and may either be removed from the tissue or translated. To obviate this, Pelc[4] fixed thyroid tissue in alcohol. However, it has been shown[5] that autoradiographs obtained by fixing thyroid tissue in aqueous fixatives do not differ from those obtained by freeze-drying. This indicates[6] that iodine is probably rapidly bound to protein in the gland and ceases to become diffusable. Aqueous fixatives are therefore admissible for thyroid autoradiographs.

Following fixation, the thyroid lobes were embedded in wax in the usual way, and serial sections of the whole gland were cut at a thickness of 7 μ. The ribbons bearing the sections were floated on warm water in a dark room and mounted directly on to the emulsion of Ilford thin-film high-resolution plates (4½ cm. × 6 cm.). All sections were mounted in series and dried overnight. Then the wax was dissolved off (paraffin wax absorbs some of the radiation). The plates were re-dried and kept in a light-tight box for six days, then developed by usual methods. The sections remained in place and were later stained with neutral red. (Hæmatoxylin and eosin) tends to obscure the blackened emulsion. Localization of radioactive iodine in the colloid of the follicles was clearly demonstrated by this method. It is known[6] that within half an hour of administration radioactive iodine has begun to accumulate in the thyroid,

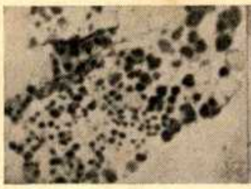

Fig. 1

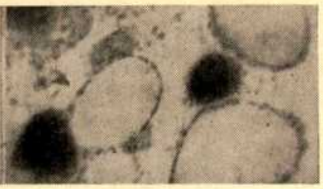

Fig. 2

Fig. 1. Low-power view (× 40) of autoradiograph of mouse thyroid. Small and medium-sized follicles are blackened; larger follicles are not

Fig. 2. High-power view (× 270) of part of autoradiograph of mouse thyroid. Two large follicles can be seen with practically no blackening of the colloid. In the top right-hand corner can be seen a further large follicle in which the follicular cells are taller than in the other large follicles in the section. The colloid has blackened slightly more than in the others. Two small follicles can be seen which have given an intense blackening

and in the present work (two hours after injection) most of the follicles had shown some signs of concentrating the iodine.

The smallest follicles appeared to have concentrated the radioactive iodine more rapidly than the larger follicles. (Hamilton[7] made a similar observation on the thyroids of two hypothyroid children.) In some very large follicles no blackening in the region of the colloid had occurred. In these the process of concentrating iodine was probably at a very low level or had ceased.

It was found that no part of the thyroid was more active than any other part in concentrating the radioactive iodine. Follicles of different sizes were scattered indiscriminately through different parts of the gland. All the small follicles with cuboidal or near-cuboidal cells had radioiodine in their colloid, and all the large ones showed varying amounts according to the degree of flattening of the epithelium. In some large follicles with moderately flattened cells—although the colloid showed no reaction—there was a rim of blackened emulsion surrounding the colloid and coinciding with the epithelium. It is of interest that blood vessels in the preparations, which must have been carrying radioactive iodine, showed no signs of having blackened the emulsion, presumably because the former is present in too low a concentration. Leblond[8] has shown that, 15 hr. after administration, radioactive iodine is present in greater amounts in acidophilic than basophilic thyroid follicles (Mallory's trichrome stain); he believes the difference is due not to the differing powers of storing radioiodine but to variation in time of retention. The present experiment (2 hr. after administration) suggests that iodine is still being absorbed and that the follicles store it at various rates, and that the more flattened the epithelium the slower the rate of storage (a not unexpected finding). The staining method used did not permit a satisfactory differentiation between acidophilic and basophilic follicles.

GEOFFREY H. BOURNE

Histology Department,
London Hospital Medical College,
London, E.1.
May 14.

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Effect of Phosphorus on the Hydrolysis and Absorption of Sucrose by Plant Cells

SOME years ago I demonstrated[1] that excised barley leaves from phosphorus-deficient plants showed considerably increased respiration intensities if their cut ends were immersed in neutral sodium phosphate solution instead of water. Feeding similar leaves with sucrose solution also increased the respiration-rates; but the increase was much smaller than when phosphorus was administered. The sucrose effect was less apparent when phosphorus deficiency was more acute. Still higher rates of respiration were obtained if the phosphorus-starved leaves were supplied with both sucrose and phosphate together.

Later, I showed[2,3] that when slices from storage organs are floated in sucrose solution, the latter is never absorbed by the plant tissues as such: but it is always first inverted in the medium and the products of inversion are afterwards absorbed. I have recently noticed the same phenomenon when the cut ends of plant leaves are dipped in sucrose solution, the sucrose being hydrolysed before its absorption. Feeding experiments on normal and phosphorus-starved barley plants are now in progress, and the results indicate that when excised phosphorus-starved leaves are dipped in sucrose solution, the rate of sucrose inversion in the medium and also the rate of uptake of the hydrolysis products are remarkably reduced. Feeding with neutral phosphate and sucrose together restores the normal hydrolytic and absorptive capacities to these plants.

This is interesting because it shows that in the early respiration experiments, the sucrose of the culture medium never entered the cells as such; and sucrose could not be synthesized inside the phosphorus-deficient cells because of the lack of phosphorus[4,5,6,7]. It is also evident that the respiratory substrate may be directly produced from sucrose hydrolysis[8,9,10]; but the latter process is extremely affected by phosphorus, being very much reduced under conditions of phosphorus starvation. In this connexion, it may be mentioned that Lyon[11] and Richards[12] advocated the view that phosphate is normally involved in the respiratory breakdown of sugar in plant leaves.

HUSEIN SAÏD

Faculty of Science,
Fouad I University, Cairo.

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Crystallization of Whale Myoglobin

ALTHOUGH the spectroscopic differences between blood and muscle hæmoglobin were first observed by Mörner[1] in 1897, it was not until 1932 that Theorell[2] succeeded in crystallizing myoglobin from horse-heart muscle.

The myoglobins from several species of animals have since been prepared by various workers[3,4,5,6], and recently Theorell[7] described the preparation of crystalline human myoglobin from heart muscle and from the urine of cases of myoglobinuria.

Whale meat is of a very dark colour, and since it is often available, it was of interest to establish whether it is suitable for large-scale preparations of crystalline myoglobin. Two methods of preparation are described below, and in each case good yields of crystalline myoglobin are obtained. For the production of larger crystals suitable for X-ray crystallography, the final crystallization must be carried out in phosphate solutions.

(*a*) *Crystallization of CO-myoglobin* (J. K.). The whale meat (about 4 kgm.) was roughly dissected to remove any neurovascular bundles while it was still frozen solid, cut into small cubes which were inspected for any remaining blood vessels and minced. The mince was extracted with an equal weight of water overnight in a cool place. The fluids obtained first by draining and then by pressing the mince in a hydraulic press were sometimes found to be very greasy and had to be centrifuged to remove the fat as a solid layer from the surface of the fluid. The dark red myoglobin solution was neutralized with 10 per cent sodium hydroxide to *p*H 7·3, and the bulky precipitate formed was removed by filtration through paper pulp. (For all subsequent filtrations a Buchner funnel with hardened paper was used.) The filtrate was brought up to 50 per cent and then to 70 per cent saturation with ammonium sulphate, keeping the *p*H at 7·3, and the resulting precipitates were in each case filtered off and discarded. The pigment which had by now oxidized to metmyoglobin was converted to CO-myoglobin (using a minimal amount of $Na_2S_2O_4$ as reducing agent) as this compound is more resistant to denaturation than metmyoglobin. The pigment was examined spectroscopically after each of the following manipulations, and carbon monoxide was passed through the solution when necessary. The myoglobin was next brought up to 80 per cent saturation with ammonium sulphate, rapidly filtered and the precipitate was discarded. The filtrate was dialysed against neutralized saturated ammonium sulphate until the myoglobin was completely precipitated, when it was filtered off, dissolved in distilled water and reprecipitated by dialysis.

The myoglobin was then fractionated by dialysis against neutralized ammonium sulphate at 60, 70 and 75 per cent saturation respectively, all precipitates being discarded. The filtered CO-myoglobin was finally dialysed against neutralized 80 per cent saturated ammonium sulphate until it was just faintly turbid, when it was transferred to a closed glass vessel and placed in the cold to crystallize. Whale CO-myoglobin prepared by this method forms needle- or lens-shaped crystals arranged singly, in sheaves, or in rosettes. Flat plate-like crystals with parallel sides have also been observed in the course of one preparation.

(*b*) *Preparation of Metmyoglobin crystals* (K. S.). This method was based on the known differences of solubility between the hæmoglobin and myoglobin of any particular species of animal in concentrated phosphate buffer, as described by Morgan[8] and Theorell[7].

A mixture of 491 gm. $NaH_2PO_4.2H_2O$ and 546 gm. K_2HPO_4 was added to 2,100 ml. of an approximately 1 per cent solution of CO-myoglobin previously fractionated with ammonium sulphate and dialysed against distilled water according to Theorell[7]. The resulting precipitate was filtered off and the filtrate saturated with the above phosphate mixture added in small amounts. The pigment having spontaneously oxidized during these manipulations, the precipitated metmyoglobin was filtered off on a Buchner funnel and the phosphate fractionation was repeated three times. After the second fractionation the α-band of the carbon monoxide compound as measured by the Hartridge reversion spectroscope remained constant at 5793 A. Small quantities of a mixture of 9·5 parts K_2HPO_4 and 17·0 parts $NaH_2PO_4.2H_2O$ were added with mechanical stirring until a small permanent precipitate appeared. This was filtered off on a hardened filter on a Buchner funnel. On standing at room temperature for 2–12 hours the metmyoglobin crystallized from the filtrate in dark-brown crystals belonging to the orthorhombic system[9].

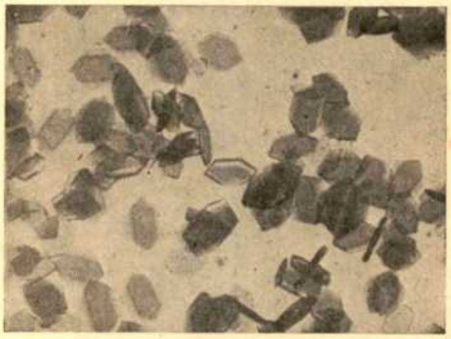

Fig. 1. Phosphate buffer. *p*H 5·7. 3·5 *M*. × 89

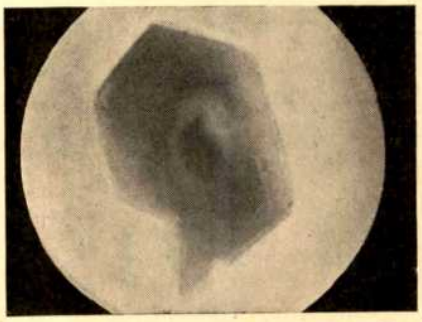

Fig. 2. Phosphate buffer. *p*H 5·7. 3·4 *M*. Large crystal. × 34

We wish to thank Prof. A. C. Chibnall for his interest in this work and Dr. J. G. Sharp of the Low Temperature Research Station for the whale meat. Thanks are also due to the Medical Research Council (J. K.) and to the Stiftung für Stipendien auf dem Gebiete der Chemie (K. S.) for personal grants.

JOAN KEILIN
K. SCHMID

School of Biochemistry,
Cambridge.
Aug. 3.

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THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, TRINIDAD

THE ceremony of the opening of the Colonial Microbiological Research Institute in Port-of-Spain, Trinidad, British West Indies, was performed on July 5 by Lord Hankey, in the presence of a distinguished gathering including the Governor of Trinidad and Tobago, Sir John Shaw; the chairman of the Standing Closer Relations Committee, Sir Hubert Rance; Prof. J. L. Simonsen, director of research of the Colonial Products Research Council; the principal of the University College, Jamaica, Dr. Taylor; the acting principal of the Imperial College of Tropical Agriculture, Trinidad, Dr. Shepherd; and delegates from other Caribbean countries, from the United States, Mexico, Venezuela, Honduras, etc.

Introducing Lord Hankey, the Governor expressed his satisfaction at the presence of Lord Hankey and of so many distinguished delegates; on behalf of the peoples of Trinidad and Tobago he thanked Lord Hankey for having chosen Trinidad for this undertaking, which he understood was to serve as a research centre for theoretical and applied microbiology for the benefit of the Colonial Empire as a whole.

In a message read by Lord Hankey, Sir Robert Robinson, president of the Royal Society, conveyed the following greetings from the Royal Society: "It is impossible to visit any tropical or sub-tropical country without becoming more and more insistently aware of the importance of general microbiological research. In the field of the pathogenic organisms this need has long been recognized, and to some extent satisfied, but the importance of the wider aspect has not been equally well understood. Entirely inadequate provision has been made for such investigations whether from the point of view of pure biology, biochemistry, hygiene and medicine, or of industry. When Dr. Simonsen and I visited Trinidad in 1944, the need for extended microbiological research was obvious to us as a special instance of the general thesis. It was clear, too, that the facilities that could be made available, the side-contacts, and the general conditions were favourable for the development contemplated. Not only the health of the community in the physical sense, but also in the economic sphere, was seen to be tied up with microbiology in its wider implications.

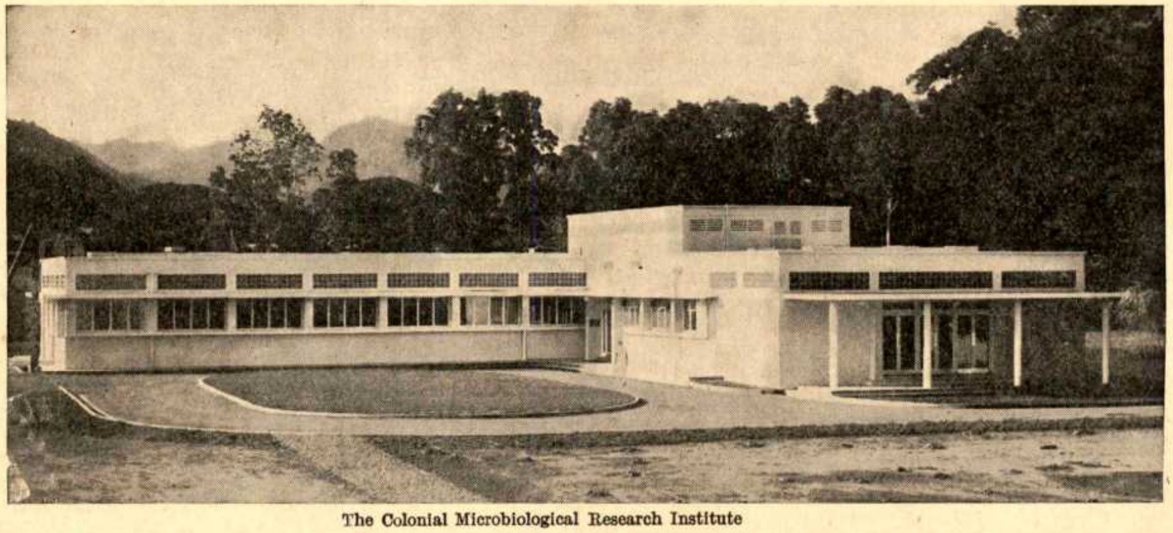
"On return to England, we found as a most fortunate and compelling circumstance that it might be possible to persuade Dr. Thaysen to undertake the organisation and first Directorship of a projected Institute for Microbiological Research. That was decisive and further steps taken are well known to you all. It is with real satisfaction that I send this message of felicitation to an Institute which I am sure is destined, not only to play an important part in the development of Trinidad and the Caribbean, but also to give an example to the rest of the world. It will surely make a significant contribution to science and we hope also to human happiness and prosperity."

In his address, Lord Hankey gave a brief review of British Colonial policy and organisation in scientific research and development in which the Institute is a link, and he sketched the history of the Institute's conception.

Amplifying Sir Robert Robinson's remarks, Lord Hankey asked: "Our aspirations! What are they? I dare not pitch them too high, or we may disappoint you. I must not pitch them too low, because, on a long view, they have no ceiling any more than has the blue firmament above Trinidad. But our first aspiration must be pure research; that wresting from Nature of her secrets; that process of getting to the bottom of things from which great results follow. Think of the pioneer work of Newton, of Faraday, of Herschel, of Pasteur, of Rutherford, and hundreds of others from which have been produced the marvels of modern science. Apply that thought to microbiology and you get some idea of our fundamental aims and ambitions for the microbiological institute.

"But we shall not limit ourselves to pure science. We shall continue, as hitherto, to exploit to the utmost the application of research for the benefit of mankind.

"It will interest you to know that, as the result of a recommendation by the British Commonwealth



The Colonial Microbiological Research Institute

Scientific Official Conference in 1946, the Microbiological Institute in Trinidad has become an official centre for the British Commonwealth for Culture Collections of Micro-organisms, where types of micro-organisms will be carefully preserved. That is essential if full advantage is to be taken of research in microbiology.

"I could give many further illustrations of what we have accomplished in our early, pioneer years, but I have said enough to give some impression of the kind of benefits we hope to derive from the pursuit of microbiology in this Institute; but in saying that, I must again emphasize that pure research must come first and that any deviation from that aim in pursuit of quick results might be calamitous."

Lord Hankey then went on to ask why Trinidad had been chosen for this important work. To begin with, he said, it was essential that the work undertaken in a new centre being intended mainly for the good of the tropical Empire should be undertaken within the tropics. "We were greatly influenced also," he continued, "by previous experience of the danger of placing such an Institute in isolation. Apart from the Caribbean Research Council, Trinidad already houses the famous Imperial College of Tropical Agriculture with its valuable library, and it seemed to us that to place the Institute within easy reach of the College should be of material benefit to both, owing to the close association with other scientists that each would enjoy. In this connexion it is very interesting that Dr. L. F. Wiggins, who has been prominent in assisting Sir Norman Haworth on the important work at Birmingham University on starch and sugar to which I have already referred, has recently been appointed by the West Indies Sugar Association as head of the new Department of Sugar Technology at the College. This should give a splendid start to the development of this branch of the College which was another of the suggestions made by Sir Robert Robinson and Prof. Simonsen.

"We had in mind also the opportunities that the Institute might afford for the important study of soil microbiology, and we did not overlook the prospects of invaluable contacts with the scientists of the Trinidad Government and of the refineries, oil companies and other industrial concerns in the island, as well as its associations, societies, and institutes. In particular we look forward to a close link with the University College of the West Indies.

"But to these more or less official reasons for the selection of Trinidad I would add one more, which makes a special appeal to me, as a layman, and is expressed in language more eloquent and more imaginative than I can command in the following passage from Charles Kingsley's 'At Last', chapter 14, entitled 'The High Woods', which was inspired by his observation of the Trinidad forest, while visiting the island in the last century: 'The eye is not filled with seeing, or the ear with hearing; and never would be, did you roam these forests for a hundred years. How many years would you need merely to examine and discriminate the different species? And when you have done that, how many more to learn their virtues, properties, uses? By what miracle they are compacted out of light, air and water, each after its kind? How, again, these kinds begin to be and what they were like at first? Whether these crowded, struggling, competing shapes are stable or variable? Whether or not they are varying still? Whether even now, as we sit here, the Great God may not be creating, slowly, but surely, new forms of beauty around us.' To sum up—in the words of Lucretius—'*Felix qui potuit rerum cognoscere causas*' (Happy is he who can know the causes of things. Lucretius, 'De Rerum Naturæ')."

After luncheon the company proceeded to the grounds of the Institute and here Lord Hankey unveiled a plaque with the name of the Institute engraved upon it, and opened the main entrance door with a key made of West Indian gold and presented to him by the architects who designed the buildings, Messrs. Watkins and Partners, of Bristol and Port of Spain. At the suggestion of the Director, Lord Hankey graciously consented to have his name associated with the culture collection maintained at the Institute as a link with Commonwealth culture collections of micro-organisms, and agreed that this culture collection in future should be known as "The Hankey Culture Collection" instead of the "Colonial Culture Collection".

A description of the Institute has already been given in *Nature* of July 3, p. 14.

Following the official opening, two morning sessions on July 6 and 7 were held in the library of the Institute. At the first of these Lord Hankey took the chair, and at the second, Prof. J. L. Simonsen. Many delegates and others read papers at these meetings, which were largely attended.

It is hoped, in due course, to compile an abbreviated account of the subjects dealt with in these discussions, and to issue them as a commemorative publication.

J. L. SIMONSEN

SOUND TRANSMISSION AND NOISE

A VERY successful symposium on sound transmission and noise was held during July 14–16 by the Acoustics Group of the Physical Society, with the kind co-operation of the Royal Institute of British Architects, in the Jarvis Hall of the latter, at Portland Place, London. The proceedings were opened by Mr. H. L. Kirke, chairman of the Group, and overseas visitors were present from the United States, France, Denmark, Holland, Sweden, Switzerland, Italy and Germany.

The opening session was devoted to problems of sound transmission. In the first paper, Dr. L. L. Beranek, of the Massachusetts Institute of Technology, described investigations he has been carrying out into the determination of the attenuation of single and multiple panels. To avoid the expense of the usual two-room method, he has developed a model test using panels 18 in. square giving results which agree well with full-scale tests and with theory. He has applied the theory to seven kinds of structures and has deduced charts which enable the attenuation, for partitions of known dimensions, mass and porosity, to be readily determined. Similar work in Great Britain at the National Physical Laboratory was described by Dr. G. H. Aston. He has not found any marked effect with size in the attenuation of glass windows, but there is an upper limit to the mass which it is worth while using set at 24 oz. glass by the compliance of the framing. With double windows there is an increase in attenuation with spacing even up to 7 in. at low frequencies, but 4 in. is sufficient at high frequencies. His work on plaster walls has shown a curious effect with time, the attenuation showing a cyclical variation during the first few days. He finds that strip metal ties for cavity walls provide much more coupling than wire 'butterfly' ties, especially at low frequencies.

Dr. Theodore Vogel, of the Centre National de la Recherche Scientifique, Marseilles, could not attend, but his paper on the transmission of sound by elastic panels was read by Prof. Canac. It gives a mathematical treatment of the vibration of a thin plate to waves of normal incidence using Lagrange normal co-ordinates. The resulting expression contains the simple piston result of Davis together with a term depending on the panel dimensions. Extensions of the theory to cases of double partitions and panels covered with porous coatings are given, and all the formulæ have been checked experimentally.

Mr. W. A. Allen, of the Building Research Station, Garston, Herts, traced the development of the party wall. The modern standard is an attenuation of 55 db., and no practical single-leaf construction has been found to give this. Two-leaf constructions of 3 in. and 4 in. thickness can reach the required standard; but it is necessary to give special attention to leakage paths, especially windows and chimneys.

Dr. Furrer, of the G.P.O., Berne, gave very interesting and useful information on the elastic properties of various materials in sheet or quilt form suitable for making floating floors to reduce impact sound. His results illustrate the good elastic properties of glass silk.

A joint committee representing Britain, Denmark and Holland has been formulating proposals for measuring insulation to air-borne and structure-borne sound, and these were put forward on behalf of the committee by Dr. Ingerslev, of Denmark. Air-borne insulation results should be corrected to a reverberation time of 0·5 sec. to match ordinary rooms. Impact sound insulation should be determined with closely specified apparatus, and subjective measurement is important. Analysers of ½ or ⅓ octave bandwidth are used and the results are summed. Dr. Aston described work at the National Physical Laboratory on the insulation of wood joist floors. Using a raft and pugging, he has attained 55 db. insulation to air-borne sound and 20 db. more than an ordinary floor to impact sound.

Measurements of impact sound at London, Copenhagen and Delft were described by Dr. Kosten. Discrepancies were removed by using the same tapping instrument, a 'Rawlplug' hammer.

A record of team-work by the National Physical Laboratory and Building Research Station staffs on the insulation of discontinuous structures was given by Mr. W. A. Allen. Mr. H. R. Humphreys described further work at the Building Research Station on floating floors, giving details of different constructions and results obtained in the laboratory and actual buildings.

The final paper for this session was read for Mr. Kipfer by Mr. P. Germain and described the method developed at the University of Brussels for measuring footsteps noises. In the discussion on the first day's papers, Prof. A. Giacomini made a plea for agreement on acoustical definitions and authors replied to questions, mainly on attenuation in structures. Cases of linear and geometric attenuation in decibels with distance were quoted.

The morning of the second day was devoted to papers of architectural interest, under the chairmanship of Mr. Hope Bagenal. Mr. W. A. Allen presented the results of a survey of domestic noise giving the proportion of people suffering in one way or another from noise. Banging doors appear to cause most trouble, but very careful framing of questions is necessary to obtain reliable information. He emphasized the strain due to self-imposed constraint on one's activities.

A large-scale investigation on a number of experimental flats at Rotterdam was described by Dr. Kosten. Several kinds of walls, ceilings and floors have been tried, together with resiliently isolated piping and sanitary installations. Dr. Kosten continued with a critical examination of similarity or scale tests, and his analysis shows the method to be very useful in determining sound insulation.

A short paper by Dr. J. L. Burn, medical officer of health, Salford, on noise in schools was read by Dr. King. The problem is outlined and results of noise measurements in typical schools are given.

Dr. Grunenwaldt's paper, also read by Mr. Germain, gives noise surveys of the ships *Prinz Albert* and *König Albert* and compares them with earlier surveys by Robinson. The engine rooms have been treated and show 102–106 phons.

Noise on board aircraft as it affects telephony was discussed by Mr. P. Chavasse, chief engineer of the Acoustic Department, Centre National d'Études Télécommunications, Paris. His paper gives general directions for improving telephonic communication on board and includes an analysis of the origin and nature of the various noises.

A complementary paper to Mr. Allen's on domestic noise was read by Mr. P. H. Parkin, also of the Building Research Station, on insulation of flats from sound. The complete programme outlined begins, logically, with a social survey, discusses methods of measurement of attenuation of air-borne and structure-borne sound and gives test results on typical constructions.

Prof. Canac's paper, which he gave in French, on the acoustics of ancient Greek and Roman theatres, came as a welcome change to many present. His studies of the theatres of Orange and Vaison have shown the importance of the various structural features and point out lessons. The relation between the various absorption coefficients was discussed by M. Grunenwaldt. His paper gives the experimental basis for a relation between the Taylor and Sabine coefficients.

In the ensuing discussion, Dr. Beranek referred to the calculation of loudness from analyses and Dr. King outlined the method, originally due to Dr. B. G. Gates, which he uses. Dr. Mintz, U.S.A. Navy Department, suggested an accelerometer instead of velocity meter for similarity tests.

The morning of the third day was devoted to noise measurement, the chairman being Mr. W. West. The opening paper by Mr. R. S. Dadson, of the National Physical Laboratory, gives a survey of the problem of noise measurement, outlining the difficulties in making measurements in the field in terms of the fundamental unit of equivalent loudness. He compares the performance of objective and subjective meters particularly on motor-car exhaust noise, and points out the necessity for general agreement on equal loudness contours and the summation of analyses.

Dr. A. J. King's paper on a portable objective noise meter refers briefly to the errors of sound-level meters on complex noises and describes a much simplified peak/R.M.S. meter. Readings on typical noises are compared with subjective and sound-level meters showing less errors than the latter.

A mains-driven meter operating on the same principle was described by Mr. D. A. Nutt. This instrument conforms to the standards of the Acoustical Society of America but also incorporates peak/R.M.S. measurement. It is intended for routine factory use.

M. P. Baron gave his paper on objective noise measurement in French. He feels that objective meter readings and summations from analyses are unreliable and should be confined to comparing similar noises.

In his paper, Mr. Maurice, of the B.B.C., deals with a different aspect of noise, namely, interference with broadcast reception. He has correlated subjective assessment of interference with readings by various meters and finds a weighted energy meter gives the closest correlation.

The paper by Lord Halsbury describing a rapid wave analyser was read in his absence by Mr. D. G. Jaquess. The instrument is a heterodyne analyser covering 0–30 kc./s. with provision for sweeps of $\frac{1}{4}$ to $\frac{1}{8}$ sec. and maximum resolution. It also permits more detailed examination of a 2 kc./s. band.

In his paper on the reduction of noise in aircraft, Mr. N. Fleming, of the National Physical Laboratory, deals with the contributions from the engine, propellers, aerodynamic flow and auxiliaries. He has studied octave frequency bands in each case and he shows the effects of power, tip speed and air velocity.

M. P. Chavasse read his paper describing an apparatus to produce complex sounds and artificial voices for acoustic tests in French. It is based on valve noise with suitable modulation to simulate the voice. Results obtained with it agree well with those for the natural voice.

In the discussion after this session, Dr. Beranek described recent work in the United States tending to confirm the level high-intensity equal loudness contours. He questioned the differences between pressure and field sensitivities of the ear, hinting at an obscure effect. He also asked for terminological agreement on 'random' and 'white' noise. Mr. Fleming objected to the indiscriminate use of phons for decibels, and Dr. Furrer asked about the calculation of loudness from analyses.

For the final session Mr. Kirke was again in the chair, and papers covered a wide range of applied acoustics. First, Dr. L. Cremer, who had only just arrived from Munich, read his paper on sound insulation at oblique incidence. Consideration of the travelling waves along a panel with a sound at oblique incidence suggested to him that grooves in the panel would improve attenuation. His paper gives the theory and experimental confirmation.

Dr. Kosten had had to return to Holland, so the joint paper on sound absorption in layers of material was read by J. van den Eijk. The paper gives the theoretical performance of such layers and includes experimental confirmation.

In his paper on noise in air ducts, Dr. Grunenwaldt gives the results of noise measurements on several ventilation systems with various air velocities and duct lengths. These data enable him to design duct systems for given room noise conditions.

The paper by Dr. A. Schoch, of Göttingen, on absorption by gradual transition gives the theory for successive layers of material of increasing density, leading up to the modern wedge construction. He takes as an example a linear wedge structure and gives curves for its performance.

Mr. C. A. Mason described the development of quiet chokes for use with fluorescent lamps. His paper examines the essential causes of the noise—magnetostriction and bad joints—and shows the stages followed in their reduction. He also considers the noise of a number of chokes.

In his paper on the elastic properties of rubber, Dr. E. Meyer, of the University of Göttingen, describes an elegant method using a sample in a resonant column of liquid. This gives bulk modulus and dissipation, while Young's modulus is given by longitudinal resonance or travelling waves. The frequency range covered is 10 c./s. to 20 kc./s. Effects of temperature and load are also discussed.

Mr. C. H. Bradbury's paper discusses the noise of machines, especially Diesel engines. He gives noise spectra and considers the pitched and unpitched components. He emphasizes the shock excitation of damped systems and uses a loud speaker to show up resonances. He also considers the effect of background noise.

Owing to the unavoidable absence of Prof. P. Bruel, Dr. V. L. Jordan, Mr. E. N. Storr and Mr. R. S. Hogben, their papers were not read but will be published in the *Proceedings*.

There were many contributors to the closing discussion. Among them, Mr. Fleming quoted work at the National Physical Laboratory disagreeing with Dr. Cremer on grooves and he also suggested that 'frequency of troubling' should be included in Mr. Allen's questionnaire. Mr. Mason asked about the critical frequency between dynamic-static properties of rubber, and Dr. Meyer gave it as 1 or 2 c./s. Dr. King said he was investigating the matter and thought it would be nearer 0·1 c./s. M. Brillouin gave a humorous contribution suggesting that the phon is insufficiently defined for practical purposes, but Mr. Fleming, chairman of the British Standards Institution Committee on Noise Measurement, gave a convincing reply.

A. J. KING

MIDDLE EAST OIL

THE name of that distinguished American geologist and statistician, Dr. Everette de Golyer, has been proverbial in international oil technology for many years past. He has an almost uncanny flair for predicting correctly the trend of events in the petroleum world, and his forecasts on developments in those countries comprising the Middle East are no exception. So long ago as 1925 the writer remembers de Golyer saying that "he expected from Persia a continued increase in production, as handling and marketing facilities are increased, so long as the fields may last". Nearly twenty years later, when leader of the United States Petroleum Commission to the Middle East, he stated that "the centre of gravity of world oil production is shifting from the Gulf – Caribbean area to the Middle East and is likely to continue to shift until it is firmly established in that area". That this has actually happened is probably not generally appreciated: the economic, technical and political implications of the fact have yet to be assimilated by the public, quite apart from the industry itself. To this end an up-to-date, straightforward survey of the position is essential to its understanding, and the *Petroleum Times* has rendered signal service by publication of its "Review of Middle East Oil" (London, June 1948, 7*s.* 6*d.*).

This review is not a mere compilation. It presents 'eye-witness' accounts of the shape of things concerning oil in Iran, Iraq, Bahrein, Saudi Arabia and Kuwait as they are to-day. It is based fundamentally on a two-months tour of the oilfields at the close of 1947 undertaken by Dr. C. T. Barber, joint editor of the *Petroleum Times*, with reinforcements by Dr. G. M. Lees, chief geologist of the Anglo-Iranian Oil Company, Ltd., Max Weston Thornburg, war-time petroleum adviser to the U.S. State Department, Christopher Holme, well-known writer and broadcaster on Middle East affairs, and T. D. Weatherhead, technical manager, Hunting Aerosurveys, Ltd.

Consider first some vital statistics that emerge from this survey. In 1936 the proved oil reserves of the world were proportioned as follows: U.S.A., 48·1 per cent; Middle East, 21·1 per cent; U.S.S.R., 12·9 per cent; Caribbean and Mexico, 9·7 per cent; and the rest, 8·2 per cent. In 1944 the figures were 33·9, 42·3, 9·0, 10·0 and 4·8 per cent, respectively. Thus in eight years Middle East reserves were doubled. Next are the production figures. In 1936, the U.S.A. produced 60·7 per cent, Middle East 5·4 per cent, U.S.S.R. 11·9 per cent, Caribbean and Mexico 13·2 per cent, and the rest 8·8 per cent of the world total output of crude oil. In 1947 the figures were 63·6, 9·8, 5·5, 17·3 and 3·8 per cent, respectively. Again, in the intervening years, Middle East nearly doubled its production. Further, with 42 per cent of world reserves, the Middle East produces 10 per cent of world output and in 1947 was drawing on reserves at the rate of 1·14 per cent per annum. By contrast, the United States with 33·9 per cent reserves produce 64 per cent of world output and are drawing on reserves at the rate of 9·25 per cent per annum. Still more striking, as Dr. Barber shows, is the fact that in 1947 Middle East production of 306 m. barrels was obtained from 223 wells, an average of 1·37 m. barrels per well, whereas the United States production of 1,985 m. barrels was obtained from more than 425,000 wells, an average of 4,660 barrels per well.

It is commonly believed that the present drastic rationing of petrol in Great Britain is a post-war legacy and a dollar-saving necessity. Why, it is asked, if we control such enormous oil production in the Middle East, is petrol so short in Britain, and why import from the Americas? The fact is that dollar-saving is not the whole story by any means. All over the world people are using more and more oil. In 1947 the American demand was 73·1 per cent more than in 1938; the demand in Great Britain was 45·3 per cent more; the British Commonwealth as a whole consumed over 100 per cent more, while other countries increased their demand by 17·2 per cent. In other words, the world oil demand has increased more than 50 per cent in the nine-year period, accounted for largely by heavily increased requirements of the United States for military, agricultural, domestic and transport purposes. C. J. Bauer has estimated that world demand in 1951 will be 23·4 per cent greater than that for 1947, and to meet this unprecedented rise the Middle East fields will have to increase production by 100 per cent by that year. From all that transpires in the present "Review of Middle East Oil" there appears to be no reason why this should not happen, particularly as the European Recovery Plan allows for 82 per cent of Western European demands for petroleum being met from Middle East resources in 1951.

Besides the purely economic aspects, technical developments of a high order of efficiency will be essential if the 1951 target is to be reached. In this direction optimism is well sustained, if past history of this great oil province is anything to go by. The achievements of the oil companies concerned, not excepting the cultural and social evolution of the native populations, constitute alike a fine record and a model of how things should be done in all spheres of exploiting mineral resources in virgin territory. The "Review" covers these activities and illustrates them, too, in a most convincing manner. It is a valuable publication, one to be commended to all who wish to understand the present problem of oil supply and its vital incidence on international politics in these critical times.

H. B. MILNER

CONCENTRATION OF COBALT BY MICRO-ORGANISMS AND ITS RELATION TO COBALT DEFICIENCY IN SHEEP

By Dr. J. TOSIC
Rowett Research Institute, Bucksburn, Aberdeenshire
AND
Dr. R. L. MITCHELL
Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen

WORK on wasting diseases in Australia[1,2] and New Zealand[3], and 'pining' in the United Kingdom[4,5], has established that cobalt is an essential factor in ruminant nutrition. Deficiency of cobalt results in various wasting diseases, the literature of which has been adequately reviewed[6,7,8,9]. In contrast to the ruminant, it appears that non-ruminants, for example, the rat[10] and the rabbit[11], require very little, if any, cobalt in the diet, for they can thrive on diets containing cobalt in concentrations much below those which would cause wasting diseases in ruminants.

Recent work[12,13], in which radioactive cobalt was injected intravenously into adequately fed cattle, showed that most of the isotope injected was excreted in the urine, and that only small amounts were found in the milk and saliva and none in the rumen content; radioactive cobalt introduced directly into the rumen was excreted chiefly in the fæces, and none was detected in the blood, saliva or milk, thus suggesting relatively poor absorption of the element. Although it is known that the liver is the storage organ for cobalt in sheep[14] and cattle[13], and that the cobalt content in the liver of a cobalt-deficient sheep is considerably lower than that in a healthy sheep on good pasture[14], the mechanism of the action of cobalt in animal nutrition remains still unknown. Using an as yet unpublished procedure[15] for the separation of rumen micro-organisms and other fractions of the rumen contents, and after chemical concentration[16] applying a spectrographic method[17] to the quantitative determination of cobalt in the rumen fractions, we have been able to demonstrate that rumen micro-organisms accumulate cobalt from their external environment. Since we find that a large proportion of the cobalt present in the rumen of a sheep is situated in the rumen micro-organisms, it is possible that in cobalt-deficient sheep the host and the microbial population of its rumen compete for the already low concentration of cobalt available in the feed, and in this way accentuate a deficiency at the place(s) of its physiological function.

In this work we have used three sheep with rumen fistulæ[18]. One, a two-year-old wether (*A*), gained weight on a seeds hay diet (0·27 p.p.m. cobalt in dry matter). The other two wethers, kindly placed at our disposal by Dr. A. T. Phillipson, of the Rowett Institute, and bred originally on a cobalt-deficient pasture, were maintained on a hay diet containing only 0·07 p.p.m. cobalt in dry matter but otherwise adequate. One of these animals (*B*) remained in poor condition (weight at 10 months, 60 lb.) and served as control, while the other (*C*) was dosed daily (during the morning feeding) with 1 mgm. Co (as cobalt chloride) for a period of six weeks. At the end of this period, when sheep (*B*) and (*C*) were about ten months old, rumen contents were collected (10 hr. after last feed) and fractionated. The fractions separated were examined microscopically and were as follows: fraction I, consisting mainly of protozoa and large rod-shaped bacteria, some smaller bacteria occurring singly, in chains, sarcina-like and in other irregular formations, in addition to a fair proportion of finer plant particles; fraction II, similar in microscopic appearance to I but almost completely free from protozoa and plant particles; fraction III, consisting principally of small cocci occurring mostly singly; fraction IV, consisting of coarser plant particles almost free from micro-organisms adhering to their surfaces; and fraction V, consisting of the supernatant rumen liquid after the separation of fractions I–IV, containing a small proportion of rumen micro-organisms still remaining suspended in the liquid. There was no marked difference in microscopic picture in comparable fractions separated from sheep *A*, *B* and *C*. The total dry matter, and nitrogen, ash and cobalt (on dry matter basis) were determined for each fraction, but for brevity only figures for cobalt are given (Table 1) in this preliminary note.

Our data show that, in the adequately fed sheep (*A*), the cobalt content of the micro-organisms is some three times the cobalt content of similar microbial fractions from the rumen of a sheep (*B*) consuming cobalt-deficient hay. But in sheep (*C*) consuming cobalt-deficient hay and dosed with 1 mgm. cobalt daily, the cobalt content of the microbial fractions is about five times that of a similar sheep (*B*) receiving no cobalt supplement. When cobalt contents of microbial fractions I, II and III are compared with those for the respective supernatant rumen liquids (cobalt content of which in *A* and *B* is probably contributed mainly by the remainder of suspended micro-organisms and in *C* by the daily dosage of cobalt supplement), and the hay fed, it is apparent that rumen micro-organisms concentrate cobalt from their external environment.

Table 1. Cobalt contents of microbial and other fractions separated from rumen contents of sheep fed cobalt-adequate hay or cobalt-deficient hay with or without addition of cobalt (as p.p.m. Co in dry matter)

Fraction	Sheep fed on:		
	(*A*) Adequate hay	(*B*) Cobalt-deficient hay with no cobalt added	(*C*) Cobalt-deficient hay with 1 mgm. cobalt added daily
Microbial (I)	1·85	0·58	3·51
Microbial (II)	3·81	1·49	5·70
Microbial (III)	3·80	1·55	8·25
Plant particles (IV)	0·19	0·12	4·00
Supernatant liquid (V)	0·12*	0·16*	1·94
Total rumen contents before fractionation	0·67	0·29	2·22
Hay as fed	0·27	0·07	0·07

* Probably due mainly to residual suspended micro-organisms.

Using our results in order to calculate the contribution of each of the separated fractions towards the dry matter of the unfractionated rumen contents, in Table 2 cobalt data are derived for each fraction in terms of micrograms of cobalt per 100 gm. of fresh rumen contents and as percentage recovery from, and distribution in, total rumen content. Good agreement has been obtained between the total cobalt in the rumen contents and the sum of the contributions of the individual fractions. From Table 2 it is seen that most of the cobalt found in the rumen contents is found in rumen micro-organisms (about 80 per cent in undosed animals), and that only a small proportion of the total cobalt is found in the external environment (fractions IV and V), except in sheep *C*, where greater amounts of cobalt were present in the supernatant fluid, due to the daily cobalt dosage.

From our findings it appears that, in sheep, the cobalt content of the microbial population of the rumen is related to cobalt concentration in the diet. If cobalt is essential for micro-organisms, but not for the host, then absorption of the element by the host

Table 2. Distribution of cobalt in separated fractions from rumen contents and contribution of those to the total rumen contents

Fraction	Sheep fed on:					
	(*A*) Adequate hay		(*B*) Cobalt-deficient hay with no cobalt added		(*C*) Cobalt-deficient hay with 1 mgm. cobalt added daily	
	μgm. Co/100 gm. rumen content	% of total rumen content	μgm. Co/100 gm. rumen content	% of total rumen content	μgm. Co/100 gm. rumen content	% of total rumen content
Microbial (I)	1·13	39·5	0·69	52·3	3·67	31·1
Microbial (II)	0·34	11·9	0·10	7·6	0·55	4·7
Microbial (III)	0·95	33·2	0·40	30·3	2·63	22·3
Microbial total	2·42	84·6	1·19	90·2	6·85	58·1
Plant particles (IV)	0·39	13·6	0·22	16·7	1·98	16·8
Supernatant liquid (V)	0·15*	5·2*	0·21*	15·9*	2·49	21·1
Total of individual fractions	2·96	103·5	1·62	122·8	11·32	96·0
Total rumen contents before fractionation	2·86	100·0	1·32	100·0	11·80	100·0

* Probably due mainly to residual suspended micro-organisms.

would deprive the micro-organisms of a factor essential for their growth and/or metabolism. It may even be that pining and other wasting diseases are due to cobalt deficiency of the bacteria, the animal requiring not cobalt but the bacterial products which have thereby become deficient. If cobalt is an essential metabolite for the host alone, then its concentration in micro-organisms may reduce its availability for the host. In this connexion it is of great interest that cobalt has been found to occur to the extent of 4·0 per cent of the crystals (dried *in vacuo*) of the naturally occurring anti-pernicious anæmia factor[19]. It is possible that both the host and the microbial population of its alimentary canal require cobalt for their respective metabolic activities. On a low cobalt diet these competitive relations may assume some importance in the etiology of cobalt-deficiency diseases. How far cobalt found in rumen micro-organisms, after leaving the rumen, can be made available for absorption by the host or for intake by its microbial population in the lower parts of the alimentary canal, and with what result, remains to be shown experimentally, together with the points raised earlier.

Full details of this work involving a study of several trace elements in rumen micro-organisms, and certain pure cultures of bacteria and yeasts, will be published elsewhere.

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LARDER OF THE RED-BACKED SHRIKE

MR. J. H. OWEN has given some interesting information about a bird the habits of which are little known to present generations because the bird has become so scarce (*British Birds*, **41**, No. 7; July, 1948). From observations it would appear that all red-backed shrikes (*Lanius c. collurio*) make larders provided they do not need the catch when it is taken. The male bird seems much more given to 'lardering' than the hen, and as many as six larders may be used by one pair of birds. Usually the larders are not far from the nest, but some have been reported 150 yards away. Often the number of larders is one or two. Shrikes prefer to nest in one of a number of isolated bushes, provided one of them is suitable, rather than in a hedge. Hedgerow larders are usually not at all easy to find. The favourite bushes are hawthorn or blackthorn, especially a part that has been killed by fire or some other means. The large thorns on rough briars and brambles are frequently used as larders, and occasionally barbed wire is also used. Larders often have a considerable number of humble-bees (*Bombus*) in them, often a small bird and, occasionally, a house-mouse (*Mus domesticus*) is found.

Queen humble-bees figure prominently in the larders. The birds usually devour workers and males, carder bees and honey bees (*Apis*) as they catch them. Sometimes wasps (*Vespa*) are taken and the remains found in pellets; but it is rare to find a wasp in a larder. Dor-beetles (*Geotrupes*) and cockchafers (*Melolontha*) are seen pinned up. Insects are usually pinned through the underside of the thorax, back uppermost; but occasionally some are pinned through sideways or through the back. The victims are often found alive. Larders are more likely to contain food at night than in the morning, and on cold misty mornings the larder that was well stocked at night is often empty. Among the young birds which were found were willow-wrens (*Phylloscopus trochilus*), whitethroats (*Sylvia communis*), linnets (*Carduelis cannabina*), and pipits (*Anthus*), while common lizards (*Lacerta vivipara*), field-voles and wood mice (*Apodemus sylvaticus*) are also taken.

The larder is used for other purposes than feeding. Often the old birds will carry sacs of excrement from the nest and place them on the tips of thorns in a regular larder. This always occurs when pellets are thrown up by the young. Attempts have been made to pin up dead small birds and mammals in the larders. Observations have shown that these have never been pinned up to the satisfaction of the shrikes, and usually a cock bird pulls the bodies free and fixes them elsewhere. There is a certain amount of evidence to show that the hen fetches food from the larder much more than the cock, although he alone may provision it. Both may use it to cram the young before a thunderstorm, for example, or if they have been kept away from the nest for some time.

T. H. HAWKINS

WAVE MECHANICS IN SCIENTIFIC RESEARCH

PROF. C. A. COULSON'S inaugural lecture as the first professor of theoretical physics at King's College, London, which he delivered on March 2, 1948, is printed in full in the July issue of *Science Progress* (**36**, 436; 1948). Taking as his subject, "Wave Mechanics in Physics, Chemistry and Biology", Dr. Coulson shows, by several well-chosen examples, that wave mechanics, in spite of its early successes, does not provide neat, complete solutions to all physical and chemical problems, thus obviating experimental research; but, as a branch of theoretical physics, is most useful in correlating different pieces of information and in bringing out the essential underlying character of what is observed and measured.

From de Broglie's concept of a particle as a wave, enunciated in 1924, Schrödinger in 1926 treated the simple case of the non-relativistic and unperturbed hydrogen atom and introduced the wave equation, that equation which replaces the ordinary Newtonian equation of motion of the particle. He showed that the rules of quantization were automatically obeyed. The subsequent generalization and wide application of Schrödinger's wave mechanics proved remarkably successful, but there were limitations. One-electron problems or problems with separable variables could be dealt with; but the equations for H_2, the simplest molecular problem, or for the reaction $H + H_2 \rightarrow H_2 + H$, which is the simplest three-electron problem of chemical interest, to say nothing of the more complicated problems of large molecules, are insoluble. These severe limits to the complete calculation of almost any single physical or chemical property led to considerable despondency, and this despondency, it is Dr. Coulson's belief, is due to a wrong conception of the true function of wave mechanics. "Wave mechanics", to quote Dr. Coulson, "is the key—or perhaps *a* key—to the future of physics, chemistry and biology. However, when we open doors with it we do not find completely worked out, neat solutions to all our problems, but new ideas, new principles, new understanding of processes the details of which we shall probably never calculate to 'so many' significant figures, and new relations between apparently unrelated properties."

The examples chosen by Dr. Coulson to illustrate his meaning are taken from fields in which he has made important contributions. They include: atomic and molecular structure, referring briefly to stereochemistry, and to the structure of benzene, which introduces the general phenomenon of 'resonance' and the idea of fractional bond order; electrons in metals, and the understanding of conduction, photo-conduction, fluorescence, etc., which has resulted from the idea of bands of energy-levels but without the band distribution of any single metal ever having been completely calculated; colour; chemical reactions; and finally, the very large molecules from which the nature of life may be determined.

THE HATHERLY BIOLOGICAL LABORATORIES, UNIVERSITY COLLEGE, EXETER

By PROF. JOHN CALDWELL

THE foundation stone of the Hatherly Biological Laboratories of the University College of the South-West, Exeter, was recently laid by the Marquess of Salisbury, president of the College, in the presence of representatives of the County, the City and the College. When the building is completed, as it is hoped, within the next two years, it will accommodate the Departments of Botany and Zoology, which are, at present, housed in very inadequate and cramped quarters in the Old College buildings in the centre of the city.

The War has, of course, greatly impeded the development of the College as regards buildings, and the estate which the College acquired some twenty-five years ago affords great opportunity for building development, though inevitably that development must be temporarily delayed. It is fitting, therefore, that the first of the post-war buildings should be for the Biological Departments in a College which serves primarily an essentially agricultural area, so that these Departments may have adequate space for the development of their work in the service of the community.

The erection of the Laboratories has been made possible by a bequest of the estate of Mrs. Heath, supplemented by grants from the University Grants Committee. The teaching and research work of the biological departments has expanded very greatly from the time of the appointment of the late J. L. Sager as head of the Department of Biology in the Royal Albert Memorial College in 1907. The scope of the Department increased rapidly right from the beginning, and in 1928 a Department of Zoology was set up under Dr. G. Lapage, who was succeeded on his appointment to Cambridge by Mr. L. A. Harvey, the present head of the Department of Zoology. Mr. Sager continued as head of the Department of Botany until his retirement in 1935, when he was succeeded by the present writer, who had previously been on the staff of the Department of Plant Pathology at Rothamsted Experimental Station. Both Departments in the College, as is common to all university departments at present, are overcrowded and badly in need of additional accommodation.

When the new Laboratories are completed, each Department should have adequate accommodation for reasonable expansion. Each will have three large main laboratories and a small laboratory for honours students, with adequate private rooms, preparation and lecture rooms. There will also be a large lecture room, museum accommodation and dark rooms, tank and constant-temperature rooms for general use.

The building, which is designed by Mr. E. Vincent Harris, is in the form of a main block with private rooms and caretakers' quarters on the front, with five bays running back from it in which are situated the laboratories. This arrangement will allow of the maximum of light being available in the laboratories without having a south exposure.

As the site is on the College estate on the outskirts of the city, there is a considerable amount of ground available behind and around the building, which it is proposed to lay out for botanical collections and experimental ground with glasshouses. The whole should eventually form an ideal unit for biological investigation and teaching. The Departments have now, even under the present conditions, a wide range of research work on hand. On the botanical side, various aspects of virus diseases are being studied, both on the more general side and on diseases of specific crop plants common in the region.

Other phytopathological work includes the study of the ecology of fungi in relation to plant disease, investigation of the Erysiphales, and of the rust of *Chrysanthemum* and similar studies. The cytology of various plants is being investigated as well as more general cytogenetical subjects. At the same time there is a considerable amount of work being done on the cultivation of various plants of some economic importance, and a study of their anatomy and physiology in relation to different cultural methods. It is hoped also to expand and develop an ecological survey of a portion of Dartmoor.

On the zoological side investigations are being carried out on the ecology of areas in the south-west with special reference to Lundy, on some aspects of parasitic protozoology and on some problems of human fertility.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, September 28

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Paul Bloomfield: "The Eugenics of the Utopians; the Utopia of the Eugenists".*

Tuesday, September 28—Thursday, September 30

Society of Chemical Industry (at the University, Leeds).—Conference on "Dust in Industry".

Tuesday, September 28

At 9.30 a.m.—"Physical Characteristics and Estimation of Dust"; at 2.30 p.m.—"Practical Aspects of the Dust Problem", Part 1.

Wednesday, September 29

At 9.30 a.m.—"Practical Aspects of the Dust Problem", Part 2; at 2.30 p.m.—"Fire and Explosive Hazards".

Thursday, September 30

At 9.30 a.m.—"Health Hazards"; at 2.30 p.m.—Summation of the Work of the Conference.

Wednesday, September 29

Television Society (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr. Arthur Blok: "Some Personal Recollections of Sir Ambrose Fleming" (Third Fleming Memorial Lecture).

Society for Visiting Scientists (joint meeting with A.S.L.I.B., at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Dr. F. R. Ranganathan: "Self-Perpetuating Classification—the Need and Possibility".

Wednesday, September 29—Thursday, September 30

Institute of Welding.—Autumn Meeting.

Wednesday, September 29

At 2.30 p.m. (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Discussion on "Technical Training for the Associate-Membership Examination of the Institute" (to be opened by Mr. T. R. B. Sanders).

Thursday, September 30

At 10.30 a.m. (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1).—Dr. H. G. Taylor: "Some Aspects of Welding Research in Great Britain and America" (Session arranged by the British Welding Research Association); at 2.30 p.m.—Discussion on "The Training of Welders" (to be opened by Mr. F. Clark, Mr. S. W. Carpenter and Mr. R. J. Fowler); at 6 p.m.—M. André Goelzer: "Repair and Reinforcement of Metal Bridges by Welding".

Thursday, September 30

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. Peter G. Masefield: "Some Economic Factors in Civil Aviation, with Emphasis on Civil Aircraft and their Prospective Trends of Development" (Fourth British Commonwealth and Empire Lecture).

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (in Room B 1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m.—Symposium on "The Limitations of Statistical Methods".

Saturday, October 2

Society of Public Analysts and other Analytical Chemists, North of England Section (joint meeting with the Physical Methods Group, at the Stork Hotel, Queen Square, Liverpool), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Technician to take charge of the Medical Unit Laboratory—The Secretary, St. Mary's Hospital Medical School, Praed Street, London, W.2 (October 1).

Scientific Officer (male) for work on cereal breeding, a Scientific Officer for work dealing with virus diseases of potatoes, and a Scientific Officer to work in collaboration with other members of the plant breeding staff on genetical and cytological problems—The Secretary, Scottish Society for Research in Plant Breeding, 8 Eglinton Crescent, Edinburgh 12 (October 2).

Lecturer (man or woman) in Agricultural Sciences, and a Lecturer (man) in Agriculture (farm implements, building construction, etc.), at the Cheshire School of Agriculture, Reaseheath, Nantwich—The Director of Education, County Education Offices, City Road, Chester (October 2).

Responsible Lecturer in Mechanical Engineering, a Lecturer in Mechanical Engineering, and a Lecturer in Mathematics for engineering students—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (October 2).

Assistant Agricultural Economist *or* an Investigational Officer and Clerk Accountant—The Registrar, The University, Leeds 2 (October 4).

Research Assistantships (2) for work on (*a*) physical and chemical aspects of selective flotation, and (*b*) mining research problems—The Registrar, The University, Leeds 2 (October 4).

Assistant Advisory Officer in Agricultural Botany—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (October 9).

Laboratory Technician in the Department of Organic Chemistry—The Registrar, The University, Liverpool (October 9).

Mechanical and Electrical Engineers in the Higher Departmental Grades in the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1 (October 12).

Research Officer to undertake research and assist in the work of the Photometry Laboratory (Ref. No. 1917), a Research Officer to assist in physical investigations at low temperatures (Ref. No. 1918), and Research Officers (2) to undertake research on the physical properties of wool fibres and related materials (Ref. Nos. 1919 and 1920), in the C.S.I.R. Division of Physics, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 16).

Research Officer in the C.S.I.R. Division of Industrial Chemistry, Melbourne, to assist in the X-ray crystallographic investigations of the Division's Chemical Physics Section—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Ref. No. 1913 (October 16).

Brotherton Research Fellowship in Physical Chemistry, and the Bradford Dyers' Association Research Fellowship—The Registrar, The University, Leeds 2 (October 18).

Assistant Professor in Inorganic Technology at the Faculty of Engineering, Fouad I University, Giza, Egypt—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (October 18).

Mechanical Production Engineer, and Mechanical Design Engineers (2), for the G.P.O. Engineering Department (Research Branch), Dollis Hill, N.W.2—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2288 (October 21).

Technicians (2) in the Engineering Research Laboratory; Technicians (4) in the Standards Laboratory; a Senior Mechanical Draughtsman and Mechanical Draughtsmen (2) in the Design Section; a Technician in the Workshops Planning Section; Toolmakers (4) in the Machine Room, and a Leading Hand Toolmaker and a Toolmaker in the Grinding Room, of the Precision Metal Workshop; a Technician in the Electrical, Electronics and Acoustics Laboratory; and Technicians (2) in the Instrument Testing and Development Section; of the Dominion Physical Laboratory at Wellington—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (October 30).

Life Fellowship in Botany—The Registrar, Trinity College, Dublin (January 1).

Entomologist in the Medical Department (Sleeping Sickness Service), Nigeria—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Works Chemist to undertake production and/or development responsibilities on shift work (if necessary) in a chemical factory of the Department of Atomic Energy, Springfield's Factory, Salwick, Preston—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Technicians (2, Grade III) in the Department of Botany—The Secretary, University College, Gower Street, London, W.C.1, quoting "Botany/1".

Laboratory Technician (Grade B) in the Department of Pharmacology—The Secretary, Medical College of St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

Senior Research Worker (with extensive experience in modern biochemical or experimental physiological methods as applicable to research in psychiatry)—The Medical Superintendent, Bristol Mental Hospital, Fishponds, Bristol.

Physical Chemist or a Physicist to undertake fundamental work on metal finishing problems including electrodeposition and electropolishing—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

Instrument Makers (2, Grades I and II) in the Department of Electrical Engineering—The Secretary, University College, Gower Street, London, W.C.1, quoting "Elec. Eng./1".

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of the Ministry of Health for the Year ended March 31st, 1947, including the Report of the Chief Medical Officer on the State of the Public Health for the Year ended 31st December, 1946. (Cmd. 7441.) Pp. viii+204. (London: H.M. Stationery Office, 1948.) 3*s.* 6*d.* net. [187

Quarterly Bulletin of the British Psychological Society. Vol. 1, No. 1, July 1948. Pp. 36. (London: British Psychological Society, 1948.) [197

Metallurgical Abstracts (General and Non-Ferrous). Vol. 13, 1946 (New Series). Edited by S. C. Guillan. Pp. viii+553. (London: Institute of Metals, 1946.) £3. [197

Catalogues

Technique, a Journal of Instrument Engineering. Vol. 2, No. 3, July. Pp. 17–24. (Beckenham: Muirhead and Co., Ltd., 1948.)

Sunvic Evacuated Bimetal Switches. (MS. 10a.) Pp. 2. (London: Sunvic Controls, Ltd., 1948.)

VHF Direction Finder with Remote Control and Presentation. (Ref. SL. 34.) Pp. 4. Marconi Broadcasting. (Ref. SP. 12.) Pp. 12. (Chelmsford: Marconi's Wireless Telegraph Co., Ltd., 1948.)

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FREEDOM AND OBLIGATIONS

IN the summary of the proceedings of the meeting of the Committee on Science and its Social Relations held in Paris during June 15–16 which has been sent to the scientific press and to scientific organisations, special emphasis is placed on a declaration on the principles of a charter for men of science. This declaration is the outcome of a discussion on the obligations and rights of scientific men in which due note was taken of the charter proposed by the World Federation of Scientific Workers and of a resolution adopted by the General Assembly of the International Council of Scientific Unions in London in July 1946. This resolution, which arose out of discussions on research on nuclear energy, affirmed the conviction of the International Council that international security and welfare would be impossible if in any country military secrecy be allowed to dominate scientific discovery or to prevent the frank discussion and open publication of scientific results. Accordingly, the General Assembly, in the name of the men of science of the nations represented, acknowledged in this resolution the duty on the part of scientific workers: (*a*) to maintain a spirit of frankness, honesty, integrity and co-operation and to work for international understanding; (*b*) to promote the development of science in the way most beneficial to mankind and to exert their influence as far as possible to prevent its misuse; (*c*) to serve the community not only by their specialized work but also by assisting so far as they are able the education of the public in the purposes and achievements of science.

The declaration now issued by the Committee on Science and its Social Relations points out that the prominent position held by science in society and the rapid transformation of the world through the application of science carry with them, for scientific workers, special obligations over and above the ordinary duties of citizenship. The Committee lists among these obligations the first two recorded in the resolution from the International Council of Scientific Unions, and adds three others: to examine consciously the meaning and purposes of the work that he or she is performing; when in the service of others to inquire into the purpose for which the work is being done and the moral issues that may be involved; and to assist in the education of the people and government in the purposes and the achievements of science. Furthermore, to fulfil these obligations, the Committee urges that it is necessary to claim certain rights for scientific workers, and especially: (i) freedom of publication and the utmost freedom to discuss one's work with other men of science; (ii) economic security and the right to participate freely in all activities permitted to all citizens; (iii) the possibility of obtaining information about the purposes for which his or her work is being done.

Now the obligations detailed by the General Assembly of the International Council of Scientific Unions are clearly in line with the rights defined in the United Kingdom draft of an International Bill of Human Rights, as well as with American opinion in this field, and are the counterpart of the freedom of speech and publication and information set forth in that draft, though it should be noted that however admirable the sentiments it is not easy in practice to give precise meanings to some of the terms. There may well be acute differences of opinion in interpretation and even sharp dispute. The further obligations and rights detailed in the new declaration from the Committee on Science and Social Relations, however, bristle with such difficulties and require very careful scrutiny before they can be accepted for what they purport to be and held universally valid.

In the first place, when the proposed charter substitutes an over-riding professional loyalty, something in the nature of a Hippocratic oath, for the strong national loyalties of to-day, it is as well to be quite clear as to the consequences. Something of what may arise is indicated by the circumstances in Britain which last spring forced the Government to exclude from a certain range of appointments Communists and others whose particular political loyalties were suspect of over-riding national loyalties. Though there may be a large measure of international agreement on the traditional loyalty of any profession, it is imperative, in a world where international loyalty itself has commonly so little force, that national loyalties should not be disregarded too lightly, however untoward some of their consequences may be.

The framers of this declaration obviously had in mind the increasing use of science for military ends; but they do not appear to have taken sufficient account of the position of the individual scientific worker. It cannot seriously be maintained that the professional organisation of even, say, chemists is sufficiently strong and virile to afford a chemist the support and anchorage anywhere in the world which will enable him in any circumstances to refuse to work for military ends. If, say, under a dictatorship, persecution or other means compels him to do so, while in democracies and elsewhere he refuses to do so, the practical result might be the overthrow of the democracies and probably of science with them.

Viewed from this angle and without other measures, the charter might well be of no more value than the Kellogg Pact. The work of most men of science, however, is not primarily or even secondarily connected with preparations for war. Most of them are engaged in some form or other of work in industry, and the terms in which the obligations and rights of the scientific worker are set forth by the Committee on Science and Social Relations seem to take very imperfect account of that fact. The freedom of publication and freedom to discuss his work with other men of science must in industry be subject to some limitations. In practice, industry in Britain does pursue an increasingly liberal policy towards publication of research results; but while, for example, the practice of patenting remains, there are clearly other considerations, and the responsibility for decision as to publication and public discussion must remain one for management. Indeed, the claim that the man of science should be fully informed about the purposes for which his work is required makes it more essential from the point of view of industry that the management should retain the responsibility for decision as to publication. The whole trend of thought and policy is towards giving all workers more information as to the reasons for the work as the best means of securing wholehearted co-operation, and the Barlow Report on Scientific Staff and other reports have emphasized the importance of taking scientific and technical staff into the full confidence of the management. The wisdom of that practice was demonstrated repeatedly during the War in the case of what is commonly described as 'operational research'.

That, however, is reciprocal. The confidence of management in the scientific worker must be met by a readiness on the part of the scientific worker to respect that confidence, and by the understanding that there are times when it is not in the public interest to disclose information acquired in confidence. The disclosure of confidential information cannot be claimed as a right, above all in the face of a formula which almost enjoins a scientific worker so minded to pry into the whys and wherefores of what he is doing. While very few would be likely to abuse such a right, no commercial firm could be expected to tolerate the absurd position which might arise, and any charter intended for universal acceptance must have regard to the conditions of every life in which the rights and responsibilities it adumbrates will be exercised.

What sometimes appears to have escaped the minds of those responsible for drafting the present charter is that freedom and rights are contingent. Seldom, if ever, can they be regarded as absolute. That much was implicit in the United Kingdom draft of an International Bill of Human Rights, and discussions at Geneva and elsewhere have indicated not only the difficulty of giving precise definition to rights which could be legally enforceable, but also the value of a declaration as opposed to a legally binding international agreement. A declaration which, without being Utopian, represented the practice of the most advanced countries might be accepted sincerely as a standard, and may well prove to be the most satisfactory solution to the problem so far as it touches men of science.

Much searching and honest thought will have to be given to the problem if a set of formulæ is to be derived which can command universal assent and respect without being too vague to be of value. The present declaration cannot be regarded as more than a contribution to the discussion, if indeed it were ever intended as more. At least it deserves to be examined and criticized constructively by those more familiar with the problems of industry and competent to assess the position of the industrial scientific worker than the members of the Committee on Science and its Social Relations itself would appear to be. The ethical and moral basis of world order and international co-operation will not be achieved without an intellectual effort at least comparable with that through which the discipline and tradition of any profession have been developed.

NATURE AND COGNITION

Natur und Erkenntnis

Die Welt in der Konstruktion des heutigen Physikers. Von Prof. Arthur March. Pp. viii + 239. (Wien: Springer-Verlag, 1948.) 21*s*.

THE author, who is well known as one of the pioneers in the field of quantum theory, has in this book made the attempt to present the fundamental ideas of modern physics without the use of mathematics in such a way that an intelligent reader could really understand their implications. For this purpose it is of paramount importance to analyse in everyday language the hidden meaning of the mathematical formalism. This is a tremendous task, and it seems doubtful if readers who have no knowledge of higher mathematics can in this way be made to understand what is meant by infinite matrices, eigenvectors, invariants, etc. A few chapters are devoted to the discussion of the nature of particles and of waves, and the author makes every effort to explain the apparent contradiction between the two aspects of one and the same phenomenon. In spite of this, I think, the average reader will sometimes feel rather giddy from the exertion of having constantly to change his angle of view during complicated discussions, like the one on the meson theory of nuclear forces.

The most important part of the book is that in which the author attempts to explain, in a generally intelligible way, the idea of a fundamental smallest length in Nature, and in his foreword he confesses that he has written the book mainly for this purpose. As the Planck constant h restricts the detailed description of events and reduces them to 'elementary acts', similarly the existence of a smallest length l_0 restricts the measurement of space (and consequently of time), and puts a limit to the analysis of space and time relations. It is shown how by the introduction of this new principle certain serious difficulties concerning the interaction of fields and particles can be removed satisfactorily.

The author also tries to make the reader acquainted with the philosophical implications of the quantum theory. His own attitude as that of a 'phenomenologist' is to object to the use of 'not measurable' quantities in a physical theory, although he raises no objections against the use of continuous coordinates (which are not measurable according to the principle of a smallest length) or against the use of complex wave functions (which are not 'observable' quantities in quantum mechanics). He maintains that present-day quantum theory already provides the fullest possible description of the physical world and that we simply have to accept as a not further explicable fact that the individual phenomena are not subject to the law of causation, but that it nevertheless applies to mass phenomena. This sounds rather like Du Bois Reymond's defeatist "ignorabimus", and the majority of scientific men will prefer Hilbert's famous motto: "We must know and we shall know".

The book is not intended to describe the historical development of the ideas to which it is devoted, and so the names of the discoverers of the most important facts and ideas are only casually mentioned. But certain omissions are to be regretted; although, for example, the statistical interpretation of quantum mechanics forms one of the main fundamentals of the author's discourse the name of the originator of this idea, Max Born, is not even mentioned. The inclusion in the book of a short historical review with names and data and references to original literature, and an index of subjects and authors would certainly increase its value.

The book makes very enjoyable reading because of the charming way in which the subject is presented, although it was written under most distressing external conditions. It is to be hoped that it will be translated into English so that it may become available to a broader public in this and other countries.

R. FÜRTH

A REVIEW OF TRACER WORK

Dix ans d'application de la radioactivité artificielle

By Dr. Pierre Süe. Pp. 258. (Société d'Éditions Scientifique, Paris, 1948.) 675 francs.

THE Scientific Information Conference held by the Royal Society during June 21–July 2 has directed the attention of wider circles to the importance of the work of abstractors and reviewers for the progress of science. One of the Conference's recommendations was that "senior scientists should regard the provision of reviews as an important ancillary to the pursuit of new knowledge". It is obvious that the need for such help is greatest in rapidly expanding branches of science, as, for example, radioactivity.

That scientific workers in other countries are of the same opinion is shown by the survey on the use of radioactive tracers just published in Paris. The author is Dr. P. Süe, research director in Prof. Joliot's Laboratoire de Chimie Nucléaire. It represents a practically complete compilation of the relevant literature up to September 1947. The essential part is a chapter in which the material is arranged according to the subject of the researches; if the title of a paper does not seem sufficient, a brief summary of its content is added. Only the author of the paper and a number are given in these tables; the bibliographic reference is to be found in the succeeding alphabetic list of author names. If there are several authors, only the first one is mentioned, which makes it, unfortunately, impossible to trace in this way the other authors whose existence is indicated by an "et al." only. A third list which will frequently prove helpful, arranges the papers according to the radio-elements used.

The book begins with a survey of all radioactive nuclides, based largely on the well-known tables published by Prof. G. T. Seaborg in 1944. The fact that the author found it advisable to reproduce, for the benefit of his readers, so much published material shows very clearly the present weakness of our arrangements for the distribution of scientific information; for the re-setting of such complicated tables is an unpleasant task where the danger of misprints can only be avoided by very time-consuming proof reading. However, the printers and correctors seem to have been very successful, more so here than in other parts of the book; but for the errors which do occur in this first edition, certainly no excuse is needed. One regrets that, besides misprints, different types of lettering have sometimes been used by the printer without any apparent reason, and that there is no clear system in abbreviating the titles of the scientific journals, one and the same appearing under very varied contracted forms. It would no doubt have been useful to add a list of the abbreviations used, especially as some of the rarer ones can scarcely be interpreted by the average reader, and the understanding of others is made more difficult by printers' errors.

So long as the compilation of such reviews remains the arduous task of busy research workers they will always have to choose between the two evils: of allowing a number of inconsistencies and errors to remain, or to delay publication with the risk that some of the material will already be out of date when the book appears; the only way out of this dilemma seems to be the preparation of such reviews by permanent staffs of professionals and, if possible, in an international organisation. Pending that, the very comprehensive and well-arranged bibliography given to us by Dr. Süe will be found most useful by all laboratories working on radioactive tracers. Nothing equivalent seems to exist yet in the Anglo-American literature, although the bibliography contained in Appendix 5 of the Fourth Semiannual Report of the U.S. Atomic Energy Commission, which lists all papers on isotope utilization that have recently come to the attention of its Isotopes Division, is similar in arrangement. F. A. PANETH

LOW TEMPERATURE PHYSICS

Low Temperature Physics

By Dr. L. C. Jackson. (Methuen's Monographs on Physical Subjects.) Revised second edition. Pp. vii + 130. (London: Methuen and Co., Ltd., 1948.) 6*s.* net.

THE great attraction of low temperature physics as a field of research is that so many of the phenomena still lack any fundamental theory, so that the outcome of any new experiment is rarely a foregone conclusion. The outstanding phenomena at present requiring something deeper than 'phenomenological' theories are superconductivity and the properties of liquid helium, and other as yet unsuspected phenomena may come to light when the new range of low temperatures below 1° K. is properly exploited. The interest of these problems was beginning to be more widely recognized just before the War, and with the resumption of scientific work after the War there has been a great expansion, particularly in the United States, of the facilities necessary for research at temperatures within a few degrees of the absolute zero.

The appearance of a second edition of Dr. Jackson's excellent monograph is thus particularly timely, both because of this increased interest and of the considerable advances made since the first edition appeared in 1934. Dr. Jackson, who was a pupil of Kamerlingh Onnes at Leyden some twenty-five years ago and is at present in charge of cryogenic work at Bristol, writes with the authority of first-hand experience. The treatment (which is essentially the same as in the first edition, but brought up to date) combines very successfully an account of the general principles of each topic discussed with just sufficient practical detail and numerical data to make the description come alive; theoretical results are not usually derived in detail but enough is said to give a qualitative idea of where they come from, and references to more detailed treatments are indicated. In such a short book it is impossible to cover more than a selection of topics, and a wise choice has been made both of subjects which are of interest as topical problems and those needed as a background to appreciate the significance of the latest work. After two introductory chapters on the production and measurement of low temperatures, the main headings are the properties of helium, specific heats in general, electrical conductivity (including superconductivity) and magnetism. Not only may the book be warmly recommended as an excellent introduction for the final honours student or the intending research student, but it may also be read with benefit as a well-balanced survey by those already working in the field. D. SHOENBERG

AMERICAN WAR-TIME CONTRIBUTIONS TO STATISTICAL METHOD

Selected Techniques of Statistical Analysis for Scientific and Industrial Research and Production and Management Engineering

By the Statistical Research Group, Columbia University. Edited by Churchill Eisenhart, Millard W. Hastay and W. Allen Wallis. Pp. xiv + 473. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 36*s.*

IN the United States, as in Great Britain, the value of statistical method and technique became especially recognized during the War. This was an inevitable outcome of need, but is perhaps also some tribute to the contributions of the comparatively few statistical workers. The Statistical Research Group of Columbia University worked for the Applied Mathematics Panel, Office of Scientific Research and Development. One of its major contributions to technique was sequential analysis, the subject of an independent monograph recently prepared by its principal creator, A. Wald. The editors of the volume under review had the rather difficult task of assembling other much more miscellaneous work, which arose as "almost a by-product of the responsible and co-operative handling of practical military, scientific, engineering, and production problems".

They have done this with a series of more or less self-contained and independently written chapters by various authors. These have been arranged in three parts: the first, on "Industrial Statistics", including two long chapters by W. Allen Wallis on the "Use of Variables in Acceptance Inspection for Percent Defective" and by Harold Hotelling on "Multivariate Quality Control, Illustrated by the Air Testing of Sample Bombsights"; the second, on "Planning Experiments"; and the third on "Techniques and Tables". Unfortunately this arrangement is at times extremely arbitrary; for example, it is not very obvious why two technical investigations by Churchill Eisenhart on the "Effects of Rounding or Grouping Data" and the "Inverse Sine Transformation of Proportions" should be allocated to different parts. The references to sequential analysis seem unsatisfactory, an elementary account by Wallis concluding the volume, whereas the first chapter includes a sequential problem of strictly more complex type.

Such limitations cannot, however, be entirely avoided in an *ad hoc* collection of this kind. Provided it is not regarded as a text-book, but as a record of miscellaneous work, it serves two purposes: (1) as a reference book (with some useful tables and charts, and an almost too exhaustive index); (2) as an indication of the potential value of such techniques, in peace as well as in war, to its intended readers—"scientists, engineers, managers, and statisticians". One may wonder how much the middle two, at least, of these groups like the presentation, and might not have preferred the technical notes concluding some of the chapters to have spread to cover most of the exposition, leaving a simple introduction in each case to summarize the article. This would, however, have meant still more editing to meet a rather speculative requirement, for many engineers and industrialists have by now recognized the value of statistical techniques and do not need to be so spoon-fed. Perhaps before long even the claim in the preface that "the chemical, physical and engineering sciences are, on the whole, distinctly backward in the statistical planning of experiments and the analysis of empirical data, at least by comparison with the social, biological, and agricultural sciences" (compare the war-time success of biologists in the kindred subject of operational research) will no longer be tenable.

M. S. Bartlett

FRENCH PALÆOLITHIC ART

Le centre préhistorique de Ganties-Montespan (Haute-Garonne)

Par Félix Trombe et Gabriel Dubuc. (Archives de l'Institut de Paléontologie humaine, Mémoire 22.) Pp. 128. (Paris: Masson et Cie., 1947.) 1,200 francs.

This *Mémoire* of the Archives de l'Institut de Paléontologie humaine deals with palæolithic art discovered in the side galleries of an underground river by Monsieur Casteret in 1922. Near the little village of Ganties in the region of Saint Gaudens to the south of the River Garonne there occurs a sort of natural reservoir at the base of a low chain of limestone hills which separate Ganties from another little village, Montespan. During æons of time the waters which accumulate in the 'reservoir' have filtered through the limestone hills, eventually forming an underground river which comes out at Montespan to form a small tributary of the Garonne.

During the exceptionally dry summer of 1881 the water in the 'reservoir' fell so low that the underground river was for the first time disclosed and partially explored. Since then the water always stood too high and no further exploration was possible until 1912, when an artificial entrance was made. In 1922, however, Monsieur Casteret dived under a siphon at the Montespan exit and started to explore the underground river from that end. In some dry side galleries he came upon examples of palæolithic art—engravings, clay tracings and modelling, etc.—and these have now been made more accessible. In the vicinity are some rock-shelter 'homes', where traces of upper palæolithic man's handiwork, including some examples of the 'home' art, have been found.

Monsieur Casteret found no strikingly beautiful works of art, nor do paintings occur; no lovely painted bisons like those in the cave of Niaux, which is not so very far away, were discovered, but the finds are none the less of considerable interest. Some of the engravings, judging by their style, were probably the work of Aurignacian man, as too were most of the tracings in clay which recall closely those of the cave of La Clotilde in northern Spain. The rest of the engravings would seem to be early Magdalenian in date. The discovery of the body of a cave bear modelled in clay raises some interesting problems. It had no head and it would seem may have been used as a stand over which the skin and head of a real bear could be thrown. This appears to have been used as a target, and many of the arrows, penetrating the skin, have left marks in the clay underneath.

The volume gives a full account of the site and the history of the discovery, and the prehistoric art is fully described and illustrated. As is true for almost all the *Mémoires* of the Archives de l'Institut de Paléontologie humaine, it is indispensable for the student of prehistory, and this is especially true if his interests are particularly focused on the upper palæolithic art.

M. C. Burkitt

BRITISH TRADE UNIONISM

British Trade Unionism

Six Studies by P.E.P. Pp. vii+184. (London: P.E.P., 1948.) 15*s.* net.

In several broadsheets, notably that on "Output and the Worker", in April 1945, "Inside the Unions", in May 1946, and "Framework of Collective Bargaining", Political and Economic Planning has already examined problems confronting the trade unions and their position in a society organised for full employment. The present report carries that examination a stage further. It is primarily a factual study of British trade unions and their place in industrial relations, and is intended rather to provide a firm foundation for the future study of policy than to indicate solutions to the numerous vital problems which it brings into the light of public discussion. The wider interest of the study, moreover, is derived from the relation of the inquiry and the discussion it seeks to stimulate to the larger problem of active democracy on which *Planning* is simultaneously engaged.

The six studies comprising the present volume cover first the structure of the trade unions, their size, hierarchy and the characteristics of union membership at the three levels distinguished in the earlier broadsheet: the national officials, the active branch membership and the rank and file. In emphasizing the dynamic human relationships, this study makes a welcome contribution to a wider and more sympathetic understanding of the unions on the part of the general public. This contribution is the more important as much of the second study is perforce purely descriptive, and the outline it gives of the formal machinery of negotiation loses something of this vital human touch because it is compressed to a mere sketch. The balance, it is true, is redressed by a concluding section which stresses the underlying similarities of the main types of machinery and the effect upon them of the increasing concern of government with wage levels.

In the third study the part played by the trade unions in the determination of wages is brought out, the factors determining wages are indicated and some of the implications of the social redistribution of income and of a national wages policy are briefly reviewed. The latter part of this study covers such other subjects of negotiation as hours and overtime, demarcation of crafts, apprenticeship and the like. The fourth study, entitled "The General Staff of Labour", describes the work of the General Council of the Trades Union Congress, the evolution of a central trade union policy and the relations of the trade union movement with the Labour party, with employers' organisations, the Government and, more briefly, with international bodies.

Valuable as are these studies in removing misconceptions regarding trade unions, the fifth study may prove to be the most important from that point of view. In this study of relations on the job, *Planning* gives a clear account of the position and functions of the shop steward that can scarcely fail to assist constructive thought on the whole question of organisation at the workshop level and the development of joint consultation, whether from the point of view of production or for other purposes. Moreover, the concluding section on psychological and other factors affecting relations indicates the importance of a number of the problems which the Panel on Human Factors of the Committee on Industrial Productivity is already examining.

For these factual studies, that Committee may well be grateful to Political and Economic Planning; but the last study, of trade unions in post-war Britain, which surveys trade unionism in relation to economic policy, full employment, nationalized industries and other major questions of the day is undoubtedly that which will have the widest appeal. This brilliant but sympathetic analysis should challenge constructive thinking within and without the unions, and indicates where the real psychological obstacles to high productivity and industrial democracy lie. For this study alone Political and Economic Planning has earned the thanks of all who are seeking the economic recovery of Britain, and no better approach could well be made to that essential task of education and the improvement of public relations than this concise and impartial assessment of opportunities, responsibilities and shortcomings.

CLINICAL ENDOCRINOLOGY

Clinical Endocrinology and Constitutional Medicine

By Dr. A. P. Cawadias. Pp. xii + 368 + 10 plates. (London: Frederick Muller, Ltd., 1947.) 42*s.* net.

THIS is an interesting and useful book. The author has made an extensive survey of the clinical conditions that can be attributed to malfunctioning of the endocrine organs, and has based his observations upon a reasoned picture of the "physiology and pathology of the neuro-endocrine systems". The introductory part of the book, which deals with this basic information, begins with a discussion of the concept of hormonal action and of the present trend for endocrinology to find its main links in the general field of metabolism. The rest of the introductory section is devoted to a general description of the "neuro-endocrine systems" of which the derivatives of the branchial pouches are part; of the neuro-metabolic systems based upon the gonads and the adrenals; and of those based upon the pituitary and pineal. By "system" Dr. Cawadias does not mean that a given endocrine substance is responsible for a series of changes that are part of a pattern of wider change which is influenced by the whole endocrine system. The term is used to emphasize the point that the endocrine organs work in a system with such neural structures as the hypothalamus, and that the latter in turn may be influenced by psychogenic factors. When he talks, for example, of the thyro-hormone system as being part of the neuro-endocrine system, he has in mind that cortical influences can affect the hypothalamus; the hypothalamus the anterior lobe of the pituitary; and the anterior lobe the thyroid; and that the whole thyroid system can be activated from any of these centres.

After its introductory section the book deals in turn with clinical disorders that relate to the thyroid, parathyroid and thymus group of glands; to those that relate to the gonadal adrenal group; to those of the pituitary pineal group; and to those of the pancreas liver group. The description of each disorder begins with a brief definition of the condition it discusses, and then surveys its etiology and physio-pathology, its signs and diagnosis, and its treatment.

The book is well written, and contains numerous interesting references to the older literature. References to recent advances in experimental endocrinology are, however, somewhat unnecessarily restricted. The illustrations are reproductions of drawings, and may not be to the taste of all readers.

NATURE CALENDAR

The Course of Nature

Through the Year from the Pages of *The Times*. Pp. 336. (London: Hodder and Stoughton, Ltd., 1948.) 10*s.* 6*d.* net.

"THROUGH the Year from the Pages of *The Times*" is the sub-title of "The Course of Nature" by W. Kay Robinson, well known as a sound field naturalist and an able writer, with a pen in the true Gilbert White tradition. He speaks of the changing seasons, the happenings of the passing days and reviews the pageant of the year in two weekly commentaries.

Beginning with "New Year Bird Songs" and the music of the great tit, "who seldom fails to ring his bell before this month is one week old", Mr. Robinson journeys interestingly onwards through the months to finish at Christmastide with the great tit once more trying his voice. On the way the author has much to write about; for example, one of his January notes deals with the "grey squirrel's New Year Celebrations". Commenting on the activity of the grey squirrel during the hardest of weather he goes on to say: "As one passes through the oakwoods one hears, first, a 'huff, huff, huff', followed by the queer sound which, beginning like a jay's harsh screeching, ends like a kitten's mew, and is possibly a love-call, possibly a challenge, or perhaps just means the squirrel is very much annoyed". The reviewer believes this cry to be a love-song, an idea supported by the date of birth of the young, many litters being born in February.

From squirrels to moles, from moles to waxwings, and then to redwings, flits the author's pen, commenting with regard to the last named on their inability to stand prolonged hard weather. "Though they come to us from colder regions to the north, the redwings seem constitutionally less fitted to withstand the rigours of winter than our own thrushes and blackbirds, and once the hedgerows have been stripped of berries they are in a bad way." But to appreciate this excellent survey of Nature through the seasons it must be read chapter by chapter, for it is full of good matter and that whether the month be January or June.

FRANCES PITT

Thomas Jefferson Among the Arts

An Essay in Early American Esthetics. By Eleanor Davidson Berman. Pp. xviii+305+20 plates. (New York: Philosophical Library, Inc., 1947.) 3.75 dollars.

IN view of the distinguished position occupied by the United States to-day, one is perhaps apt to forget what strife and labour went into the development of the young republic in the period of its third president. Those were times when 'art' was too expensive, yet in all its forms, so much to be desired. Thus we find Jefferson the revolutionary, workman, writer, thinker, toiling ever and anon to establish culture, both abstract and material, in his youthful America. To him there was no difference between 'pure' and 'applied' (whether art or science); all was for the benefit of mankind, and the pursuit of the good. Naturally, this led to some strong likes and dislikes, short shrift for Plato and Samuel Johnson, to mention but two.

Love of contrast is characteristic; formal Palladian architecture, surrounded by 'serpentine' gardens, as if to say "Oh Western Wind, blow soft and kind" upon the exceedingly solid and uncompromising stone buildings he admired and advocated. The author of the Declaration of Independence is entitled to such light and shade in his dealings with contemporary events.

The book itself is a careful document on the whole, somewhat disfigured by a fantastic misprint ("Nogarth" for Hogarth) on Plate 10, but pleasant to read and valuable for its references. It depicts Jefferson the man, very much a son of the *Enlightenment*, the master-craftsman of his age. F. I. G. RAWLINS

Magnetic Materials

By Dr. F. Brailsford. (Methuen's Monographs on Physical Subjects.) Pp. ix+156. (London: Methuen and Co., Ltd., 1948.) 6*s*. net.

THE appearance of this excellent monograph is opportune. During the past decade there have been immense advances in the quality of magnetic materials, both for cores of special transformers, electro-magnets, and particularly for permanent magnets, leading to greatly improved instruments, methods of measurement, and components generally. In one field alone, that of recording sounds on wire or powder, the whole process of magnetization had to be re-investigated, with a resulting new idea in the selection of material, leading to the sudden improvements which are about to be made commercial.

The author gives the clues to these reconsiderations, by relating the observed phenomena to defects in the shells of electrons and the rigidity or otherwise of the crystal lattice. Theory has indicated the lines of advance, and, in the laboratory, there are already 'better' (that is, better for special purposes) materials which are impracticable only by reason of cost.

The main purpose is, however, to give a complete story of the theory behind the materials, and this is offered with the utmost clarity. L. E. C. H.

Fahrten in Island

Von Rudolf Jonas. Pp. 198 + 83 plates. (Wien: L. W. Siedel und Sohn, 1948.) 3.50 dollars.

IN 1935 a party of Austrian scientists under Dr. R. Jonas and Prof. F. Nusser made a crossing of Vatnajökull, Iceland. The personnel was organised by the Austrian Students' Travel Association. The participation of the National Union of Students in England was proposed but could not be arranged in time. Some glaciological research was completed and part of the northern margin of the ice was mapped. This book is concerned mainly with that expedition and contains some good accounts of Icelandic scenery. The nunatak known as Mount Paul was rediscovered and fixed, and the crater of Sviagigur was explored. The numerous illustrations are excellent and the maps are adequate.

Cosmic Rays and Nuclear Physics

By Prof. L. Jánossy. (Frontiers of Science Series.) Pp. xiv + 186. (London: Pilot Press, Ltd., 1948.) 9*s*. 6*d*. net.

THIS is a more popular version of the book on cosmic rays by the same author which was reviewed in *Nature* of May 22, p. 785, 1948. The subjects treated, and their ordering, are much the same as in that book, though less detail is given. Theory is, in the main, omitted; but the most important formulæ are quoted, and a valiant effort is made to explain how they are derived. The book, like the earlier one, aims at comprehensiveness; but is not too well arranged.

The Frontiers of Science Series, of which the book forms part, aims at serving the non-specialist public who have outgrown the 'told to the children' approach. But this book can appeal only to a restricted public; for example, it introduces without explanation technical terms like azimuth, pentode, radius of curvature, electron volt, rest mass and energy, relativistic velocity, etc., and the fact that relativistic ideas are in principle explained later would scarcely compensate for the confusion which their first mention would evoke. The book could be read with profit by a man who has taken a science degree with physics as at least a subsidiary part, or by a brilliant schoolboy, and can be recommended to people like these. But it is not a popular book in anything like the usually accepted sense; it is a beginner's research manual, characterized by the researcher's inclusion of much detail, many references, and minor qualifications of general statements. It can be warmly recommended to people of the right sort; but one cannot agree that it achieves the avowed aim of the Series in that it "requires no previous specialized knowledge".

T. G. COWLING

Adventures with a Naturalist

By Roy Bedichek. Pp. 258. (London: Victor Gollancz, Ltd., 1948.) 12*s*. 6*d*. net.

THE scene of this book is in Texas, and its theme is the effect of the white man on animal and plant life. The author begins: "I have been looking over a two-hundred-acre plot of fenced land and trying to compare the life it now supports with that which it had been supporting for thousands of years when the first white man occupied it a hundred years ago". Although Mr. Roy Bedichek entitles his work, "Adventures with a Naturalist", although the title is excellent and he takes us on many delightful adventures observing a variety of birds, mammals and plants, we ever come back to the distressing effect of the white man, his agriculture and other activities, on the indigenous fauna and flora, an all too sad effect not limited to the American continent, but associated with him the world over. This is an interesting and pleasant book, despite its pre-occupation with a mournful theme, and covers a wide field of Nature and country life.

FRANCES PITT

GENETICS OF CANCER

ONE of the many problems arising from the study of tumour transplantation and of chemical carcinogens is the variable degree of susceptibility to cancer shown by different animal strains. This phenomenon has focused attention upon the hereditary basis of cancer, and a great wealth of experimental data has now accrued. The aim of the recent symposium on the Genetics of Cancer held in London during June 24–25, and sponsored jointly by the Genetical Society of Great Britain and by the British Empire Cancer Campaign, was to survey this field and direct attention to the significance of such recent discoveries in genetics as, for example, the role of cytoplasmic particles in heredity, differentiation and disease.

The symposium could cover only certain selected groups of problems, and the papers presented centred around three main topics: (1) the inheritance of tumours in animals, (2) the genetical aspects of virus-induced and chemically induced tumours, and (3) the inheritance of cancer in man.

(1) The genetical basis of tumour transplantation in mice was discussed by Dr. P. A. Gorer (London), according to whom tumour-transplantability depends on a number of genes, some of which determine the production of specific antigens, identified as the 'histo-compatibility' antigens. The high rate of polymorphism observed in various strains of mice by serological analysis Dr. Gorer attributed to the high rate of mutation of these genes, a fact which would also explain the frequent failures of tumour transplantation.

The genetical basis of tumour production and that of its transmission may be quite different in complexity, as was shown by Dr. G. Högreffe (Copenhagen). Transmission of leukæmia in the 'Aka' strain of mice seems to be due to a single Mendelian factor inherited as an autosomal dominant. From transplantation experiments, however, it became apparent that the genetical basis of tumour production is much more complex.

The genetical factors involved usually operate through various intermediate agencies such as hormones. When these intermediaries are analysed in isolation the primary biological factors of tumour production may be completely obscured, and this feature was well demonstrated by Dr. R. Korteweg (Amsterdam), who dealt with the influence of œstrogenic substances on tumour susceptibility. From his data it appears that the high incidence of mammary tumours in certain strains of mice is correlated with excessive secretion of œstrogens, and that at least part of the genetically determined disposition is caused by over-production of gonadotrophic hormone.

The complexity of the hereditary basis of tumour production was further emphasized by Dr. L. Dmochowski (Leeds), who analysed the interaction of mammary tumour-inducing 'milk-factor' and genetic constitution in the development of breast-tumours in certain high- and low-breast cancer strains of mice. Dr. Dmochowski arrived at the conclusion that there are two distinct sets of genetic factors, one controlling the susceptibility of breast tissue cells to the milk factor, the other controlling the propagation of the milk factor itself. The influence of hereditary factors on the production and transmission of the milk-agent was again made clear by Dr. W. E. Heston (Bethesda, U.S.A.), whose experiments have shown that the milk-agent is not itself active, but rather prepares the substrate, that is, the mammary glands, for the initiation and mediation of tumour production by genetic factors. Dr. Heston's analysis suggests that mammary tumours may be induced in the absence of the milk-agent through the provision or construction of certain genetic and environmental patterns.

(2) The alteration of the genetic structure of cells by chemical means is a subject of relatively late development in genetics, and throws light on the possible mechanisms underlying not only 'spontaneous' or naturally occurring mutations, but chemical carcinogenesis as well. Dr. M. Demerec (Cold Spring Harbor, U.S.A.) presented evidence that when *Drosophila* males were exposed to aerosols of seven carcinogens (four hydrocarbons, three azo-compounds) six such compounds were found to be mutagenic, while of nine non-carcinogens (five hydrocarbons, four azo-compounds) only two were mutagens. Somewhat similar results were obtained by Dr. J. G. Carr (London), and it would seem that specific chemical compounds can certainly induce permanent alteration in the hereditary structure of cells, whether germ-cells or somatic cells. Prof. L. C. Strong (Yale University) described a multiplicity of biological effects obtained by injection of methylcholanthrene into a series of mice, over many generations. Some of these effects are definite point mutations, some are non-genetic, while others are possibly induced by inhibition of embryonic morphogenesis at critical periods.

Data were also obtained by Demerec, in experiments with aerosols of carcinogens on *Drosophila*, indicating that there is a semi-dominant gene which determines whether or not an individual will be sensitive to the chemical induction of genetic change. There is no doubt that experimental evidence of such a diversification of gene-controlled susceptibility to chemical effects is of the greatest significance in relation to the causation of cancer. The work of Dr. A. W. Greenwood (Edinburgh) on the inheritance of susceptibility and resistance to the virus-induced Rous sarcoma showed the existence of such genetically controlled differences in fowls.

The work of Sonneborn and others has established the existence of special cytoplasmic particles which also play a part in heredity. Prof. P. B. Medawar (Birmingham), through experiments on colour transformation in guinea pigs' skin, has provided what may be another example of the particulate basis of somatic cellular heredity, and has indicated that these determining particles can behave 'infectively' towards other cells. Dr. C. D. Darlington (London) further suggested that the origin of some types of cancer can be ascribed to mutation in such cytoplasmic determinants. By analysing the relationship between carcinogens and viruses and its bearing on the origin of cancer, Prof. A. Haddow (London) concluded that carcinogens may induce change in a cytoplasmic particle analogous with a virus, and that the change may be brought about directly or through a primary change induced in nuclear genes. In work carried out by Prof. R. D. Passey and his collaborators at Leeds, particles of 200–350 A. in diameter were identified by the electron microscope in the milk and tumours of high-cancer strain mice, and the biological test of these particles, for tumour-inducing activity, is awaited with special interest.

(3) In the session dealing with the inheritance of cancer in man, the symposium was presented with a general survey of the problem by Prof. T. Kemp (Copenhagen). The investigations carried out in Denmark suggest a genetical basis for predisposition to cancer, involving several genes, and furthermore that the localization, pathological features, rate of development and the time of onset of tumours may be similarly controlled. Since environmental factors also play a part in the development of particular kinds of cancer, any analysis of the heredity of cancer in man inevitably meets great difficulties. In order to compare the incidence of cancer in families with that in the total population, a critical collection of control material is required, and the difficulty of obtaining such material was stressed by several participants in the symposium. To a certain degree the problem has been solved by Prof. L. S. Penrose (London) and his collaborators, using the Registrar-General's statistics for calculating the expected proportion of breast cancer and cancer deaths among relatives dying at all ages and at most periods of the immediate past: the expected death- and incidence-rates for relatives can thus be compared with the observed figures. Prof. Penrose analysed the family-histories of 510 cases of mammary cancer by this method and found that the proportion of deaths due to mammary cancer in the patients' relatives was significantly increased, the rates for other types of malignancy remaining unchanged. Similar conclusions were arrived at by Prof. D. Smithers (London) from the study of family-histories of 459 patients with cancer of the breast. Prof. Penrose concluded that a specific genetical agent is responsible for mammary cancer in man. Evidence concerning the nature of this agent was obtained from studying incidence in paternal and maternal relatives, laterality, age of onset and history of breast feeding in the patient's own infancy, from which Prof. Penrose found some indication that the specific agent might be cytoplasmic but probably not transmitted through the milk.

The studies carried out by the Danish Cancer Registry on twins, under the direction of J. Clemmesen, were presented by Dr. Th. Busk (Copenhagen). From these it seems there is a greater tendency to higher incidence of cancer among partners of identical twins afflicted with cancer than among partners of fraternal twins with cancer, and also a clear tendency for tumours in identical pairs to affect corresponding organs in both partners, whereas this is not the case among fraternal twins. Though the investigation covered about 30,000 cancer patients, only 187 twins with cancer were found suitable for analysis.

It is hoped that the investigations reported at the symposium will direct attention to the importance of recording comprehensive family histories. The need for collaboration in these matters between physicians, geneticists and statisticians was illustrated in a paper by Dr. P. C. Koller (London), who presented two family-histories of xeroderma pigmentosum, one showing an unusually mild manifestation of the disease. The distribution of this condition among the two sexes and the unusual pathological features throw further light on its genetical basis and suggest that we may need to modify Haldane's concept of partial sex-linkage in respect of this particular disease.

The proceedings of the symposium will later be published in the *British Journal of Cancer*.

P. C. Koller

THE *Rh* FACTOR OF BLOOD

During the summer meeting of the British Medical Association in Cambridge, the pathological section held a discussion on "Recent Advances in our Knowledge of the *Rh* Factor". Only the opening speaker kept strictly to this title, the other two invited speakers reading papers on closely related topics; therefore each contribution will be described separately.

Prof. D. F. Cappell, of Glasgow, first briefly described the history of the discovery of the *Rh* factor. Landsteiner and Wiener, seeking to extend knowledge of the complexities of the agglutinogen *M* in man, immunized guinea pigs with the blood of rhesus monkeys. Surprisingly, they found that the resulting anti-rhesus serum agglutinated 85 per cent of human bloods and that the agglutinogen '*Rh*' so defined was unconnected with *M*. Almost immediately afterwards Wiener and Peters demonstrated the clinical importance of this antigen by showing that, in each of four cases where repeated blood transfusions had been followed by hæmolytic reactions, the cause lay in the sensitization of the patient to the *Rh* antigen. Levine and his co-workers then showed that the dreaded intra-group transfusions of women in the puerperium were also the result of iso-immunization to *Rh*, and they directed attention to the almost invariable association of such reactions with death of the fœtus or the occurrence of icterus gravis neonatorum. They produced striking statistical evidence that in these cases the *Rh* negative mother became sensitized during pregnancy to the *Rh* antigen in the blood of her fœtus and formed *Rh* antibodies.

Prof. Cappell suggested that the term *Rh* factor should be reserved for the antigenic component common to man and the rhesus monkey, and the term *Rh* blood group should be used to include the whole complex of antigens which had been shown to occur together in different combinations in man. Prof. Cappell now turned to the work of Prof. R. A. Fisher and emphasized that it was he who had first recognized the pattern behind the complex reactions within the *Rh* groups. Fisher first noted that the reactions of different bloods with two of the four *Rh* sera then discovered were antithetical, and he postulated that the alternative reactions were due to the presence of an antigen *C* in some bloods and of an allelomorph *c* in others. Fisher postulated the existence of two other pairs of allelomorphic antigens, *D* and *d* and *E* and *e*, which determined positive or negative reactions with the two other kinds of sera then known, which he called anti-*D* and anti-*E*. He predicted the discovery of two further antibodies, anti-*d* and anti-*e*, and the correctness of his entire conception was soon demonstrated when these predictions were fulfilled. Fisher's original scheme had had to be extended since Race's discovery of further allelomorphs C^w, C^u and c^v at the *C/c* locus and Stratton's discovery, recently extended by Race, of further allelomorphs at the *D* locus.

Prof. Cappell emphasized the importance of a pure anti-*D* serum for classifying bloods as *Rh* positive or negative. For clinical purposes the important thing was whether a person was *D* positive or negative, for all *D* negative persons could form anti-*D*, and sensitization to *D* was far commoner than sensitization to the other *Rh* antigens. Thus, a person of type *Cde/cde* might at one time have been considered *Rh* positive because of the possession of *C*;

but such a person was just as liable as one of type *cde/cde* to form anti-*D* and should be considered as *Rh* negative.

Iso-immunization of an *Rh* negative mother rarely occurred to a sufficient extent during a first pregnancy to produce hæmolytic disease of the newborn, but the second or subsequent *Rh* positive offspring might be affected. Prof. Cappell had found that the earlier hæmolytic disease occurred in a family, the severer was its form; he interpreted this as indicating a notably greater susceptibility to immunization on the part of some women. One remarkable fact that was now fully established, but the cause of which remained debatable, was the protection against hæmolytic disease afforded by *ABO* group differences between mother and fœtus. Thus, whereas in Scotland in a random sample more belonged to group *O* than to group *A*, in a series of 56 *Rh* negative Scottish women who had formed *Rh* antibodies, it was found that 28 belonged to group *A* and only 18 to group *O*.

Turning finally to the treatment of hæmolytic disease, Prof. Cappell said that one controversial question was whether nervous sequelæ could be prevented by early transfusion of *Rh* negative blood. In his own series of thirty infants treated by transfusion of *Rh* negative blood immediately after birth or within the following twelve hours, all developed normally, both mentally and physically. By contrast, in a series treated in Glasgow between 1934 and 1944, mainly by transfusion of blood of unselected *Rh* type, about 12 per cent showed some residual nervous sequelæ. He was doubtful whether the cerebral damage which results in nuclear jaundice occurred before birth; he suggested that anoxia in the immediate post-natal period, due to difficulty in establishing respiration, might be the cause.

Dr. P. L. Mollison confined his remarks to the diagnosis and treatment of hæmolytic disease of the newborn. At the Medical Research Council's Blood Transfusion Research Unit, Miss M. Cutbush and he had, during the past eighteen months, examined fifty *Rh* positive infants born to mothers whose sera contained *Rh* antibodies. In every case the infant's erythrocytes could be shown, by the direct Coombs' test, to have antibody adsorbed on to their surface. Only three of the fifty infants failed to develop anæmia. Since some infants with a positive direct Coombs' test never developed signs of a hæmolytic anæmia and since others only developed mild signs which did not require treatment, it was necessary to try to form an estimate of the severity of each case. This was best done by examining cord blood. Among the infants with hæmolytic disease whose cord blood they had examined, about two-thirds had a hæmoglobin value below the normal range, that is, less than 15 gm. per cent; almost all had a bilirubin concentration of more than 3·0 mgm. per cent and about three-quarters showed more than 10 nucleated R.B.C. per 100 W.B.C. in the peripheral blood. These three signs of anæmia, hyperbilirubinæmia and erythroblastæmia were fairly well correlated if cord blood was examined and, taken in conjunction with other findings, enabled one to assess the degree of affection.

Dr. Mollison pointed out that hæmolytic disease killed infants at two main stages and the mechanisms were probably separate. Deaths *in utero* or within twelve hours of birth seemed always to be associated with severe anæmia; these infants might display a syndrome similar to that developed by adults with chronic severe anæmia and described by Sharpey-Schafer as the "hyperkinetic phase"; its chief features were: a raised cardiac output, a high pulse-rate and pulse pressure, a high venous pressure and œdema. They had found that a raised venous pressure was a striking feature in severely anæmic infants born alive. The second group of deaths occurred at two to four days; in these cases the infant was profoundly jaundiced and at autopsy kernicterus was a frequent finding. At present the most rational method available for trying to prevent deaths from both of these causes was premature termination of pregnancy followed by an exchange transfusion with *Rh* negative blood.

Exchange transfusion had become a relatively simple procedure since the introduction by Dr. L. K. Diamond of the technique of passing a fine transparent plastic catheter up the umbilical vein; the infant's blood was then withdrawn and replaced by *Rh* negative blood in successive stages. It was an advantage to use a slightly concentrated suspension of erythrocytes so as to leave the infant with a count of approximately 5,000,000 *Rh* negative erythrocytes per c.mm. by the end of the exchange transfusion. It was seldom necessary to have to carry out any further treatment.

Dr. Mollison stated that the overall mortality in the small series he had referred to was 28 per cent. He considered it impossible to make any worth-while comparisons with other series and mentioned the following difficulties: the small size of this and of most other series; recent changes in the diagnostic criteria of the disease; the different prognosis of different forms of the disease and the consequent important effects of selection of cases. As an example he quoted some of their own findings. The first affected infant in a family had a 92 per cent chance of recovery if its mother had never received a transfusion of *Rh* positive blood; but if she had been transfused and was thus more highly sensitized, the infant's chance of survival was only 50 per cent. An undue proportion of transfused mothers in a series of cases would thus greatly increase the mortality. He considered that exchange transfusion should be given a widespread trial because it was a rational treatment and because in practice it had proved to be the most simple and satisfactory method available.

Dr. R. R. A. Coombs described work carried out in the Department of Pathology at Cambridge which had established the occurrence of hæmolytic disease in newborn thoroughbred foals; this disease, like the human one, was due to iso-immunization of the mother during pregnancy against a blood group antigen present in the erythrocytes of her offspring. This work followed on that of Caroli and Bessis, who last year had shown that the icterus of newborn mules was also due to iso-immunization during pregnancy.

Dr. Coombs emphasized that the present investigation had been undertaken by a team. The clinical studies were made by Mr. Parry, scientific officer of the Animal Health Trust, and Messrs. Day and Crowhurst, veterinary surgeons at Newmarket; the hæmatological examinations had been made by Dr. Hoogstraten; the morbid histology had been studied by Dr. Hinde and the serology by Dr. Heard and himself.

Clinically, the foals were normal at birth; thereafter at periods varying from a few hours to five days, they showed progressive weakness, icterus and pallor, accompanied in acute cases by hæmoglobinuria.

The serological investigations had been greatly complicated by a lack of knowledge of the blood groups of horses and by difficulty in obtaining blood samples from the sires of the affected foals. However, they had tested the sera of all the mares, the offspring of which were affected, against the red cells of other mares and of various other available horses. They had found that most of the sera contained high titre saline agglutinins acting on various other horse bloods and all contained blocking antibodies, revealed by the indirect antiglobulin sensitization test. None of the control sera contained more than traces of iso-antibodies.

As in the human disease, the direct anti-globulin sensitization test had proved extremely valuable in making a rapid diagnosis. Hæmolytic disease in newborn foals had to be differentiated from bacterial septicæmia which might also cause jaundice. They had tested six cases of hæmolytic disease, all of which had given strongly positive tests, and two cases of septicæmia, both of which had given negative tests. The reagent they had used was a rabbit anti-horse globulin serum.

The hæmatological picture was one of profound anæmia, with hæmoglobin levels of only 3–4 gm. per 100 ml. Nevertheless, very few reticulocytes and no erythroblasts were seen in the peripheral blood.

One of the most interesting features of the morbid histology was an extension of tubular epithelium into the glomeruli in three cases which had shown hæmoglobinuria; similar changes had been observed in 'traumatic anuria' in man.

Finally, Dr. Coombs mentioned some work which Dr. Heard is conducting. This is an attempt to produce hæmolytic disease in rabbits. There was every reason for hoping that this work would be successful and there was no need to stress the advantage that would result from having a laboratory animal in which the disease could be produced at will. Many problems of hæmolytic disease could only be investigated by experiment and could therefore never be tackled directly in man. P. L. MOLLISON

GENETICAL STRUCTURE OF PLANT POPULATIONS

A SYMPOSIUM on the "Genetical Structure of Plant Populations" was held at the Brighton meeting of the British Association for the Advancement of Science, on September 13, in Section K (Botany), with Col. F. C. Stern in the chair. Dr. W. B. Turrill (Kew), in an opening paper, defined a population, as the term should be used in biology, as the sum total of individuals of a stated kind, in a stated area, at a stated time. The need of careful determination of 'kind' and the desirability of preserving proper voucher specimens where there is the slightest possibility of determinations being called in question were emphasized. The extensive and intensive studies now being completed on numerous populations of a limited number of species of seed-bearing plants of the European flora have revealed an unexpected wealth of variation in structure and behaviour. At Kew and Potterne, investigations combining the methods of modern taxonomy, cytogenetics and ecology are throwing much light upon the make-up of species as population complexes. Attention was directed to the bladder campions (*Silene maritima* and allied species). In these some variations are common, as degrees of indumentum in *S. cucubalus*, others are rare, as long cylindrical calyx in *S. maritima*. Some characters have obvious survival value for definite ecological habitats, such as habit differences between different species or varieties. Spasmodically occurring mutations may be lethal or harmful in various degrees, like 'poor petal' or 'split calyx', whereas other variations appear to be neutral at least in some environments. Some variants have a wide geographical range while others are restricted to very local habitats. Hybridization experiments on a very extensive scale have shown genetic differences for most of the variations; but whereas some characters have a simple genetic basis others can only be explained by the interaction of several genes. Long-isolated populations of relatively small size (as some inland populations of *S. maritima*) may show much less variation than is normally found in more widely spread populations. Parallelism between sea-coast and high-mountain populations of different species is very striking.

Mr. J. L. Crosby (Durham) dealt with intra-population heterogeneity and the breeding range of the individual plant. In the primrose (*Primula vulgaris*), in addition to reciprocally outcrossing plants with 'pin' and 'thrum' flowers, there are, in certain populations in Somerset and the Chilterns, plants with 'long homostylous' flowers which are normally self-fertilized and outcross on to pins. Observation agrees with theoretical conclusions that 'homostyles' are increasing to about 80 per cent, 'pins' are decreasing to about 20 per cent, and 'thrums' are entirely disappearing. Slow at first, change later becomes quite rapid. Considerable heterogeneity between different parts of any one such population may exist. A few yards only may separate groups with constitutions so different that they represent evolutionary stages many generations apart. Such large differences cannot have arisen in one generation by chance from a homogeneous population but must have been initiated at an early stage. One section of the population reached the stage of more rapid change and the difference then became amplified. The change could not, however, even be maintained with free distribution of pollen between the divergent groups, even though 'homostyles' are self-pollinated. The breeding range of the individual primrose must be of the order of a few yards only, and a single population cannot be considered as a continuous interbreeding unit.

Dr. A. J. Bateman (John Innes Institution) considered populations of cultivated plants. He pointed out that the breeding system of the species is of paramount importance in determining the genetical structure of a population. The total range of breeding systems is from complete self-fertilization as in barley to complete cross-fertilization as in cabbage. Subordinated to the breeding system are selection intensity, population size, and gene dispersal. Heritable variation would be at a minimum in a pure line; but varieties of self-fertilizing crops are rarely represented by pure lines. The different causes of variation within varieties which should be pure lines are: (*a*) residual hybridity of the original variety; (*b*) mutation and structural change; (*c*) seed admixture; (*d*) cross-pollination. Cultivated plants show a continuous range in breeding systems from self-incompatibility and diœcism giving full outbreeding, to regular self-pollination and vegetative reproduction, giving full inbreeding or its equivalent.

Experiments with rye indicate that thirty-six plants can maintain a variety in its original form; but six plants are too few to avoid inbreeding depression and undesirable loss of variability in cross-breeding crops. Cultivated plants are selected for a special environment. When human selection is relaxed the subsequent deterioration shows us how natural populations with similar breeding systems will respond to changes of environment. A study of the dispersal of pollen of cultivated plants shows that inter-crossing is mainly confined to immediate neighbours, though finite amounts of crossing occur up to large distances. The part which this dispersal plays in determining population structure again depends on the breeding system.

Dr. H. G. Baker gave an account of gene-flow between inter-fertile species. In 'pauciform' hybrids, the individuals are without fertility and cannot be back-crossed to their parents or form segregating swarms by selfing. Other hybrids, termed 'multiform', are sufficiently fertile to perform either of, or both, these acts. Yet in 'multiform' hybrids gene-flow is often restricted or even absent. In the sub-tribe Madiinæ of Compositæ, lack of internal harmony within the plant may lead to certain 'recombination types' failing to endure serious competition. Self-pollination reduces frequency of hybrids, as do also cleistogamy as in *Viola* and apomixis as in *Poa*. Certation effects favouring pollen-tubes of the same species as the styles also reduce interspecific hybrids as in *Melandrium*. Interspecific hybridization is more likely to occur where one or both species is under- rather than over-dispersed. Matrocliny may increase the possibility of gene-flow. Linkage hinders gene-recombination and may be of importance in preserving the parental types in natural populations. 'Variance of fertility' is sometimes seasonal. Internally determined restrictions on gene-flow are no less important than those imposed by the external environment. Some hybrid swarms develop under man's influence; others do not. When two kinds of plants come to occupy adjacent habitats, the exchange may occur of genes resulting in characters which are neutral so far as the ecological distinction between the kinds is concerned. With modification of the environment, characters excluded previously on ecological grounds may occur.

Dr. D. H. Valentine described interspecific hybridization between primrose (*Primula vulgaris*) and oxlip (*P. elatior*) in woods in certain regions of East Anglia. The populations of individual woods are isolated from one another. Some woods contain one or other of the pure species, others contain the two species and their hybrids. Where the species meet, they occupy distinct areas in the wood, probably because of their different ecological preferences. Hybrids are always frequent, but they do not outnumber the pure species. From reciprocal artificial crosses, a low yield of viable seeds is obtained, and the vigour of the F_1 hybrids is variable. A somewhat better yield of seed is obtained when the F_1 hybrid is selfed or backcrossed. There are thus both ecological and genetical barriers which tend to prevent fusion of the species. The condition appears to be one of equilibrium, which may shift in one direction or the other as variations of local climate and other environmental factors occur. Efficient barriers of more than one kind separate oxlip and cowslip (*P. veris*), and the hybrid between primrose and cowslip, which is partially fertile, is of widespread occurrence; but extensive hybrid populations are apparently rare, perhaps because of the marked ecological differences between the species.

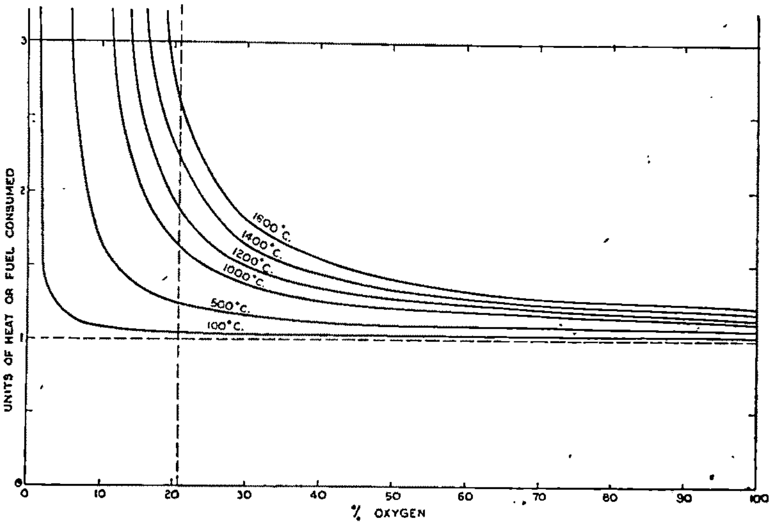
In the discussion following the five papers, Dr. J. M. Rasmusson commented upon the successful attempt to combine the points of view of wild and cultivated plants, of the botanist and the plant-breeder. In sugar-beet it had been found that from five to ten plants were too few and forty to sixty plants enough to prevent inbreeding depression. A distance of 200 yards prevents crossing in the open in sugar-beet. Dr. C. D. Darlington questioned Mr. Crosby's explanation of the spread of homostylous plants in his primrose populations. Prof. J. G. Nannfeldt urged that the experimental methods of genetics and ecology should be increasingly applied to the native flora. Captain C. D. Diver noted that while there were considerable differences in breeding mechanisms between animals and plants, results were often similar. Mr. A. J. Wilmott asked that more investigation should be undertaken on chances of cross-pollination by wind with increasing distance. Mr. O. H. Frankel maintained that seed merchants in Great Britain aimed for saleability (largely a matter of uniformity), not quality (productivity).

APPLICATION OF OXYGEN TO STEEL-MAKING

By Dr. W. C. NEWELL
British Iron and Steel Research Association

MANY modern technical developments have been made by preparing materials of greater suitability for specific purposes from the naturally occurring materials which were employed earlier. An obvious example of this is seen in the superior materials now used for building construction and a comparison with natural clay which is still used in some places. Though air has, wittingly or unwittingly, been used for combustion from very early times, the bulk manipulation of gases on a commercial scale is such a modern development that the commercial use of oxygen for combustion is only now just becoming possible. The use of an oxygen-enriched air blast does not appreciably increase the heat of combustion, but it does reduce the cooling effect of the nitrogen present in air which is normally passed through furnaces. The magnitude of this effect is appreciated when it is pointed out that during the combustion of carbon to the dioxide with ordinary air, the weight of nitrogen involved is nearly ten times the weight of the carbon. Under certain conditions thermal recuperation or regeneration of the heat from the gases leaving the furnace is possible, but at high temperatures this is inefficient and costly.

The magnitude of the loss of sensible heat with the nitrogen passing off from furnaces is greater the higher the temperature, and for steel-making temperatures, of say up to 1,700° C., it becomes of such major importance that many attempts have been made in various parts of the world to employ oxygen-enrichment to improve the thermal efficiency of steel-making processes. Recently[1] full technical details have been published of the way in which oxygen-enrichment is being successfully applied on a continuous production basis at Messrs. Cattons' steel foundry in Leeds. The accompanying chart shows for the combustion of carbon to dioxide the number of



Effect upon fuel consumption of emergent gas temperature for the reaction: $C + O_2 \rightarrow CO_2$

units of fuel consumed for varying percentages of oxygen used in the blast of the furnace, the heat units consumed above one unit being those wasted as sensible heat with the emergent nitrogen. From this chart it will be seen that, for emergent gas temperatures below 1,000° C., little thermal gain can be effected by the use of oxygen enrichment, but that the gain increases rapidly for higher temperatures. Further, it is seen that there is little thermal advantage to be gained by raising the oxygen content of the blast beyond about 40 per cent.

A steel foundry requires molten steel to be supplied intermittently and at a higher temperature than for the production of steel ingots, and at these trials at Leeds, by using 30 per cent oxygen in the blast (as compared with normal approximately 20 per cent in air), it has been found possible to obtain molten steel 50° C. hotter with a simultaneous economy in costly ferro-silicon, which is normally employed as a fuel of high calorific value. Alternatively, advantage has been taken of this gain in thermal efficiency by adding cold steel scrap or ferro-alloys to the steel after the blowing operation. Thus substantial economies have been shown to be practicable, and the way has been opened up for the use of the side-blown Bessemer converter for the production of more highly alloyed steel. Moreover, it has been shown that the use of molten steel of higher temperature does not necessarily mean that there will be any greater attack upon the refractory material of the converter lining or upon the sand of moulds into which the steel is cast; indeed, the penetration of liquid steel between the sand grains has been less than usual, and the surface finish of the castings has been better.

The most striking result of the use of oxygen enrichment is that the flame issuing from the converter is far brighter than usual and the steel is made in about half the usual time. This is a reminder of those early experiments of Priestly which are repeated to this day in school laboratories to demonstrate the enhanced rate of combustion of a wooden splint in oxygen. Normally, during the early stages of blowing a side-blown Bessemer converter, silicon is being oxidized and there is very little flame; and the flame later is associated with the combustion of carbon monoxide at the mouth of the vessel. Using oxygen enrichment and a very low silicon content in the molten metal, the flame is observed right from the commencement of the blowing operation; but it is interesting to note that in spite of the fact that under these conditions the flame is of far greater intensity the agitation of the metal within the vessel appears to be less, as judged by the lower loss of ejected metal. In fact, with higher oxygen contents in the blast there are distinct indications that the metal is not agitated enough to ensure uniform oxidation. These observations are leading to trials of modifications in the design of the vessel, and especially the tuyeres, which may lead to greater efficiency of operation and to the extension of this process of steel-making for bulk ingot steel production.

The industry concerned with the large-scale production of oxygen is making great efforts to keep pace with the rapidly increasing demand; but some idea of the magnitude of the problem is gained when it is pointed out that in the steel foundry referred to about 1,500 cubic feet of oxygen are consumed per ton of steel made, this volume of oxygen weighing about one hundredweight.

At the present time, large consumers of oxygen are supplied with liquid oxygen, which though costing more to produce than oxygen supplied in gaseous form, is much cheaper to transport. However, at the works referred to, about eight tons of oxygen are consumed per week, and this makes necessary a regular shuttle service of lorries carrying liquid oxygen. Thus it appears that the magnitude of the demand is going beyond the economic limit for the supply in liquid form, and extensive plans are being made for the supply of oxygen by some form of gas pipe line to those parts of Britain where the demand for oxygen for such purposes is likely to be great. At the present moment, the high cost of oxygen supplied in liquid form is likely to restrict extensive application of the process to steel foundries where greater advantage can be taken of the technical improvements brought about by oxygen enrichment.

[1] Harrison, J. L., Newell, W. C., and Hartley, A., *J. Iron and Steel Inst.*, 281 (July 1948).

OBITUARIES

Prof. S. W. J. Smith, F.R.S.

Samuel Walter Johnson Smith, formerly Poynting professor of physics in the University of Birmingham, died on August 20 in his seventy-eighth year. His death will be deeply regretted by many former students of the Royal College of Science, London, and of the University of Birmingham, who will remember him gratefully both as a teacher and as a friend.

The son of a well-known railway engineer, Smith was born in Scotland in 1871 and went first to school in Tayport and Dundee, completing his early education at Rutherford College, Newcastle-upon-Tyne. In 1887 he entered the Royal College of Science with a national scholarship, and after completing the course there went to Trinity College, Cambridge, in 1891 with a major scholarship. He obtained a first in Part 1 of the Natural Science Tripos in 1892 and in Part 2 he had the rare distinction for those days of obtaining a double first, in physics and chemistry. Afterwards he was appointed Coutts-Trotter Student and worked in the Cavendish Laboratory under Sir J. J. Thomson until 1896.

Upon leaving Cambridge, Smith returned to the Royal College of Science, London, as senior demonstrator in physics and became assistant professor in 1912. He obtained the D.Sc. degree of London in 1908 and was elected a fellow of the Royal Society in 1914. During this period at South Kensington, he took a prominent part in the work of the Physical Society of London, being honorary secretary from 1908 until 1916 and vice-president during 1916–19. In addition to his heavy secretarial and teaching work, he did a great deal of research in this phase of his career and it was probably his most fruitful period.

In 1919 he succeeded Poynting as professor of physics at Birmingham and undertook the difficult task of coping with the many problems arising from the First World War, particularly those resulting from a great increase in the number of students. Somewhat later, about 1924, he organised a new honours course in physics, as up to that time only a general degree had been awarded. He was dean of the Faculty of Science from 1929 until 1932. In 1936 he retired and was appointed emeritus professor, and from that time until his death he lived a quiet and somewhat secluded life.

In his researches, Smith devoted himself almost exclusively to two fields of work. His first investigation arose quite naturally from his training in both physics and chemistry; he selected it himself and worked at it in the Cavendish with very little guidance. It dealt with the contact difference of potential arising at a mercury – electrolyte interface, and necessitated a great deal of careful observation using various types of capillary electrometer; the conclusions were published in the *Phil. Trans. Roy. Soc.* of 1899. Later, at South Kensington, with the assistance of collaborators, he extended and amplified this work, turning to problems of electrolytic resistance and ionic migration. The results of these experiments were published in a series of papers in the *Phil. Mag.* and the *Proceedings of the Physical Society*.

The second and perhaps the more important field of Smith's work started from a problem in ferromagnetism suggested to him at South Kensington by Sir Arthur Rücker, who surmised that an examination of the magnetic properties of meteoric iron might throw some light upon the cause of terrestrial magnetism. It soon became clear, however, that this was no problem in terrestrial magnetism but rather a problem from the domain common to geology, metallurgy and physics. The meteoric irons are, in fact, examples of iron – nickel alloys which have cooled with extraordinary slowness and show structural characteristics not reproducible by artificial means. Smith worked alone on this question for a number of years, using a method of investigation simple in principle but requiring great skill and care in execution. He published the results of his observations in an important memoir appearing in the *Phil. Trans. Roy. Soc.* for 1908.

This work was continued at Birmingham where, in addition to extensions of the magnetic technique, metallographic and X-ray methods were called into service. During these years a great deal of assistance was given by the late James Young, who published a number of papers dealing with the results of the X-ray examination of some of these meteoric specimens. The magnetic and metallographic work was carried out under Smith's direction, and there exists a great deal of unpublished material. It is probable that towards the end of his life Smith was searching for some far-reaching synthesis of the observations which he failed to discover. In March 1939 he published in *Nature* a very brief summary of the work and of his tentative conclusions.

Smith was a man of great personal charm with a manner at once disarming and dignified. Over many younger men he exercised a special fascination, arising from a genuine gift of sympathy and also from the interest of his conversation. As a teacher he was held in the highest esteem throughout his life. In 1900 he married Dorothy Muriel Stamp who, together with an only daughter, survives him.

M. L. OLIPHANT
A. A. DEE

King Ferdinand of Bulgaria

EX-KING FERDINAND OF BULGARIA, who died recently at Coburg at the age of eighty-seven, was born a prince of Saxe-Coburg Gotha. From early youth he had a passion for natural history; but he was no mere amateur, and his studies of botany, entomology and ornithology were serious and scientific. Of the three, his chief interest lay in ornithology, and he first made his appearance among ornithologists at the age of thirteen, under the guidance of Crown Prince Rudolf of Austria, himself an ornithologist of repute. In 1887 Prince Ferdinand joined the Deutsche Ornithologische Gesellschaft, of which Society he remained patron until his death; in later years he was elected an honorary member of the Royal Hungarian Institute of Ornithology and also of the British Ornithologists' Union. In 1879 he made an official visit to Brazil the opportunity for studying the bird-life of South America, and on becoming Tsar of Bulgaria he gave every encouragement to the study of the ornithology of the Balkans and the collection of specimens. The museums and zoological gardens of Sofia are further and concrete evidence of his active interest.

After his abdication, he retired to Coburg, where he devoted most of his time to his private museum and large collection of living birds, though he frequently visited his castle in the Carpathians. The aviaries at Coburg contained more than eight hundred specimens, including many rare species, most of which had been collected by King Ferdinand himself, and he knew where each one had been obtained or purchased. He would spend hours in his aviaries studying the habits of the birds. A section of the gardens was set aside for wild-flowers which the King had either collected himself or had had given to him, from every part of the world; and, as with the birds, he knew the history of each plant.

In 1927–28 King Ferdinand made a collecting trip to South America and described his experiences in his book "Der König reisst". In 1929 he made an expedition, accompanied by his niece, Princess Victoria, Countess of Solms-Rödelheim, a keen botanist, and his museum curator, Dr. Hans von Boetticher, to Victoria Nyanza and the mountains of equatorial Africa. His account of the expedition, with a report on the ornithological observations, compiled by Dr. von Boetticher, was published as a special supplement of the *Journal für Ornithologie* in 1930. He was a regular attendant of the meetings of the Deutsche Ornithologische Gesellschaft which were held each year in various parts of Germany and took part in all the ornithological excursions, however arduous. In 1934 he attended the International Ornithological Congress at Oxford, including the visit to the bird islands off the Pembrokeshire coast. His enthusiasm and activity were such that even at the age of seventy-six, in 1937, he was considering the possibility of a trip by aeroplane and motor-car from Cairo to the Cape in order to study the bird-life throughout Africa.

He was a brilliant linguist, and in fact it was difficult to discover how many languages he did know, for he would turn with bewildering speed and facility from French, German, English, Bulgarian to Portuguese. His dominating personality, astuteness as a politician and the unpopular role he took in the destinies of Europe have always been emphasized; but his love of beautiful things, his great generosity to the cause of science and to his friends, his delightful sense of humour and a surprising simplicity are sides of his character which have generally been missed.

PHYLLIS BARCLAY-SMITH

WE regret to announce the following deaths:

Peter A. Bungart, for nearly twenty-five years associated with the Department of Geology and Palæontology of the Cleveland Museum of Natural History, who was a distinguished collector and preparator of fossil fish, on July 30, aged seventy-two.

Prof. Alexandr Orlov, professor of petrography and chemical mineralogy at the Charles University of Prague, known for work on the origin and occurrence of groups of ore-bearing rocks and soils, the metamorphosis of limestones and dolomites and especially for his petrographic studies of Czech garnet deposits, aged forty-nine.

Prof. D. A. Welsh, emeritus professor of pathology in the University of Sydney, where he held the chair from 1902 until 1936, on May 13, aged eighty-two.

NEWS and VIEWS

Botany at Cambridge:

Prof. F. T. Brooks, C.B.E., F.R.S.

ON September 30 Prof. F. T. Brooks retired from the professorship of botany in the University of Cambridge, which he has held since 1936. When he succeeded Sir Albert Seward he became head of a large and well-organised department, which continued to expand and prosper under his direction in spite of the difficulties and restrictions of the war years. At the present time, accommodation in the Botany School is strained to its utmost by ever-increasing numbers of research students, and investigations are being made in all the main fields of botanical science, while the number of undergraduate students is well maintained. During his tenure of the chair, Prof. Brooks has continued his researches in plant pathology, and during his career he has been responsible for the training of a large number of mycologists and plant pathologists who now hold important posts in many parts of the world. His wise guidance and administrative ability have been freely extended to the University Botanic Garden; he has acted as chairman of its executive committee and as secretary of the managers of the Cory Trust. His work has extended beyond the University; he was for five years an active member of the Agricultural Research Council and has been one of the general secretaries of the British Association for the Advancement of Science. He will continue to live in Cambridge and to carry on his researches in the Botany School.

Prof. G. E. Briggs, F.R.S.

PROF. G. E. BRIGGS will succeed Prof. Brooks as professor of botany. He will be the ninth holder of the chair, which was founded in 1724, and the first plant physiologist to be appointed to it. His researches on photosynthesis and growth have brought him a world-wide reputation as a clever experimenter and a critical and original thinker. A pupil of F. F. Blackman, he has been head of the Sub-department of Plant Physiology in the Botany School since 1937, and was raised to the rank of professor in 1946. He is a man of wide interests, distinguished as a teacher, and he has had considerable administrative experience in the University and as a fellow and officer of St. John's College.

Solar Eclipse of November 1: British Expedition to Mombasa

A SMALL expedition from the Royal Observatory, Greenwich, under Dr. R. d'E. Atkinson, is proceeding to Mombasa to observe the eclipse of the sun on November 1; the purpose is to try out a method of correcting the moon's place from observations on the thin crescent of the sun seen from a station where the eclipse just fails to be total. Measurements of the position-angle of the line of cusps, as a function of the time, can give corrections to the differential co-ordinates of sun and moon which are independent of any assumption about their apparent radii, and independent also of irradiation if the sky is uniform. If a large number of such measures is made, the effects of irregularities of the moon's limb also cancel out to a considerable extent. In the neighbourhood of Mombasa, where the eclipse is nearly 98 per cent total, the position-angle swings round through about 70° in $2\frac{1}{2}$ minutes; it is hoped to obtain 3,000 timed pictures on 35-mm. film in this interval. The camera will be stationary, and the trail of successive images produced by the sun's diurnal motion will give the zero of position-angles. An ordinary small visual telescope-lens, stopped down to about $f/40$, is being used, in conjunction with a green filter and exposure times of 1/1,000 sec. Special time-signals will be sent from Rugby, and these will be recorded, together with the instants of the shutter-openings, on tape-chronographs which have been made at Abinger. The accuracy of the results will be limited by uncertainties about the contour of the moon's limb;

it seems certain that if the limb were smooth the moon's place would be determined with considerably greater accuracy than that with which it is at present computed in the Nautical Almanac. Whatever the limb-effects may be, the accuracy should be higher than that which results from six thousand ordinary occultations, since the timing is considerably better than is possible with visual methods, while all effects due to personality, systematic time-differences between stations, and real changes of libration are eliminated. If the method works out as well as is hoped, it will probably be used for long-range geodetic purposes; the accuracy will then be more severely limited by our ignorance of the moon's limb, since considerable changes in the libration are inseparable from a long shadow-path. However, the accuracy should still be considerably greater than can be obtained, for the same purpose, by merely timing the instants of contact, since in that case all the emphasis is on some one point of the limb at each contact; a chance error at that point can cause a large error in the time.

Frozen Foods Consultative Group

To ensure the fullest co-operation and collaboration between the various research organisations engaged in the field of food, and also that inquirers will be directed to the best sources of information, the Frozen Foods Consultative Group was set up last year. It consists of representatives of research organisations, official and semi-official, under the chairmanship of the director of food investigation, Dr. Franklin Kidd. The objects of the Group are in the main the exchange of information on research investigations in progress on the preservation of food by quick-freezing processes so as to prevent overlapping and to discover gaps in research programmes. The terms of reference are: (*a*) to table and discuss the results of investigations into new developments in methods of preserving food by freezing; (*b*) to consider the planning of further investigations (each organisation to retain its own independence and the responsibility for its own programme); (*c*) to maintain contact between investigators in such fields as packaging and engineering which bear on preservation by freezing; (*d*) to direct inquirers in industry to the best sources of information. The following research organisations and stations are represented: Low Temperature Research Station, Torry Research Station and Ditton Laboratory (all of the Department of Scientific and Industrial Research); Scientific Adviser's Division, Ministry of Food; British Food Manufacturing Industries Research Association; Printing, Packaging and Allied Trades Research Association; British Baking Industries Research Association; Fruit and Vegetable Preservation Research Station, Chipping Campden. The Group has power to invite to its meetings representatives of other organisations such as the Refrigerated Cargo Research Council, the Institute of Refrigeration and the Food Manufacturers Federation. The secretary of the Group is Mr. P. R. P. Claridge, Food Investigation Organisation, Lloyds Bank Chambers, Hobson Street, Cambridge.

Petroleum Films Bureau

IT may not be generally known that there exists in London an organisation specializing in circulation (free of charge to responsible bodies such as educational and Service authorities) of 35 mm. and 16 mm. sound and silent documentary instructional films. The August catalogue has reached us from the Petroleum Films Bureau, 46 St. James' Place, London, S.W.1, sponsors of this scheme, from which it is clear that the range of subjects covered is not limited to varying aspects of the oil industry. Titles of general interest include the microscope, microscopy of opaque objects, hydraulics and hospital service. "How Oil is Produced and Refined" is covered by fifteen different reels giving a total of more than three hours showing. Other sections deal with automobile engineering and road safety for children. Short synopses of each film are available; also lantern slides, with appropriate lecture notes, on the subject "About Oil" can be borrowed to illustrate the early history of oil, its nature, origin, production, refining and transportation. This is a valuable scheme, capable of great expansion and certain of support in lecture theatre, classroom, drill hall and, presumably, the home.

Fertilizer Manufacture in East Africa

A SCIENTIFIC mission from East Africa is at present on a short visit to the United States to study the methods employed by the Tennessee Valley Authority in the manufacture of fertilizers. Large deposits of rock phosphates are known to exist in Uganda, and it is expected that the knowledge gained from this visit can be applied to the exploitation of these deposits when hydro-electric power becomes available from the Owen Falls scheme. The members of the mission are: Dr. A. J. V. Underwood, industrial consultant in London to the East Africa High Commission; Mr. H. B. Stent, acting chairman of the East African Industrial Research Board; Dr. K. A. Davies, director of the Geological Survey, Uganda; and Mr. C. R. Westlake, chairman of the Uganda Electricity Board.

Life-Histories of Birds

THE United States National Museum has issued a number of bulletins dealing with the life-histories of various North American birds. The latest addition to the series covers the nuthatches, wrens, thrashers and their allies, and is a painstaking work. Mr. Burt, the author, says that he has endeavoured to give as full a life-history as possible of the best-known sub-species of each species, and has written more briefly of the related sub-species, by this method avoiding repetition and duplication. He has amassed much information which is presented in a clear and readable manner, the volume being illustrated by a large number of photographs, mostly excellent ones, the last, of a sage thrasher, being a particularly successful picture.

Edward Livingston Trudeau (1848–1915)

WHEN he was a student at the New York College of Physicians and Surgeons, Edward Livingston Trudeau, who was born on October 5, 1848, was taught to regard tuberculosis as an incurable disease. When, therefore, the celebrated physician Edward G. Janeway in 1873 diagnosed extensive tuberculosis in his left lung, his patient, who had recently graduated and married and whose brother had died of the same disease, felt he was under sentence of death and gave up his practice to spend his last days in the Adirondack Mountains. To his and everyone else's surprise he recovered, and in 1884 established the open-air Adirondack Cottage Sanitarium—the first in the United States. In the isolation of a primitive forest, badly crippled and single-handed, Trudeau preached and practised the gospel of fresh air and extolled the virtues of rest. Having read a translation of Koch's classic paper on the etiology of tuberculosis, he built himself a modest laboratory in his own home. Out of its ashes sprung the present Saranac Laboratory—the first of its kind in the United States. Trudeau wrote little on clinical subjects; but his laboratory studies are contained in a large number of valuable papers, including experiments on immunity and on the effect of fresh air on tuberculous rabbits. He was the first president of the National Association for the Study and Prevention of Tuberculosis. His optimism and charm endeared him to all his patients, perhaps the most famous of whom was Robert Louis Stevenson.

Convention on High Vacua

THE Society of Chemical Industry is sponsoring a convention on high vacua under the presidency of Sir Charles Darwin, director of the National Physical Laboratory, which is being organised by Mr. L. L. Maitland, director of British-American Research, Ltd., to be held at Gleneagles during October 12–13. Among the topics to be discussed are the applications of high vacua to plastics, dehydration, distillation generally and the distillation of fatty oils, the metallurgical industry and nuclear physics and atomic energy. Full opportunity will be provided for discussion. Information on accommodation and travel arrangements can be obtained from Mr. L. L. Maitland, British-American Research, Ltd., Block E.2, Hillington North, Glasgow, S.W.

Photo-electric Spectrometry Group

AN association has been formed of those interested in instruments for photo-electric spectrometry and their applications. It has been named the Photo-electric Spectrometry Group, without prejudice to its possible future affiliation to an existing scientific body. The inaugural meeting of the Group was held in Cambridge on July 16. Out of about a hundred and twenty who were invited, sixty-four attended. New instruments were on view and papers were read by Dr. E. R. Holiday (London Hospital) on "Adaptation of the Hilger Spekker and Medium Spectrograph for Photoelectric Work", and by Mr. G. H. Beaven (Thornton Research Centre, "Shell" Refining and Marketing Co., Ltd.) entitled "Notes on the Operation, Maintenance and Servicing of the Beckman Model D.U. Spectrophotometer".

The following were appointed officers of the Group: *Chairman:* Dr. J. R. Edisbury, Research Department, Lever Bros. and Unilever, Ltd., Port Sunlight; *Vice-Chairman:* Mr. G. H. Beaven, Thornton Research Centre, "Shell" Refining and Marketing Co., Ltd., P.O.B. No. 1, Chester; *Hon. Secretary:* Mr. W. H. Storey, Unicam Instruments (Cambridge), Ltd., Arbury Works, Cambridge; *Hon. Treasurer:* Mr. J. R. Stansfield, Hilger and Watts, Ltd., 98 St. Pancras Way, London, N.W.1; *Committee:* Mr. C. G. Cannon, Physics Department, University of Reading; Mr. B. S. Cooper, Research Department, General Electric Co., Ltd., Wembley; Dr. J. G. A. Griffiths, A.D.I. (Sc.), Air Ministry, Whitehall, S.W.1; Dr. E. R. Holiday, Research Department, London Hospital, E.1; and Dr. F. Wokes, Ovaltine Research Laboratories, King's Langley, Herts. Subjects on which it is proposed to hold further meetings or whole-day conferences are flame photometry (jointly with the Institute of Physics Industrial Spectroscopic Group), fluorescence, photo-electric recording of spectra, stray light, and reflexion spectra. A bulletin will be issued periodically for private distribution to members and will contain reports of meetings with details of papers and discussions. It will also include abstracts, a question and answer section, and give information about new designs and the location of spares for existing instruments. The subscription is 10*s.* per annum, commencing October 1, and includes the cost of the bulletin. Membership forms can be obtained on application to the honorary secretary.

National Research Council of Canada: Medical Fellowships

MEDICAL fellowships have been awarded by the National Research Council of Canada to thirty-one graduates in medicine to enable them to pursue post-graduate research during 1948–49. Distribution of the awards by the universities at which they will be held is as follows: McGill, 8; Montreal, 1; Queen's, 4; Toronto, 7; Western Ontario, 8; Manitoba, 1; Oxford, 1; Zurich, 1. These fellowships vary in amount from 1,500 to 2,500 dollars, depending on the previous training and experience of the candidates. The Division of Medical Research of the National Research Council also makes grants-in-aid to Canadian universities for medical research studies on approved subjects. During the present year, 118 such grants, valued at 264,173 dollars, are being held. The nominal value of the thirty-one medical fellowships awarded this year is 64,600 dollars.

Physical Society of London: Award of Charles Vernon Boys Prize

THE Charles Vernon Boys Prize of the Physical Society, given annually for distinguished research in experimental physics, is being awarded this year to Prof. S. Tolansky in recognition of his work in interferometry. The Prize will be presented at a meeting of the Society on October 8, when Prof. Tolansky will give an address on "Current Investigations with Multiple-Beam Interferometry". Prof. S. Tolansky has held the chair of physics at the Royal Holloway College, University of London, since 1947, and has done extensive research work in optics and spectroscopy; during the war years he was engaged on research in connexion with atomic energy.

Prof. R. W. Wood, professor of experimental physics at the Johns Hopkins University since 1901 and research professor since 1937, will give an address to the Society before the award of the Charles Vernon Boys Prize, his subject being "Spontaneous Deformation of Crystals". Prof. Wood is receiving an honorary degree of D.Sc. from the University of Oxford.

Lectures on the Atomic Age

THE Sir Halley Stewart Trust has arranged a course of six free lectures on "The Atomic Age", to be given at the Memorial Hall, Farringdon Street, London, on Tuesdays, beginning October 26, at 6 p.m. The speakers will be Prof. M. L. Oliphant, on "The Scientific Achievement"; Prof. P. M. S. Blackett, on "The Military Consequences of Atomic Energy"; Mr. R. F. Harrod, on "The Economic Repercussions of Atomic Power"; Lord Russell, on "Our Scale of Values in the Atomic Age"; Mr. Lionel Curtis, on "The Political Repercussions"; and Prof. D. W. Brogan, on "America as Atlas". For free reserved seats application should be made to the Secretary, Sir Halley Stewart Trust, 167 Strand, London, W.C.1.

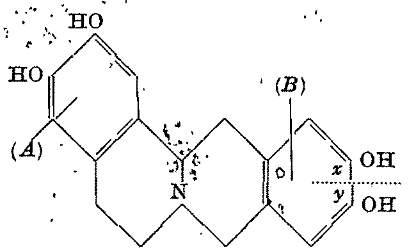
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

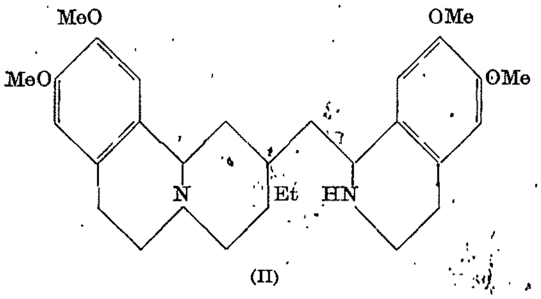
Structure and Biogenesis of Emetine

In making favourable comment on Woodward's ingenious suggestion respecting the biogenesis of strychnine[1], the hope was expressed that further speculation of a similar kind would be based on a comparable "degree of coincidence". The remarkable development mentioned below certainly meets this requirement. It provides an outstanding example of interaction of results in two fields, strengthening theoretical conclusions in both of them.

I noticed that (excluding consideration of the methylation of phenolic hydroxyls) emetine could be constructed from three molecules of dihydroxyphenylalanine and one of the formaldehyde equivalent, assuming a fission of one aromatic nucleus on Woodward's lines. Following these quite closely, it will be noted that the hydroxyl in the meta position to the side-chain of the amino-acid becomes an aldehyde group; that in the para position is found in the alkaloid in a state of oxidation equivalent to that of an alcohol. Postulating exactly the same circumstances in the case of the stages leading, on this hypothesis, to emetine, we arrive without ambiguity at a single formula (II). Thus the *nor*-pseudotetrahydroberberine (I) represents the familiar *nor*-laudanosine of the Winterstein – Trier hypothesis condensed with formaldehyde or its equivalent. What has long been known[2] about emetine proves that our next stage cannot be the degradation of the *A*-nucleus. If we assume the oxidative degradation of the *B*-nucleus, as indicated by the dotted line, and so that *x* becomes a formyl group, and the chain beginning with *y* is fully reduced, and later that the new aldehyde condenses in the usual manner with dihydroxyphenylalanine (decarboxylated at some stage) to an *iso*quinoline derivative, then, after O-methylation, emetine would be (II).



(I)



(II)

No special importance was attached to this speculation until, in the course of a discussion with Dr. M. J. S. Dewar, he wrote down formula (II) as the most likely interpretation of results described in three recent communications[3] on the subject of the chemistry of emetine. Of these, the work of Späth, and of Pailer, solves the problem of the arrangement of carbon atoms in the chain connecting the *iso*quinoline nuclei; that of Karrer and his co-workers supplies a detail which indicates the relation of this carbon skeleton to the tertiary nitrogen.

Thus the constitution (II) appears to be firmly established by these recently disclosed experiments, and by the earlier investigations. It is surely significant that, without knowledge of the recent publications, the same constitution was deduced by applying Woodward's theory of biogenesis of strychnine to a complex member of the *iso*quinoline group.

R. Robinson

Dyson Perrins Laboratory,
University, Oxford.
Sept. 5.

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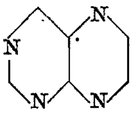
[1] Woodward, R. B., *Nature*, **162**, 155 (1948).

[2] Carr, F. H., and Pyman, F. L., *J. Chem. Soc.*, **105**, 1591 (1914); Späth, E., and Leithe, W., *Ber.*, **60**, 688 (1927).

[3] Späth, E., *Monatsh.*, **78**, 348 (1948). Pailer, M., *ibid.*, **79**, 127 (1948). Karrer, P., Eugster, C. H., and Rüttner, O., *Helv. Chim. Acta*, **31**, 1219 (1948).

A Synthesis of Pteridine

Although many derivatives of pteridine, both natural and synthetic, are known, the parent substance pteridine (I) does not appear to have been described. This substance has now been prepared by the condensation of 4 : 5-diaminopyrimidine with glyoxal bisulphite.



I

4 : 5-Diaminopyrimidine has been described by Isay[1], but it is more readily available by a slightly modified procedure. 2-Chloro-4-amino-5-nitropyrimidine, m.p. 232° (Isay, *loc. cit.*, gives m.p. 217°), is hydrogenated in methanol over a nickel catalyst to give 2-chloro-4 : 5-diaminopyrimidine, m.p. 232° (found: C, 33·3; H, 3·7; N, 38·7; Cl, 24·6. $C_4H_5N_4Cl$ requires C, 33·2; H, 3·5; N, 38·8; Cl, 24·5 per cent). Catalytic dehalogenation over palladium on charcoal in the presence of barium oxide gives 4 : 5-diaminopyrimidine, m.p. 204°, which forms a crystalline nitrate decomposing without melting above 260° (found: C, 27·8; H, 4·0; N, 40·0. $C_4H_7O_3N_5$ requires C, 27·7; H, 4·1; N, 40·5 per cent). Reaction of the diaminopyrimidine in aqueous solution with glyoxal bisulphite gives pteridine which crystallizes from alcohol in pale yellow plates, m.p. 140° (found: C, 54·3; H, 2·9; N, 42·9. $C_6H_4N_4$ requires C, 54·5; H, 3·05; N, 42·4 per cent).

Pteridine is soluble in water and alcohol and readily sublimes *in vacuo*. Its ultra-violet absorption spectrum in aqueous solution at *p*H 5·8 shows a sharp maximum at 299 mμ with $\varepsilon = 7,890$ (Beckmann spectrophotometer), and in neutral or alkaline solution it shows a violet-blue fluorescence in the ultra-violet. It forms a picrate m.p. 117·5° (found: C, 35·9; H, 2·8; N, 24·6. $C_{12}H_7O_7N_7.2H_2O$ requires C, 36·2; H, 2·8; N, 24·7 per cent), and an oxalate which decomposes without melting above 128° (found: C, 37·5; H, 3·5. $C_8H_6O_4N_4.2H_2O$ requires C, 37·2; H, 3·9 per cent).

W. G. M. JONES

Imperial Chemical Industries, Ltd.,
Research Laboratories,
Hexagon House, Manchester 9.
Aug. 10.

[1] *Ber.*, 39, 250 (1906).

Chemical Assay of Streptomycin *B* (Mannosido – Streptomycin)

MORRIS[1] has recently described the use of a new reagent (0·2 per cent anthrone, a reduction product of anthroquinone, in 95 per cent sulphuric acid), for quantitative determination of carbohydrates. We have found that it can be used not only for distinguishing streptomycin *B* (a mannoside) from streptomycin *A*, but also for estimating the amount of the former present in a mixture. The glucosamine moiety, present in both molecules, apparently does not react with the reagent. Results obtained are in accord with those calculated from biological and chemical assays, making the accepted assumption about the relative biological activities of the two streptomycins.

It is hoped to publish elsewhere details of the analytical procedure, with some typical results.

W. B. EMERY
A. D. WALKER

Fermentation Division,
Glaxo Laboratories, Ltd.,
Barnard Castle,
Co. Durham.
July 30.

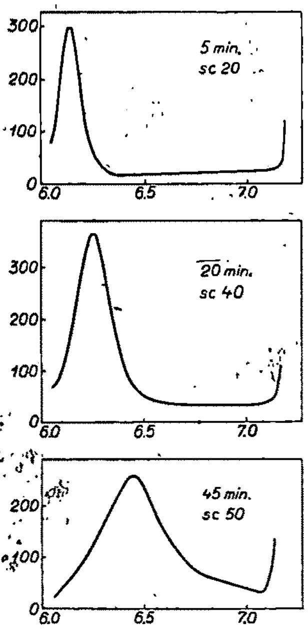
[1] Morris, *Science*, 107, 254 (1948).

Molecular Weight of Malt-Amylase

IN an earlier investigation[1], the molecular weight of α-amylase from pig's pancreas[2,3] was found to be 45,000, as calculated from the values[4] $s_{20} = 4·50\,S$, $D = 8·05 \times 10^{-7}$ c.g.s. and $V_{20} = 0·70$. At this Institute a new method for the isolation of amylase from malt has been developed[5]. It was shown that by repeated purification of the albumin fraction from malt a preparation was obtained with high α-amylase and β-amylase activity. Therefore it was assumed that the amylase activity of malt is localized in the albumin fraction. By ultracentrifugation of the albumin fraction, only one peak was obtained. It must be stated here that malt-amylase is more polydisperse than α-amylase from pancreas.

A determination of the molecular weight was carried out on an amylase preparation with a saccharification activity[6] of 45,000 and a dextrinizing activity[7] of 57,400, calculated for the dry substance. The determination was carried out in a buffer solution with a concentration of 0·2 *M* sodium chloride, 0·03 *M* primary sodium phosphate and 0·02 *M* secondary sodium phosphate, *p*H 7.

Ultracentrifuge measurement. The accompanying sedimentation diagrams were obtained by centrifuging at 65,000 r.p.m.



Sedimentation curves for malt-amylase. In Table 1 the sedimentation constants for different concentrations are shown

Table 1

Conc. of amylase (per cent)	$s_{20}S$
0·19	4·62
0·28	4·44
0·31	4·96
0·32	4·22
0·41	4·76
0·45	4·12
0·75	4·69
1·00	4·44
1·05	4·39

The sedimentation constant is evidently independent of the concentration. An average value of the sedimentation constant is $s_{20} = 4·52\,S$.

Diffusion measurement. The determination of the diffusion constant was carried out in exactly the same way as for α-amylase from pancreas[1]. The resulting values of the diffusion constant are shown in Table 2.

Table 2

Diffusion time (sec.)	34,440	79,020	99,960	129,420	Average value
D_m	6·96	6·70	6·70	6·59	6·74
D_A	6·42	6·20	6·29	6·36	6·32

The agreement between D_m and D_A is good. The average value of $D = 6·53 \times 10^{-7}$ c.g.s. is used in the following. The value $V_{20} = 0·69$ was kindly determined by Prof. C. Drucker. Using these values, the molecular weight of malt-amylase is 54,000. Evidently this value is of the same order of magnitude as that for α-amylase from pancreas. It is an interesting fact that the amylase activity is associated with molecules with about the same molecular weight in both the plant and animal kingdom.

CARL-ERIK DANIELSSON

Institute of Physical Chemistry,
University of Uppsala. May 24.

[1] Danielsson, C.-E., *Nature*, 160, 899 (1947).

[2] Meyer, K. H., Fischer, E. H., and Bernfeld, P., *Experientia*, 2, 362 (1946); *Helv. Chim. Acta*, 30, 64 (1947).

[3] Fischer, E. H., "La purification et l'isolement de l'α-amylase de pancréase". Thèse No. 1094 (Genève, 1947).

[4] Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge" (Oxford, 1940).

[5] Danielsson, C.-E., and Sandegren, E., *Acta Chem. Scand.*, 1, 917 (1947).

[6] Windisch, W., and Kolbach, P., *Woch. Brau.*, 42, 139 (1925).

[7] Ehrnst, L. E., Yakish, G. J., and Olson, W., *Cereal Chem.*, 16, 724 (1939).

Action of Oxalyl Chloride on the Aromatic Hydrocarbons

THE action of oxalyl chloride on an aromatic hydrocarbon in the presence of anhydrous aluminium chloride and in a solvent (for example, carbon disulphide) can lead to the production of the aromatic acid as the chief reaction product. This may provide, too, a general method for the synthesis of *p*-alkylbenzoic acids[1].

Schönberg and Kraemer[2] isolated *p*-ethylbenzoic acid only by the interaction of oxalyl chloride, ethylbenzene, and aluminium chloride in carbon disulphide solution at a low temperature. No mention was made of the yield of the acid. On repeating their experiment and modifying the procedure so as to extract the acid directly from the reacting mixture with a dilute alkali solution, *p*-ethylbenzoic acid (m.p. 112–113°) was obtained in 43 per cent yield, rising to 66 per cent if equimolecular amounts of the substances interacted at room temperature. *p,p'*-Diethyldiphenyl ketone was also isolated.

The action of oxalyl chloride on the higher *n*-alkylbenzenes, under similar conditions, led to the formation of the corresponding *p*-*n*-alkylbenzoic acids in satisfactory yield. Results are shown in the accompanying table.

Action of oxalyl chloride on alkylbenzenes in carbon disulphide in presence of aluminium chloride at room temperature

Alkylbenzene	Acid formed	Yield of acid (%)
Toluene	*p*-toluic	60
Ethylbenzene	*p*-ethylbenzoic	66
n-propylbenzene	*p*-*n*-propylbenzoic	70
n-butylbenzene	*p*-*n*-butylbenzoic	50
n-amylbenzene	*p*-*n*-amylbenzoic	50
n-hexylbenzene	*p*-*n*-hexylbenzoic	40
n-heptylbenzene	*p*-*n*-heptylbenzoic	40
n-octylbenzene	*p*-*n*-octylbenzoic	3

The yield of the *n*-octylbenzoic acid was exceptionally low. This might be due to the fact that the reaction was not complete at room temperature.

HUSSEIN AHMAD FAHIM
Chemistry Department,
Faculty of Science,
Fouad I University,
Abbassia, Cairo.
May 4.

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[1] Comp. Zaki and Fahim, *J. Chem. Soc.*, 307 (1942).

[2] *Ber.*, 55, 1174 (1922).

Selective Development of Fission Tracks in an Electron-sensitive Emulsion

THE interpretation of records of nuclear reactions occurring in photographic emulsions is materially assisted by differences in the solidity and grain-frequency of tracks produced by particles of different ionizing power[1]. Discrimination between tracks of various particles can be enhanced by using emulsions with a range of intrinsic sensitivities[2]; to a lesser extent by varying development time and composition of developer[2,3]; or by applying oxidizing solutions between exposure and development[4].

Special emulsions have been produced which are sufficiently sensitive to record tracks of electrons[5,6], whereas at the other end of the range there are emulsions sensitive only to tracks of fission fragments[7,8]. The advantage of the latter is, of course, that fission fragments alone can be recorded in spite of a heavy background of radiation from other less strongly ionizing particles.

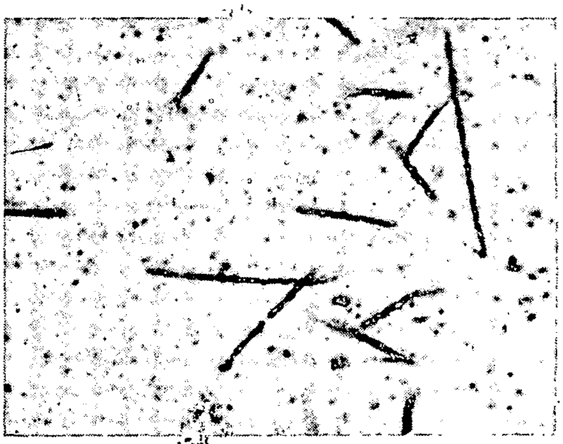


Fig. 1. Photomicrograph of tracks from uranium layer, dipping into NT.2*a* emulsion. Development 10 min. D.19*b*

It would be very convenient to be able to utilize an electron-sensitive emulsion for the selective recording of fission tracks, so that this whole range of results could be spanned with a single emulsion. A means of achieving this result by controlled under-development is the subject of the present communication.

Deliberate under-development implies that the development process will be stopped before all the exposed emulsion grains have been developed. Control of the results (particularly with thickly coated emulsions) is therefore facilitated by the use of long development times with severely restrained and slow-working developers. In preliminary tests it was noticed that a para-aminophenol solution, used at such a low *p*H that it would not even develop alpha-particle tracks, still gave strong development of abrasion marks in the emulsion surface. It seemed possible that such a solution would also develop fission tracks.

Glass plates were coated with a suspension of ammonium diuranate in gelatin (equivalent to 0·01 gm. uranium/cm.^{2}). These were packed in contact with 'Kodak' NT.2*a* plates, which have previously been shown to be capable of recording electron tracks[5,6]. Some of these were shielded with $\frac{3}{8}$ in. of lead and exposed to a flux of 5×10^{11} neutrons per cm.^{2} of plate in the nuclear pile at Harwell.

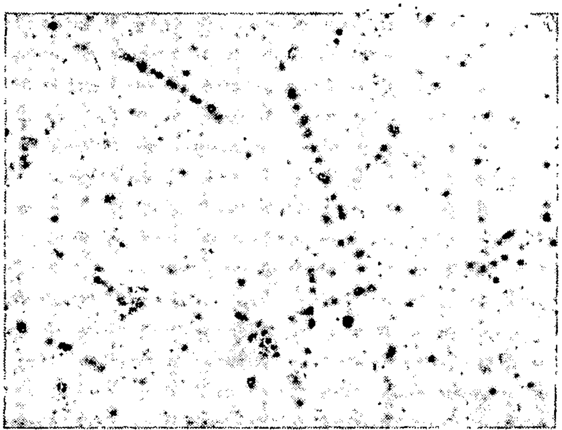


Fig. 2. Tracks given by 40-min. development in a low-energy para-aminophenol developer (solution I)

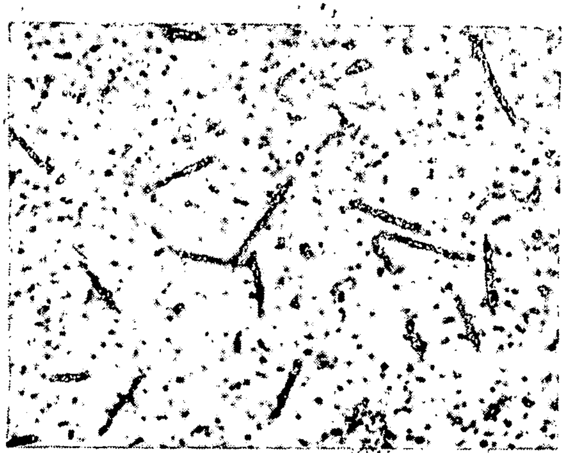


Fig. 3. Fission tracks dipping into emulsion on plate developed in solution I after exposure in the pile in contact with uranium

Strips exposed in the pile ('pile-plates') and controls left in contact with uranium only were developed for ten minutes at 70° F. in D.19*b* and for forty minutes in special low-energy para-aminophenol developers. These were prepared from three stock solutions: (*A*) contained 15 per cent para-aminophenol hydrochloride and 2½ per cent $NaH.SO_3$; (*B*) 5 per cent $Na_3PO_4.12H_2O$, 4 per cent Na_2SO_3 and 0·4 per cent KBr; and (*C*) 5 per cent $Na_2HPO_4.12H_2O$, 4 per cent Na_2SO_3 and 0·4 per cent KBr. Solution I contained 2 c.c. *A*, 20 c.c. *B* and 80 c.c. *C*. Solution II contained 2 c.c. *A* and 100 c.c. *C*.

The pile-plates developed a density of 4 in an 'Elonhydroquinone' developer (Kodak formula D.19*b*), and no tracks could be seen because of the high opacity, while the control showed solid alpha tracks (Fig. 1). In contrast to this, solution I produced on the control plates alpha tracks showing as tenuous chains of grains (Fig. 2), and the pile plate developed a density of only 0·5. Under the microscope, the latter showed solid fission tracks readily distinguished from the residual background (Fig. 3). Solution II, an even weaker developer, showed no alpha tracks at all, but still gave recognizable fission tracks on the pile plate (Fig. 4). Perfilov[4] obtained similar discrimination between alpha and fission tracks by treating the exposed plates in a dilute chromic acid bleach before development. We have been able to confirm the general nature of this result, and preliminary comparisons indicated that the discrimination is surprisingly similar to that given by these special para-aminophenol developers.

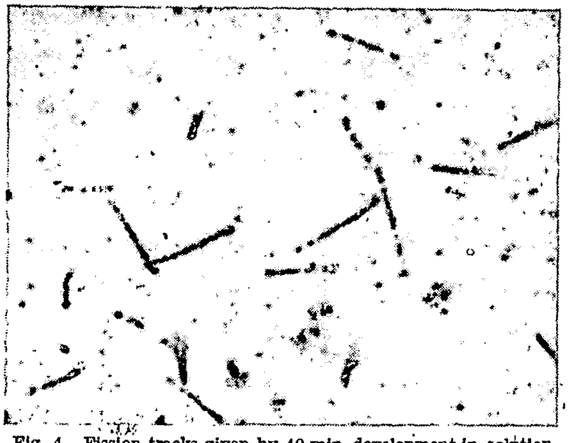


Fig. 4. Fission tracks given by 40-min. development in solution II, which cannot develop alpha tracks at all

Similar discrimination has also been obtained by using 'Elon' (methyl *p*-aminophenol sulphate), glycin and hydroquinone in solutions adjusted to give about the same development activity. The effect is thus not exclusive to one developing agent, but para-aminophenol and 'Elon' gave the more attractive results. Discrimination has also been obtained by adding progressive concentrations of potassium bromide to these solutions at higher *p*H values. On the other hand, substantially no discrimination between alpha and fission tracks was obtained by developing for only one minute in D.19*b*. A continuously graded series of developers can also be conveniently prepared by raising the proportion of stock solution *B* to increase the *p*H and developer activity, and some of these more active developers give considerable discrimination between alpha particle and proton tracks.

Considerable advantage may accrue if procedures of this type can be standardized without excessive trouble. The results given by such gross under-development are, however, likely to be particularly sensitive to small variations of temperature or composition. Reproducible results may, therefore, only be obtained by performing the development operation with the care used in other physico-chemical experiments.

I wish gratefully to acknowledge the help of the Director, Atomic Energy Research Establishment, Harwell, in obtaining neutron exposures, and to thank him for permission to publish these results which were obtained while working under contract to the Establishment.

G. W. W. STEVENS

Research Laboratory,
Kodak, Ltd.,
Wealdstone,
Harrow, Middlesex.
July 30.

[1] See, for example, Powell, C. F., and Occhialini, G. P. S., "Nuclear Physics in Photographs" (Clarendon Press, Oxford, 1947).

[2] Powell, C. F., Occhialini, G. P. S., Livesey, D. L., and Chilton, L. V., *J. Sci. Inst.*, 23, 102 (1944).

[3] Demers, P., *Can. J. Res.*, 25, 225 (1947).

[4] Perfilov, N. A., *C.R. Acad. Sci. U.R.S.S.*, 42, 258 (1944).

[5] As reference 3.

[6] Berriman, R. W., *Nature*, 161, 432 (1940). Herz, R. H., *Nature*, 161, 928 (1948).

[7] Borst, L. B., and Floyd, J. J., *Bull. Amer. Phys. Soc.*, 21, No. 3, 13 (1946).

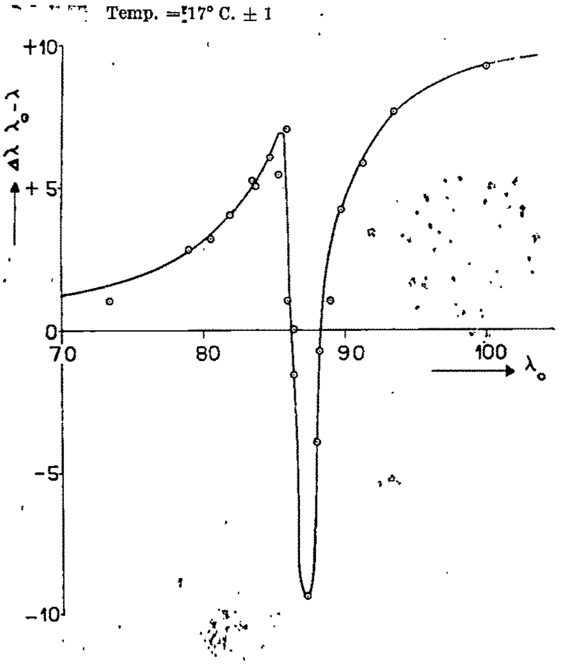
[8] Green, L. L., and Livesey, D. L., *Nature*, 158, 272 (1946), obtained a similar result from incidental desensitization occurring when plates were bathed in uranyl acetate.

Anomalous Magnetic Behaviour of Nickel–Iron at High Frequencies

In the course of a series of experiments that is being carried out under the direction of Miss H. J. van Leeuwen in this Laboratory in order to determine the high-frequency magnetic permeability of ferromagnetic materials, a peculiar property of a nickel–iron alloy has been found.

Two concentric Lecher systems are used in the experiments, the outer conductor of both being made of copper, while the inner conductor of one is a copper wire, that of the other a nickel–iron wire (35 per cent nickel, 65 per cent iron). Both systems are coupled to an oscillator and the wave-lengths of standing waves are measured.

It can be shown mathematically that for a magnetic permeability μ greater than 1 of the ferromagnetic material, the wave-length λ for the ferromagnetic wire is smaller than the wave-length λ_0 for the copper wire. The results of the measurements in the interesting range are shown in the accompanying graph, the abscissa representing λ_0, which is practically equal to the wave-length *in vacuo*, while the ordinate signifies the difference $\Delta\lambda = \lambda_0 - \lambda$.



The graph resembles strikingly an anomalous dispersion curve. In a narrow interval, between $\lambda_0 = 86$ and 88 cm., the wave-lengths on the nickel–iron wire become considerably larger than those on the copper wire, which means that μ there is smaller than unity or even negative.

Similar experiments have been carried out previously in this Laboratory by J. Smidt[1] with a pure iron wire. This showed no anomalous behaviour except that the descent of the curve to zero near $\lambda_0 = 60$ cm. was much steeper than could be expected from theory[2]. A possible explanation would be that the wave-length for the anomalous behaviour of iron falls just in this region, the minimum of the curve being obliterated because the magnetic susceptibility of iron disappears below 60 cm.

It is expected that these and further experiments will reveal new information on the internal conditions of ferromagnetic materials.

A. Wiebberdink

The experiments just described can be interpreted in their essence by assuming that the magnetization induced in the material of the wire by a harmonically varying magnetic field is represented by a function of the frequency of the same type as that met with in the case of the electric polarization for a system subject to a harmonically varying electric field and possessing a resonance frequency.

As is well known[3], the magnetization in ferromagnetic substances in general is built up from three contributions: the irreversible displacements of the boundaries of the Weiss domains, the reversible displacements of these boundaries and the change in direction of the magnetic moments of such domains by the external field. At the frequencies and field-strengths here considered, the first cause is no longer operative[3]. The reversible motion of a boundary will, it is true, have a certain characteristic frequency of oscillation about its equilibrium position; but this will depend on local conditions such as stress, impurities, etc., and hence will vary from one boundary to another, thus not giving rise to a well-defined resonance frequency for macroscopic pieces of material. In its orientation, however, the resultant magnetic moment of a Weiss domain is bound to the crystal field, tending to give it preferential directions with respect to the crystal axes (while strong stress or the influence of a constant external magnetic field may supersede the crystal field). In consequence, the magnetic moment will precess about the preferential direction, and it is this precession frequency which acts as resonance frequency for the magnetization. In nickel the crystal field is equivalent to a magnetic field of about 100 oersted, whereas for iron the value is several times as large[3]. The double Larmor frequency in a field of that strength is about 3×10^8 Hz. In other words, it is located just in the proper frequency-range. As in the theory of electric polarization, an absorption will be associated with the anomalous dispersion, which can be described by a line-breadth. This is determined by the natural transition probability of the magnetic moment between its different stationary states in the crystal field, the transitions being brought about by the coupling of the magnetic moment with the conduction electrons and the lattice waves.

An investigation of the influence of stress and of a constant external magnetic field on the value of the resonance frequency will be very instructive and is being planned.

A more detailed discussion of the experiments as well as of the theory will be given in *Applied Scientific Research*.

R. Kronig

Laboratory for Technical Physics,
Delft.
May 14.

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[1] Smidt, J., *App. Sci. Res.*, B, 1, 127 (1948).

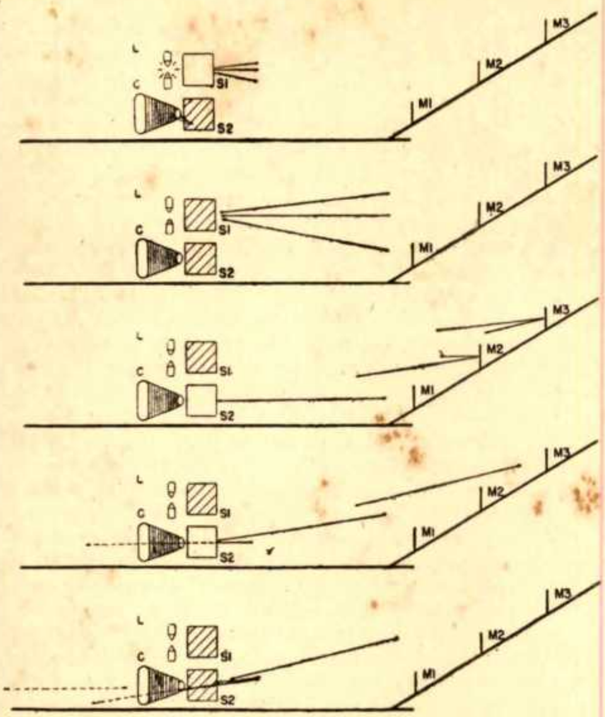
[2] van Leeuwen, H. J., *App. Sci. Res.*, B, 1, 135 (1948).

[3] Becker, R., and Döring, W., "Ferromagnetismus" (Berlin, 1939).

Brief Light Pulses using Kerr Cells

In connexion with certain studies of electrical discharges, we have found it necessary to develop an extremely fast shutter for photography. The electro-optic Kerr effect is used. Mounted 5·1 mm. apart in nitrobenzene in a glass Kerr cell, the electrodes are 12·7 mm. wide and 20·3 mm. long. Selected pieces of 'Polaroid *J*' film are placed outside the fused-on windows. The cells are subjected to single pulses of about 12,500 volts from a hydrogen thyratron and *RLC* pulse-forming network, thus admitting light to the lens of an ordinary camera. We have been photographing such intensely self-luminous objects as sparks and electrically exploded wires with exposures of a microsecond or less.

We report here a side-experiment designed to show directly the length of the segment of a light beam that we have been able to chop off with a Kerr cell.



L, light source ; *C*, camera ; *S* 1, 2, Kerr cell shutters ; *M* 1, 2, 3, mirrors

In this experiment, two shutters, separated by an optical path of a few metres, were arranged to be pulsed in sequence. If the second shutter were thus opened at a suitable moment following the opening of the first, to allow for the transit time of the light between them, a source of light in front of the first shutter could be photographed by a camera behind the second. If the time delay of the second shutter were appreciably different from the transit time, no light reached the camera. The light source was a wire electrically exploded just previous to the opening of the first shutter.

For convenience, the optical path was folded by using a plane mirror, so that the camera was just below the source. In our experiment, not one but several mirrors were used. These were all so placed as to be illuminated by the source, and all were in the field of view of the camera. Thus several optical paths were set up, each with its own mirror (see accompanying diagram). Since successive mirrors were separated by 30 cm., the optical path differences were 60 cm. By virtue of the finite speed of light, a brief sequential pulsing of the two shutters should, in any given exposure, show not all the mirrors to be effective in reflecting the light pulse. The accompanying photographs show the mirrors, located 30 cm. apart. Certain of them are seen to reflect the light ; from a count of these, the length of the light segment may be estimated. By altering the relative timing of the shutters, the reflexions can be made to appear in the near mirrors or the far mirrors.

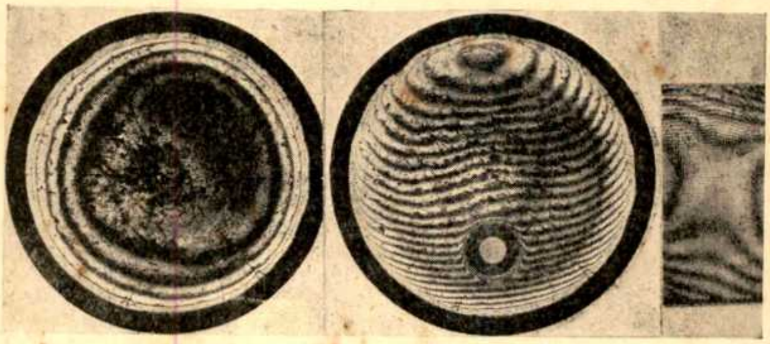
For a semi-quantitative estimate of the length of the beam segment, the method was to compare visually the density of the photographed reflexions in two negatives, one of which had been exposed to two flashes and the other to a single flash. It was noted that seven of the images on the double exposure are more intense than the brightest image on the single exposure. From this it is deduced that the measured length of the beam, between half-intensity points, is about 4·2 m. Neglect of the inverse square law is approximately justified. This measured length depends upon the speed of the second shutter as well as that of the first. If we make the plausible assumption that the voltage applied to each shutter is a similar Gaussian function of time and calculate therefrom the variation of the transmittance of either shutter during the pulse, the distribution of the exposure among the several photographic images is predicted to be approximately Gaussian with a width at half-maximum which is about 23 per cent greater than that of either shutter. The actual length of the beam is thus $4{\cdot}2/1{\cdot}23 = 3{\cdot}4$ m. between half-intensity points. Furthermore, since 70·7 per cent of the area of the shutter transmittance function lies between abscissæ only 78 per cent as far apart as its half-value points, we may say that the effective length of the beam is only 2·7 m. Its duration is therefore 270 jiffies, or about 9×10^{-9} second. This last figure is in good agreement with the value calculated from the oscillogram of the pulses applied to the Kerr cells.

W. M. CADY
A. M. ZAREM

U.S. Naval Ordnance Test Station,
Pasadena Annex,
Pasadena, California.
July 23.

Liquid Surface Interferometry

THE property that liquid surfaces have of indicating level is frequently employed in physical and engineering metrology. Surprisingly little use is made of the property of flatness which, with certain reservations, is possessed by a reasonably extensive liquid surface, which provides a naturally reproducible reference basis. The earth's radius of curvature causes the centre of a liquid surface of 25 cm. diameter to project by only 12 A. above the true plane intersecting its



1 and 2 show two depositions of fringes in a liquid paraffin layer floated on a lapped cast-iron surface, and indicate that, apart from slight concavity at the centre, the metal surface is generally convex in shape. 3 shows two fringe systems obtained when a wedge plate of glass (20 cm. × 10 cm.) is supported over the liquid surface. *N.B.*—1 fringe in liquid paraffin and glass is equivalent to 0·18 μ ; in air the equivalent is 0·27 μ

perimeter, if the effect of capillary curvature at the boundary region is omitted from consideration.

Preliminary experiments at the National Physical Laboratory, with a liquid surface serving as the reference plane in one of the usual arrangements of a Fizeau interferometer[1], have yielded very promising results over a field of 25 cm. diameter. We find, however, that Rayleigh described long ago the use of a water surface for similar purposes during a Royal Institution lecture[2]. Our experiences are much the same as those described by Rayleigh, except that we find it important to use liquids of higher viscosity than water to avoid the vibrational troubles which he reported. Among the liquids we have tried are a micrometer oil (Price's 'Albaline') and glycerine; but the most successful is medicinal liquid paraffin, because it requires no special site or anti-vibration arrangements and yet flows fairly easily. The capillary curvature is also less extensive than that reported for water by Rayleigh. It is necessary to work with a clean surface and to shield it from air draughts. An interesting effect is the unusual response to vibrations observed in the neighbourhood of any sudden and marked change in the depth of the liquid layer.

An important item of the equipment we use is a simple plano-convex lens of 38 cm. diameter (*F*/5) acquired from war surplus stocks of optical components. This is arranged horizontally as the collimating lens of the Fizeau interferometer and directs a beam of parallel monochromatic light vertically downwards on to a lapped cast-iron surface plate of 30 cm. diameter supported on three levelling feet. The liquid paraffin layer, about 3 mm. in thickness, is floated on the metal surface and retained by paper strip gummed round the periphery of the plate. The disposition of the fringes which are produced by two interfering beams, one partially reflected from the liquid surface and the other totally reflected from the metal, is controlled with the levelling feet.

The three interferograms reproduced were obtained in mercury green light using exposure times of 5–20 sec. with Ilford *HP*2 plates (6 cm. × 4 cm.). No. 1 shows fringes—rather like a system of Newton's rings—produced over the lapped surface plate when symmetrically disposed to the liquid surface. The black border represents the boundary region from which no light is received owing to capillary curvature. This effect extends into the region from which light is received but vanishes at about 2·5 cm. from the boundary. No. 2 shows fringes over the same plate when slightly inclined to the liquid surface. The white disk represents the end of a 1-in. diameter Hoffmann roller standing in the liquid. A disturbance due to capillary curvature extends about 2·5 cm. outwards from the cylindrical surface which, like the gummed paper, is wetted by the oil.

As glass and liquid paraffin have nearly the same refractive index it is preferable to support glass plates over the liquid surface during examination. In No. 3 the widely spaced fringes are produced by interference in the air film between the liquid and the lower surface of a glass plate 1 cm. thick. The closely spaced system is due to the two surfaces of the glass plate itself and shows that it is wedge-shaped.

We direct attention to this use of a liquid surface as an interferometer mirror because it may have many applications, especially for studies of the physical properties of liquids. It has many obvious advantages as a ready means of verifying large flat surfaces of a precision character.

A fuller account of this work, forming part of the research programme of the National Physical Laboratory, will be published elsewhere.

H. Barrell
R. Marriner

Metrology Division,
National Physical Laboratory,
Teddington, Middx.
June 25.

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[1] Williams, W. E., "Applications of Interferometry", 64 (Methuen, 1948).

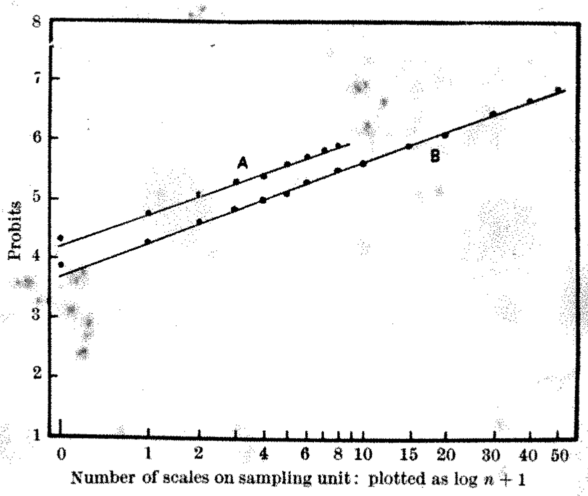
[2] Rayleigh, Lord, *Proc. Roy. Inst. Lond.*, **14**, 72 (1893); *Nature*, **48**, 212 (1893).

Truncated Log-Normal and Root-Normal Frequency Distributions of Insect Populations

In entomology it is usual to find that the numbers of insects or their eggs occurring in each sampling unit are not distributed normally, the many lesser and zero values causing the distribution to be extremely skewed. When such distributions occur, the gross deviations from normality invalidate the use of classical biometrical methods.

I have found such markedly skew distributions of the number of red scales (*Aonidiella aurantii* Mask.) on individual citrus leaves and of the number of eggs laid by *Anobium punctatum* females. It has been found that these two cases can be plotted as straight lines when the probit methods suggested by Gaddum[1] are used, and it appears that these methods may give a solution of other skewed distributions. The red scale data required a logarithmic transformation of the enumeration variable, the *Anobium* data, a square root transformation. The usual device of plotting $n + 1$ instead of the number n has been adopted to allow zero values to be plotted on a logarithmic scale.

As illustration of the degree of linearity achieved by probit methods, the data for red scales on citrus leaves as given in the table, and that of Upholt and Craig[2] for black scales on citrus twigs, have been so plotted in the figure.



Degree of linearity achieved by probit methods. Line *A*, black scales on citrus twigs (Upholt and Craig[2]). Line *B*, red scales on citrus leaves

Frequency distribution of red scales on 720 citrus leaves

Number of scales per leaf	Observed frequency	Number of scales per leaf	Observed frequency	Number of scales per leaf	Observed frequency
0	89	22	7	47	1
1	79	23	4	50	1
2	78	24	7	52	2
3	58	25	5	53	1
4	51	26	3	55	1
5	30	27	3	57	2
6	39	28	8	59	1
7	34	29	2	60	1
8	27	30	5	62	2
9	18	31	2	65	1
10	13	32	2	74	1
11	12	33	2	78	1
12	19	34	2	80	1
13	16	35	1	81	1
14	13	36	1	88	1
15	6	37	4	94	1
16	12	38	1	96	2
17	6	39	2	103	1
18	5	41	2	105	1
19	8	42	2	185	1
20	6	44	5	241	1
21	5	45	1		

Marked breaks and changes of slope occur with some published data; but these may be due to sampling of mixed populations.

The truncation to the left apparent in the figure can be eliminated by increasing the size of the sampling unit until zero values do not occur. When this was done with red scale using counting units of twenty leaves, it was found that the frequency distributions of these units were still log-normal. After the six twenty-leaf values of each of thirty trees had been transformed to logarithms, Nayer's test[3] showed that the various populations could be regarded as having a common variance and thus normal statistical methods could be used. The obvious method of overcoming difficulties arising from truncation of these curves is an increase in size of sampling unit; but if it is necessary to compare data already collected this device may not be available.

From the ease with which data can be reduced to a series of straight lines, it appears preferable to assess significance of differences between two or more sets by linear regression methods, rather than argue back to parent distributions. The usual methods of calculating regressions and their variance cannot be used because points other than the first are not independent. Methods of calculating regressions and variance of such transformed data do not appear to be available, but are required before the utility of probit methods in handling skewed distributions can be determined.

The data and plots of *Anobium* egg-laying are being published elsewhere[4].

D. SPILLER

Plant Diseases Division,
Auckland, New Zealand.
July 26.

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[1] *Nature*, **156**, 463 (1945).

[2] *J. E. Ent.*, **33**, 113 (1940).

[3] *Stat. Res. Mem.*, **1**, 38 (1936).

[4] *N.Z. J. Sci. and Tech.* (in the press).

Photographic Evaluation of Blackout Indices

DURING the act of blinking the pupils are masked by the upper lids for an appreciable fraction of a second (*c.* 0·1–0·3 sec.) and, in consequence, vision is intermittent. The *blackout index* expresses the percentage of vision during which one is unsighted, and is obtained from the ratio of the blackout and interblink periods, the normal average value of the latter being for men and women *c.* 3·3 sec. In conversation, the average interblink period is only *c.* 2·7 sec.[1].

Average time constants of blinking can be assumed for a large group of individuals, so that in group photography one can expect that at any instant a definite percentage of the subjects (the average blackout index) will be unsighted and have their eyes almost or wholly closed. Examination of group photographs of a total of sixty-one subjects revealed that roughly one-tenth of them were photographed during the act of blinking, in reasonable agreement with the expected result[2]; but it seemed desirable to examine further photographs of groups and thus obtain the average blackout index for people in general.

It is essential that the time of exposure should be less than the blackout period (that is, < 0·1 sec.), for blinks will not be revealed clearly in exposures greater than the duration of a blink (0·3–0·4 sec.). Occasionally, even in time exposures, the eyes may appear somewhat blurred. It is therefore important to ensure that such group photographs are either snapshots or flashlight photographs which satisfy the above condition. This is not always easy. Momentary exposures of a group of people occasionally reveal no blinks, whereas, especially with small groups, as many as one-half the subjects may have closed eyes. Many photographs are useless for the purpose in view, if the eyes of all the subjects are not clearly visible.

During the past year I have examined a large number of photographs to ascertain with greater accuracy the average blackout index for people in general. I have also examined many time exposures to confirm that they do not reveal blinks. No evidence of a blink was found in several group photographs taken about fifty years ago, all posed and certainly time exposures. A series of departmental group photographs of students taken during the past twenty-nine years, and all known to be time exposures, yielded only two instances of closed eyes in a total of more than a thousand subjects. Possibly these two were resting their eyes in anticipation of being photographed. On the other hand, in a large number of snapshot and flashlight photographs of a total of 2,140 subjects, 215 had closed eyes. On this evidence it seems certain that the general average blackout index does not deviate appreciably from 10·0 per cent for light-adapted eyes (pupil diameter, 3–4 mm.).

It follows that the general average *blackout period* will be 0·33 or 0·27 sec., according to which of the general average interblink periods (3·3 or 2·7 sec.) is used. As the conditions under which snapshot or flashlight photographs are taken are more often conversational than normal restful ones, the second value of the blackout period is likely to be the true one. This value lies between the limits mentioned earlier, and it is interesting to note that Miss M. P. Lord and W. D. Wright recently determined the former's blackout period to be *c.* 0·2 sec.[3].

It is clear that individual blackout indices could be determined by examination of a large number of random photographs of one and the same individual, though the process would be rather tedious. In a popular form of multiple photography, blinks can often be noticed—in one case I saw four in a total of forty-eight photographs—but it seems doubtful whether these multiple photographs are sufficiently random and unposed to serve as a basis for the determination of individual blackout indices.

ROBERT W. LAWSON

Department of Physics,
University, Sheffield, 10.
Aug. 10.

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[1] Hall, Sir Arthur, *Brit. J. Ophthal.*, 29, 446 (1945).

[2] Lawson, R. W., *Nature*, 161, 154 (1948).

[3] Lord, Mary P., and Wright, W. D., *Nature*, 162, 25 (1948).

Variation of Ground-Levels on Coe Fen, Cambridge

SOME interesting and considerable variations in level were noticed on Coe Fen, Cambridge, after the floods of 1947. A portion of the Fen is used by the Engineering Department, University of Cambridge, for practical exercises in surveying. For this purpose, concrete blocks approximately 1 ft. 0 in. square by 1 ft. 6 in. deep have been sunk into the ground to form the survey stations, the actual station being taken as the centre of a steel tube cast solid with the concrete block and projecting slightly above the surface of the block. These stations are grouped into closed polygons.

Small vertical movements of these blocks are known to take place, and have usually been attributed to frost heave. For this reason, the differences in level between all these blocks are carefully checked before the surveying course begins each summer, so that the accuracy of the students' levelling may be checked.

After the floods of 1947, during which practically the whole of this area was inundated, this check was carried out as usual, and very much larger movements than had hitherto been found were encountered. Unfortunately, the absolute levels of these blocks have never been measured with respect to some fixed and stable bench-mark, so that only their relative movements can be measured. However, between the summers of 1946 and 1947, either the south end of the Fen has lifted, or, more likely, the north end has sunk about 0·2 ft., a considerable amount in a distance of about 2,000 ft. The levels were rechecked in April of this year, and little difference was found from the previous year's figures, only slight movements, of the order of 0·03–0·04 ft., having taken place.

The nature of the ground was investigated in an endeavour to shed some light on the cause of these movements. Borings were made near three of the stations. At all these points, similar conditions were found. After about six feet of gravel, some clay was encountered. This was at first thought to be the thick underlying stratum of gault known to exist in this area. However, further boring revealed that this layer of clay was only about one foot thick, and that below this was a layer of what might best be described as liquid mud, into which the soil borer could be pushed by the weight of the body, without any twisting action being necessary. This liquid mud was about four feet thick. In some of the borings a layer of peaty substance was found at the bottom of the gravel.

E. G. STERLAND

Engineering Laboratory,
University,
Cambridge.
June 26.

Work-Hardening Under Complex Stresses

PLANE stress yielding was induced in a duralumin plate by expanding a 12-segmented cylindrical collet. The tangential strains in the plate were measured at ten values of radius by means of single-filament Minalpha resistance wire strain gauges[1]. At all loads the measured strains in the unyielded portion of the plate fitted the theoretical solution exactly. The measured values in the yielded zone from the inner radius out to the yield boundary are shown for a typical loading in the figure.

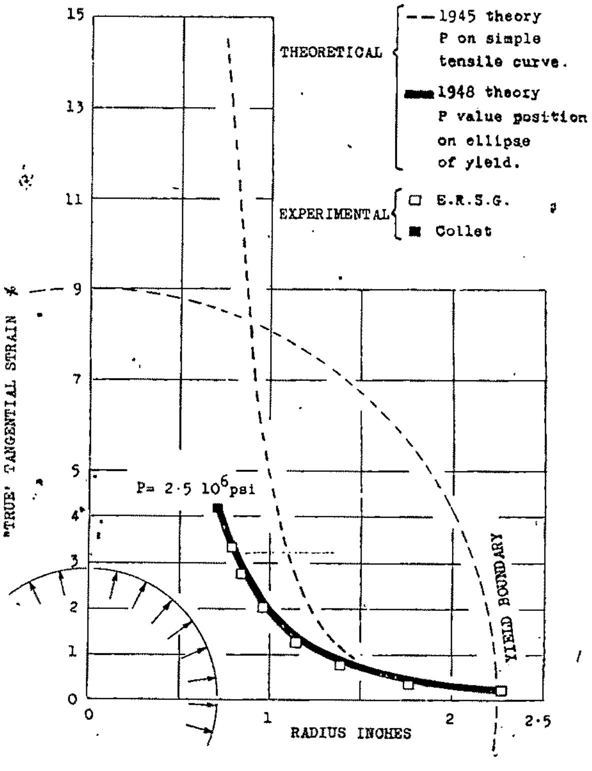
The experiment was designed to check the particular solution in my 1945 theory on post-yield stress-strain compatibility[2], but with the 1947 extension to any severity of deformation[3], since the experimental strains were large at the higher loads. The stress-strain relations for this plane-stress problem in polar co-ordinates (r, θ) are,

$$e_r = \frac{1}{E}(S_r - qS_\theta) + \int_{S_r^0}^{S_r}\left(\frac{1}{P} - \frac{1}{E}\right)dS_r - p\int_{S_\theta^0}^{S_\theta}\left(\frac{1}{P} - \frac{1}{E}\right)dS_\theta, \qquad (1)$$

with the expression for e_θ written by interchange of r and θ and in which e can be nominal strain for small strains or 'true' for any finite magnitudes[3,4], E the elastic modulus, P the inelastic modulus, S stress, q and p elastic and plastic transverse contraction ratios respectively, while superscript 0 denotes the stress operating when the element first yields. The stresses must satisfy the extended Huber – Mises – Hencky yield criterion[2]

$$S_r^2 - S_rS_\theta + S_\theta^2 = Y^2, \qquad (2)$$

the equations of equilibrium and the boundary con-



ditions as well as (1). The normal stress Y is 'equivalent' to the complex system.

Comparison of the measured strains with the theory showed that in the duralumin of the plate the stress-strain parameter P obeyed the relationship,

$$\frac{1}{P} = fY, \qquad (3)$$

with f of value $3 \cdot 57 \times 10^{-12}$ (psi)$^{-2}$. In the 1945 theory[2] P was taken as the slope of the simple tensile stress-strain curve at stress Y. Thus for duralumin in simple tension f is of value 172×10^{-12} (psi)$^{-2}$, and if this value is used in the theory would give the curve shown in the figure. It is important to note that this erroneous assumption is involved in all the recent theories in which the stress-strain parameters are assumed as functions of only octahedral shear stress[5,6].

The duralumin is 'stiffer' under the compression-tension stresses in the expanded plug test than it is under simple tensile stress. This led me to analyse tests by Davis[7] on thin-walled tubes under axial tension and internal pressure inducing tangential tension. Under the tension-tension stress loading the steel was 'less stiff' than under simple tension. Thus it appears that the strain change accompanying a stress change depends on the signs and magnitudes of the orthogonal stress components as well as on the equivalent normal or octahedral shear stress[8].

K. H. SWAINGER

Imperial College of Science and Technology,
City and Guilds College,
South Kensington, London, S.W.7.
March 14.

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Genetics of Style-Length in *Oxalis*

AMONG the tristylic plants which have attracted the attention of geneticists, without the genetic situation being fully elucidated, is *Oxalis valdiviensis*. Two years ago, work was started in this Department by setting out twelve short-styled plants for open pollination by long, as this method had proved successful in the case of *Lythrum salicaria*.

Of the twelve progenies grown in 1947, six threw no mid-styled plants, giving 363 L : 319 S. The remaining six families, which contained mids, gave 24 L : 329 M : 336 S, showing that the short parent was segregating for a factor for mid style-length, though not so as to give a 1 : 1 : 2 ratio, as with *Lythrum salicaria*.

This result suggested the possibility that the genes for short and mid were rather closely linked, with about 6·8 per cent recombination, and that the shorts used had been double heterozygotes in repulsion. In order to test this view, we have grown in 1948 fifteen progenies from shorts from these families crossed again with long. On the linkage hypothesis, the expectation is that about 1 in 15 of such parents should have received the mid gene and that it, unlike its short parent, should be a double heterozygote in coupling, giving approximately 14 L : 1 M : 15 S.

The results of 1948 have completely verified this supposition. Fourteen of the progenies grown have given long and short only, in all 723 long and 675 short, while the remaining progeny has given 17 L : 2 M : 38 S, practically in the proportions anticipated.

These experiments do not complete the demonstration that *Oxalis valdiviensis* is disomic, unlike *Lythrum salicaria*, which has been shown to be tetrasomic. Such a conclusion is suggested by Lady Barlow's earlier work[1,2], and critical tests have been prepared for next year. If, however, the species proves to be disomic, the population maintained by legitimate pollination would contain one genotype long, two mid, heterozygous and homozygous respectively for the mid gene, and four short, including the two double heterozygotes in coupling and repulsion. Plants homozygous for the short gene could not be produced by legitimate pollination. In *Lythrum salicaria*, on the other hand, there are one genotype long, four mid and ten short[3].

In any event, the fact that the two controlling factors are here linked shows that the genetic situation is quite distinct from that in *Lythrum*, in spite of the two remarkable similarities that in both species the double recessives are long-styled, and in both the factor for short-style is epistatic to that for mid.

A detailed note of these experiments will be published in *Heredity*.

R. A. FISHER
V. C. MARTIN

Department of Genetics,
University of Cambridge.
May 26.

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Microflora of the Rumen of the Sheep

IN a previous communication[1], McGaughey and Sellers stated that sheep, with permanent rumen fistulæ, fed on hay and mangolds, develop a rumen microflora similar to that described by Quin[2] as occurring in sheep in South Africa. They pointed out that the organism found overwhelmingly predominant and apparently that termed *Schizo-saccharomyces ovis* by Quin is motile, and is apparently the same organism as that described by Woodcock and Lapage[3] and now known as *Selenomonas ruminantium* (Certes).

We believe that the organism is not a Schizosaccharomycete, as a result of (*a*) the study of its morphology, for example, characteristic wriggling motility, bean shape, pointed ends and absence of endospores; (*b*) failure to grow in media usually found to be adequate for the culture of Schizosaccharomycetes. Woodcock and Lapage[3] in their detailed examination of *Selenomonas ruminantium* did not overlook the possibility of it being a yeast; but after examination of authenticated strains of Schizosaccharomycetes, decided that they were not related. Moreover, they mentioned that Ledingham[4] was unable to cultivate *Selenomonas ruminantium* on various media; our attempts at cultivation have been equally unsuccessful. Thus, plating on potato dextrose agar of a centrifugate containing 10^{10} selenomonads per ml. yielded as the most numerous types of organisms: Rhodotorulæ 5×10^6/ml., *Aerobacter* 3×10^6/ml., yellow and white cocci 1×10^6/ml., Bacilli 1×10^5/ml., *Candida*-like organisms 1×10^2 to 10^3/ml. After incubation of rumen contents mixed with dextrose solution, several other types of yeasts were isolated; these have not been fully identified, but none is a Schizo-saccharomycete.

As it is possible that the growth of bacteria and yeasts may inhibit the growth of selenomonads, single-cell culture methods were adopted. By micro-manipulation, four different morphological stages of *Selenomonas ruminantium* were transferred to each of the following media: potato dextrose agar, the same with addition of 20 per cent dextrose, synthetic medium with 2 per cent and 20 per cent dextrose added, potato dextrose agar with rumen filtrate (1 : 1) added. No growth whatever occurred after these transfers; indeed, contact with these media inhibited motility at once.

In addition to the media mentioned above, many others, inoculated with fresh motile selenomonad suspension and incubated aerobically, anaerobically, in carbon dioxide atmospheres, at low temperatures and high temperatures have been used without success.

The inferences from our culture studies are (1) *Selenomonas ruminantium* did not grow; (2) if Schizo-saccharomycetes had been present, they would have been observed.

Hence we believe that the predominant organism of the rumen is not a Schizo-saccharomycete. Further, we have found no evidence of Schizo-saccharomycetes in the rumen of sheep in Great Britain. We suggest that the term *Schizo-saccharomyces ovis*, as applied to the organisms in question, is misleading and should be discontinued.

M. INGRAM
Low Temperature Research Station,
Cambridge.

C. A. MCGAUGHEY
Institute of Animal Pathology,
Cambridge. May 25.

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British Folliculinidæ (Ciliata, Heterotricha)

SINCE February 1947, I have had the opportunity of making an intensive search for Folliculinids at Plymouth, where I found four species, and at Cullercoats where five species were discovered. Except for *Folliculina* (*Folliculinopsis ?*) *ampulla*, no record of Folliculinid species existed at these two marine laboratories. Besides the six species already recorded by me for Great Britain[1], a seventh species, *Folliculinopsis* (*Metafolliculina*) *andrewsi* (Hadzi), found by me both at Plymouth and at Cullercoats, should now be added to the list of British species.

The species recorded by me are: *F. producta*, *F. andrewsi*, *F. viridis* and *F. elegans* from Plymouth (list and specimens with Director, Plymouth Laboratory), and *F. producta*, *F. andrewsi*, *F. viridis*, *F. elegans* and *F. simplex* from Cullercoats (list with Director, Dove Laboratory). The only other records are *F. ampulla* and *F. elegans* from Port Erin (Bruce[2]), and a single species, *F. viridis*, from Swansea (Fowell[3]). The finding of *Folliculinopsis* (*Metafolliculina*) *andrewsi* (Hadzi) is the first record of the species on the east side of the Atlantic (the species being common around Woods Hole, United States), as well as a first record for Great Britain.

I shall be grateful for information regarding British records of other species of Folliculinidæ, which workers in marine laboratories may come across, to enable me to include it in the systematic account well under way for publication.

My thanks are due to Wing-Commander F. S. Russell for allowing me a table at Plymouth in September 1947, and to Prof. A. D. Hobson for facilities for work in the Marine Laboratory at Cullercoats during 1946–47.

S. M. DAS
Department of Zoology,
University, Lucknow.
May 7.

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Number of Sperms Required for Fertilization

MUCH has been done in recent years to determine the number of sperms which must be introduced by artificial insemination to maintain a normal rate of fertilization. There are, however, markedly divergent views as to the number of sperms normally present in the immediate vicinity of the eggs at fertilization. Such direct evidence as exists suggests very small numbers. Thus Hammond[1] reports finding remarkably few in smears prepared from the fallopian tube of rabbits killed 10 hr. after coitus. Hammond and Walton[2] examined the ovarian capsules of ferrets at 3–36 hr. after coitus, and counted 1,600 sperms in one ferret and 0–75 sperms in six others. The number of sperms in the tubes of rats were observed by Blandau and Money[3] to increase during the hour after coitus to a maximum of about 200.

On the other hand, it is a widely held theory that the eggs of many species of mammals must be freed from the surrounding mass of follicle cells, by means of hyaluronidase, before sperm penetration can take place, and there is a strong implication that a large aggregation of sperms is necessary to assure an adequate concentration of hyaluronidase. Pincus and Enzmann[4] stated that at least 20,000 sperms/c.mm. are required for follicle cell dispersal and fertilization *in vitro*, and Pincus[5] suggests that this may also be the case *in vivo*. Kurzrok, Leonard and Conrad[6] concluded from their studies that an accumulation of about 20 million sperms would be needed in the vicinity of the human egg *in vivo*.

It has been shown, however, that in the rat denudation of the egg is not a prerequisite of fertilization[7,8]. This would appear to remove the principal reason for supposing that large numbers of sperms are necessarily involved at fertilization. Further information on this matter has now been obtained.

When rabbits are artificially inseminated with $0 \cdot 5-1 \cdot 0 \times 10^6$ sperms and killed 12–15 hr. later, the eggs are frequently recovered in apparently intact masses of cumulus cells. Nevertheless, a proportion of the eggs show evidence of sperm penetration, and at 15 hr. the pronuclei can be discerned by means of the phase-contrast microscope. This confirms the observations previously recorded for the rat.

Attempts were made to count the number of sperms in the washings from the tubes of rabbits inseminated with about $1 \cdot 0 \times 10^8$ sperms. Accurate assessment is very difficult owing to the relatively large volume of fluid required for thorough washing; but it was estimated that about 2,000–4,000 sperms were present throughout the length of a single tube. The number in the immediate vicinity of the eggs must have been much smaller. Insemination with less than $1\cdot0 \times 10^6$ sperms, though resulting in the fertilization of a proportion of the eggs, greatly reduces the number of sperms in the tubal washings, so that even an approximate estimation was not found practicable.

Fertilization in the rat takes place in a distended portion of the fallopian tube, near the infundibulum. If the distension is incised the contents, including the cumulus masses, flow out freely, and it is likely that the special conditions prevailing permit the escape of the great majority of the sperms suspended in the fluid around the eggs. Systematic counts of sperms in this fluid and in the follicle cell-mass have been made in seven rats. The number of sperms varied from 9 to 101 in individual tubes, with a mean of 43.

Epididymal sperms were introduced into the fallopian tubes of rabbits 5–6 hr. before ovulation. Large numbers of sperms (about $2\cdot0 \times 10^6$) resulted in the fertilization of fourteen out of eighteen eggs (in four rabbits). With small numbers (1,140–1,600) four eggs were fertilized in a total of sixty-nine (in fourteen rabbits). This is a low rate of fertilization; but it should be noted that the dilutions to which the sperms were necessarily subjected (up to 1 : 2,000) had a deleterious effect upon them and about 50 per cent were immotile when introduced. Furthermore, in the 5–6 hr. before ovulation, considerable dispersion throughout the tube may have taken place, so that the number ultimately present at the site of fertilization must have been much less than the number introduced.

On the basis of these observations it is concluded that fertilization can take place when there are in the vicinity of the eggs less than a hundred sperms in the rat and less than a thousand in the rabbit.

My sincere thanks are due to the Medical Research Council and to Sir Charles Harington for the hospitality of the National Institute for Medical Research, and to Dr. A. S. Parkes for his invaluable criticism and advice.

C. R. Austin
National Institute for Medical Research,
London, N.W.3.
July 28.

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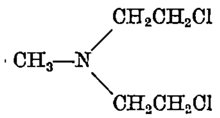
Inactivation of Complement by Nitrogen Mustard

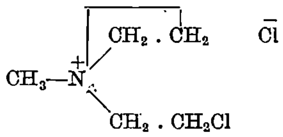
The recent clinical use of the nitrogen mustards for the treatment of Hodgkin's and other neoplastic diseases[1] has focused attention on these compounds and more particularly on their biological action. The intensive study of these vesicants made during the War[2], when they were regarded as potential chemical warfare agents, has been continued in the hope that more information will be gained about their action on animal tissues and about the basis of their therapeutic effect.

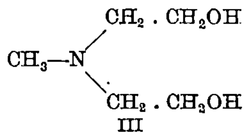
In some of our investigations we have studied the action of one of the most commonly used nitrogen mustards, methyl-*bis* (β-chloroethyl) amine (I), on complement, and have found that complement is rapidly destroyed or inactivated by the vesicant. This inactivation is similar in many respects to that effected by 'ordinary' mustard gas[3]. The amount of nitrogen mustard required completely to inactivate the hæmolytic complement of guinea pig serum at 37° is small, and the inactivation is not due to hydrochloric acid liberated by hydrolysis of the nitrogen mustard since the *p*H of the mixtures was maintained at about 7·5 throughout the reaction.

The addition of 2·5 mgm. of the nitrogen mustard hydrochloride to 0·50 ml. of guinea pig serum resulted in partial inactivation of the complement in 10 min. at 37° and complete inactivation in less than 30 min. Considerably smaller amounts of the nitrogen mustard can effect this inactivation; thus, 0·25 mgm. destroyed at least three-quarters, and 0·05 mgm. about half, of the complement activity of 0·50 ml. of guinea pig serum in 3 hr. and 6 hr. respectively at 37°. The inactivation, like that effected[3] by 'ordinary' mustard gas, ββ'-dichlorodiethyl sulphide, concerns all four components of complement, but the fourth component (that specifically inactivated by ammonia) appears to be less readily inactivated than are the others.

The nitrogen mustards quickly undergo chemical changes in solution[4,5], and the biological action of the parent substance appears to be due mainly to the capacity of some of these transformation products to react rapidly with certain tissue constituents. In aqueous solution methyl-*bis* (β-chloroethyl) amine (I) undergoes cyclization to form the corresponding very reactive imine (II); further cyclization and other changes follow more slowly, and the complete series of changes results in the production of several products, including methyl diethanolamine (III).


I
Nitrogen mustard
(Code No. HN2)


II
Ethylenimonium derivative of I


III
Methyl diethanolamine

In some of our experiments, we have tested the complement-inactivating power of 'hydrolysed' nitrogen mustard, that is, solutions of the vesicant which have been kept at 37° for varying lengths of time before addition to guinea pig serum. These experiments have shown that previous hydrolysis of the vesicant greatly reduces its capacity to inactivate complement, and that solutions kept for 3 hr. at about *p*H 7·5 and at 37° have lost most of their inactivating power. Methyl diethanolamine (III) in amounts up to 125 mgm./0·5 ml. of guinea pig serum has no significant complement-inactivating action, and the slight inactivating power of hydrolysed nitrogen mustard is probably due to the presence of a small amount of the original compound (I) in the solution, for it has been shown[5] that a 1 per cent solution of (I) kept at 25° for 70 hr. still contains about one-fifth of the unchanged compound. The toxic compounds formed from the nitrogen mustard in solution at *p*H 7·5 appear to differ from those which inactivate complement, for the activity of the former increases[6] as the solution is kept at 38° and *p*H 7·4 for 1–2 hr., whereas our experiments have shown that the complement-inactivating power decreases under these conditions.

The amount of nitrogen mustard we have used in our experiments is appreciably greater than that likely to be present in the blood after injection of the drug into patients suffering from Hodgkin's disease; but it is possible that the smaller amounts used therapeutically (for example, 0·1–0·2 mgm./kgm. injected daily for 4–6 days) may reduce the complement titre of the blood of the patients. We are therefore testing the serum of some of these treated patients and are carrying out similar tests on injected guinea pigs. A fuller account of these investigations will be given elsewhere.

We are indebted to the Medical Research Council for grants which have covered the expenses of this investigation.

W. M. WATKINS
A. WORMALL

Department of Chemistry and Biochemistry,
Medical College of St. Bartholomew's Hospital,
London, E.C.1.
May 12.

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Loss of White Cells in Bone Marrow Culture

MANY techniques of cell culture involve suspension of cells in some fluid medium, and incubation in sterile glass containers, with subsequent counting of the suspended cells. Although it has long been known that certain cells are 'sticky' and can adhere most firmly to glass surfaces[1], this fact seems to have been neglected in work with cell cultures, where some cells might be lost by irreversible adhesion to the walls of the culture vessel. The following is an attempt to investigate this point in bone-marrow culture; here adhesion is of particular importance because only certain types of hæmopoietic cells are 'sticky'.

The technique used has been previously described[2], and in essence consists of suspension and incubation of marrow cells in 80 per cent sterile serum. Comparison was made between cultures in ordinary clean glass bottles and cultures in bottles previously coated with silicone[3] to make the surface non-wettable and to prevent adhesion of cells. At all periods of incubation there was a consistently greater number of myeloid cells in the siliconed bottles, the difference being statistically significant and affecting myelocytes, band cells, and polymorphs; this difference was so great that, had silicone not been used, the increase in polymorphs due to maturation would have been missed (Fig. 1); lymphocytes and nucleated red cells showed no such effect. The loss of cells by adhesion amounted to about half a million in each bottle, and so was easily detected when the initial myeloid count was low (1,000,000 per bottle, or 500 per cub. mm.), but became statistically undetectable when the counts were higher (10,000,000 per bottle, or 5,000 per cub. mm.). This result is probably of some importance to those who are performing cultures with a low initial concentration of cells.

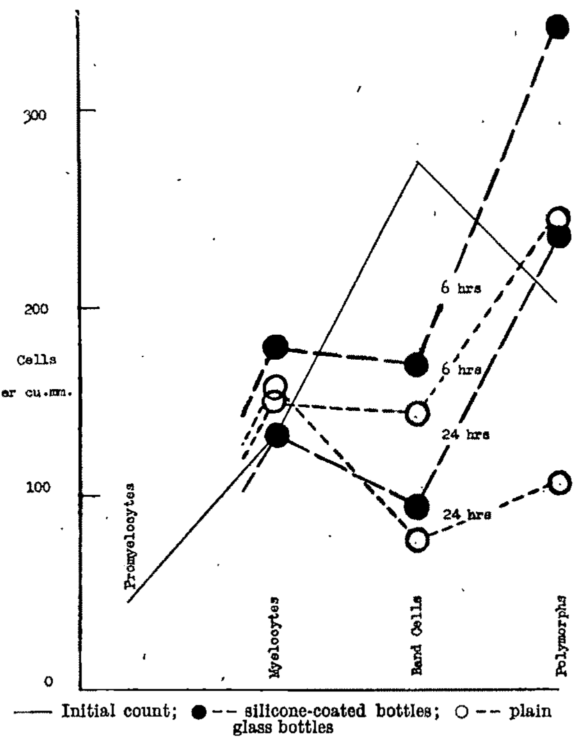

Fig. 1. Myeloid cell counts in marrow culture. Results after incubation for 6 and 24 hours in silicone-coated and plain glass bottles

Previously it had been noticed that there was an apparent increase in myeloid cells in cultures, when

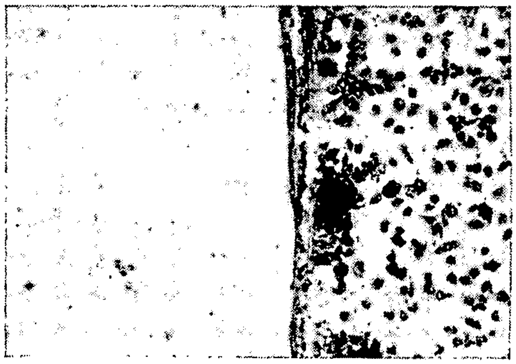

Fig. 2. Adhesion of leucocytes to glass coverslips (× 75). The left coverslip from a culture in heated serum; the right from a culture in unheated serum. Both after 48 hr.

the marrow specimens were suspended in reconstituted dried plasma or in serum which had been heated to 56° C. for one hour, instead of in unheated serum. As it is known that adhesion of leucocytes requires the presence of some thermolabile factor in serum[4], this effect was thought to be due to adhesion of the cells in unheated serum. To check this point, a grease-free coverslip was laid on the floor of each culture bottle, and was removed, washed in running tap water, and stained at the same time as the smears and total counts were made (that is, after 1–4 days). The photograph (Fig. 2) shows two such coverslips, the left from a 48-hour culture in heated serum, the right from a similar culture in unheated serum. The cells involved were always predominantly myeloid and monocytoid. No adhesion of nucleated red cells was ever seen. The density of the deposit was about 300,000 per square centimetre, this figure being of the same order of magnitude as that obtained from the silicone experiments.

H. J. F. CAIRNS
L. G. LAJTHA

Department of Clinical Pathology,
Radcliffe Infirmary, Oxford.

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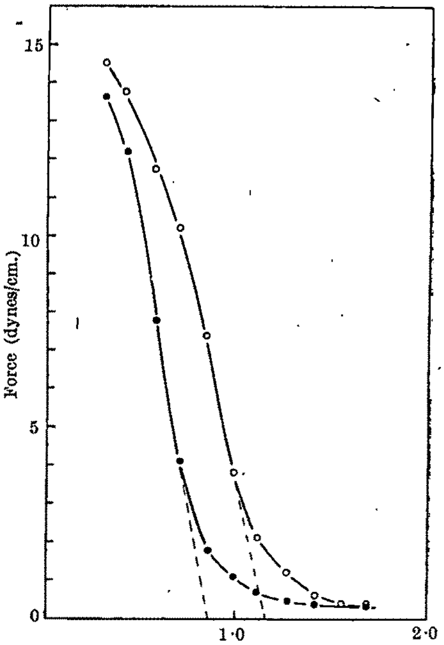
Effect of Adenosine Triphosphate on Monolayers of Myosin

LITTLE is known about the behaviour of myosin in monomolecular layers. Communications previously published on this subject[1,2] appeared at an early stage of the study of myosin, that is, before Szent-Györgyi and his school[3] had shown that myosin consists of at least two different proteins, actin and myosin proper. In connexion with work in this laboratory[4] on the interaction between high-energy phosphate compounds and the different components of myosin, the investigations have been extended to monolayers of these proteins.

The influence of adenosine triphosphate and related substances on the force-area relationships of monolayers of actin-free myosin and the complex actomyosin has been studied. The proteins in question were isolated by Szent-Györgyi's method[5]. Actin was obtained in aqueous solution, actomyosin and myosin proper in salt solutions (0·6 *M* potassium chloride). The solutions were diluted to approximately 0·2 per cent (referred to dry-weight determinations) and roughly filtered before spreading.

Actin spreads on water or salt solutions, whereas actomyosin and actin-free myosin spread effectively only on solutions of considerable ionic strength. The most favourable conditions were provided by using a veronal buffer of *p*H 5·3, made 0·6 *M* with respect to potassium chloride, in all experiments.

Each film was allowed to spread for four minutes at zero pressure before readings were taken. Experimental data for a sample of actomyosin are recorded in the accompanying graph. When adenosine triphosphate is added to the substrate to a final concentration of 0·05 mgm./ml. (0·00005 *M*), the force-area curve for the monolayer is changed. The sudden increase in slope of the curve now occurs at a larger area than before. The effect of adenosine triphosphate is highly specific, as adenosine diphosphate, and inorganic tripolyphosphate, pyrophosphate and orthophosphate employed in the same molar concentrations have no visible effect. Only on addition of these substances in concentrations approximately ten times higher are similar effects obtained. Owing to the uncertainty in the dry-weight determinations, too much emphasis should not be laid on the absolute values of the area in the diagram.



Force-area curves for actomyosin
●—●—●, without adenosine triphosphate
○—○—○, 0·05 mgm. per ml. adenosine triphosphate

The data obtained in several experiments indicate that the expanding effect is more pronounced with monolayers of myosin proper than with those of actomyosin. In the latter the area at zero compression increases after addition of adenosine triphosphate by about 30 per cent, whereas in the case of myosin proper the average increase amounts to 100 per cent. In both cases the gradient of the approximately rectilinear part of the curve decreases when adenosine triphosphate is added. Actin shows no reaction with adenosine triphosphate or the other phosphate compounds investigated.

The result indicates that adenosine triphosphate in some way combines with myosin and causes it to expand, thereby increasing the surface pressure of the monolayers in the condensed state. According to a verbal communication from Dr. D. F. Cheesman, it is probable that the effects described above may be due rather to the spreading kinetics of myosin than to the properties of the fully spread films.

My thanks are due to Prof. E. K. Rideal and Dr. D. F. Cheesman, of the Davy Faraday Laboratory at the Royal Institution, London, for hospitality and valuable advice. The preliminary experiments of the investigation were made in that Laboratory.

AGNETE MUNCH-PETERSEN

Institute of Neurophysiology,
University of Copenhagen.
May 12.

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PARAMAGNETIC RESONANCE IN COPPER SULPHATE

Experimental Investigation

INVESTIGATIONS of paramagnetic resonance in salts of the iron group of transition elements at centimetre wave-lengths have shown that it is possible to obtain detailed information about the lowest energy-levels of the paramagnetic ion by these methods[1]. We have investigated at room temperature the resonance absorption in single crystals of copper sulphate ($CuSO_4.5H_2O$) at wave-lengths of 3·04 cm., 1·23 cm. and 0·85 cm. in a magnetic field. The results show two features of considerable interest: first, that under certain conditions the absorption line is very much narrower than would be expected from the normal magnetic interaction of the ions; and secondly, that at the longer wave-lengths only one line is found, whereas theoretically two lines should appear at certain orientations of the crystal in the external magnetic field. In fact, it is only at 0·85 cm. wave-length that the two lines are just resolved.

The measurements are made by placing a section of a single crystal at the bottom of a cylindrical H_1 resonator placed in a magnetic field at right angles to the high-frequency magnetic field. The magnification factor Q of the resonator is then measured for various values of the magnetic field.

Crystallographic data[2] show that there are two non-equivalent cupric ions in the unit cell, each surrounded by four water molecules and two oxygen atoms, in a nearly octahedral arrangement. The crystalline electric field acting on an ion is mainly of cubic symmetry with a component of tetragonal symmetry, the tetragonal axis being in the direction of the oxygen atoms and the angle between the tetragonal axes of the two ions being about 80°.

On this basis Polder[3] has calculated the energy-levels of the basic spin doublet in a magnetic field and hence the susceptibility of the salt, and these calculations are in good agreement with Krishnan's experimental work[4] on the susceptibility. The energy difference between the two spin-levels in a magnetic field H may be expressed as $g\beta H$, where β is the Bohr magneton and g depends on the orientation of the tetragonal axis with respect to the magnetic field. Thus the resonance absorption should occur when $g\beta H = h\nu$. Some of the experimental results are given in the accompanying table.

Direction of H	L_1 (154°, 64°, 51°)			L_2 (78°, 130°, 52°)				L_3		
Wave-length (cm.)	3·04	1·23	0·85	3·04	1·23	0·85		3·04	1·23	0·85
H at resonance Kg	3·36	8·36	12·1	3·11	7·76	10·6	11·9	3·10	7·75	11·2
g	2·09	2·08	2·08	2·26	2·26	2·37	2·12	2·27	2·26	2·26
g (susceptibility)	2·06	2·06	2·06	2·27	2·27	2·47	2·06	2·27	2·27	2·27
Width $\Delta H_{1/2}$ gauss	28	24	25	115	640		$\simeq$ 450	58	50	—

The orientation of the external magnetic field with respect to the crystallographic axes is denoted by L_1, L_2 and L_3. L_1 is the direction at right angles to the tetragonal axes of both ions, L_2 is along one of the tetragonal axes and L_3 is a bisector of the angle between the two axes. (The angles which L_1 and L_2 make with the crystallographic axes are also given.)

The main features of the results may be summarized as follows. (1) The g values are in good agreement with those obtained from susceptibility measurements, but theoretically there should be two lines when H is along L_2. In this case H is nearly at right angles to the tetragonal axis of one copper ion, which should therefore have the same g value as when H is along L_1 (that is, 2·06). The g value of the other ion should be 18 per cent higher, the mean value of the two ions being equal to that given by the susceptibility measurements. That the appearance of only one line is not due to lack of resolution is shown by the fact that at 3·04 cm. the two lines should be about 500 gauss apart, whereas the width ($\Delta H_{1/2}$) of the line is only 115 gauss. At 0·85 cm. wave-length, however, the two lines are just resolved.

(2) The width $\Delta H_{1/2}$ given here is the difference in magnetic field between the position of maximum absorption and that at which the absorption is half its maximum value. This width varies very greatly both with orientation and with wave-length. One cause of broadening of the line is the fluctuating magnetic field due to neighbouring dipoles. The effective internal field due to this is about 370 gauss in copper sulphate, and therefore the width of the line should be of this order, whereas for H along L_1 the width is only 25 gauss.

Van Vleck and Gorter[5] have suggested that this narrowing of the line may be due to the effect of exchange forces between the copper ions, and a qualitative description of the other results may be given on this basis as follows. When H is along the tetragonal axis of one of the copper ions, the values of g, and therefore the precessional frequencies of the two ions, are different. If there is exchange between the ions, the type of absorption curve obtained will depend on whether the exchange frequency is greater or smaller than the difference in the precessional frequencies. When it is larger, a mean value of the energy of the two copper ions should be measured, whereas when it is smaller each ion should be observed separately and two lines should appear. A rough estimate of the exchange frequency can be made from the fact that at 1·23 cm. the two lines are just not resolved. The difference in frequency of the two lines at constant H would be about 0·15 cm.$^{-1}$, which is therefore the order of the exchange frequency.

On this theory the maximum width should occur when the difference between the values of g of the two ions is a maximum, that is, with H very nearly parallel to one of the tetragonal axes, and this is found experimentally. Also the minimum width should be when the two values of g are equal, for example, in the plane containing L_1 and L_3. This is also found experimentally, although the width is not constant in this plane, varying from 25 gauss along L_1 to 60 gauss along L_3. A quantitative theory of the broadening due to exchange of dissimilar ions is given in the following communication by Prof. M. H. L. Pryce.

The behaviour of copper sulphate crystals may be contrasted with that of potassium – copper sulphate ($CuSO_4.K_2SO_4.6H_2O$), in which two lines are observed[6] when H is in the appropriate direction, the values of g being in close agreement with theory. The exchange frequency in this salt is therefore very considerably smaller.

It might be expected that there would be some connexion between the exchange energy measured in this way and the specific heat anomaly found in copper sulphate crystals at about 1° K. but not found in the potassium – copper salt[7]. The order of magnitude of the exchange energy is some five times too small, but presumably exchange between like ions should contribute to the specific heat, whereas only the exchange between dissimilar ions is effective in the problem discussed here.

Details of these measurements will be published in the near future.

D. M. S. Bagguley
J. H. E. Griffiths

Clarendon Laboratory,
Oxford.
July 26.

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Theory

In many paramagnetic crystals the resonance absorption of microwaves in the presence of a transverse magnetic field spreads over a range of a few hundred gauss, and this can be accounted for by the magnetic interaction between the ions. There are certain substances, however, of which copper sulphate is an example, in which the resonance is sharper than can be explained in this way, and it has been suggested that the sharpness is due to electron exchange[1]. Gorter and Van Vleck[2] have reported the result of a calculation which shows that, while the mean square spread is unaffected by exchange, the mean fourth power spread is increased, indicating a sharpening of the peak together with an enhanced absorption in the wings of the resonance. That such an effect is to be expected can be seen from the following qualitative argument.

The effect of exchange can be described as an interchange of the spins of the ions with a frequency spectrum determined by the magnitude of the exchange energy. If this frequency is high compared with the spread of precession frequencies of the ions in the applied magnetic field, due to the random orientation of the magnetic field of neighbouring ions (the internal field), the latter will fluctuate so rapidly that only an average value will be effective. The statistical weight of states in which the average is comparable to the instantaneous internal field is relatively small, and the net effect will be to reduce the breadth of the resonance. The effect is similar to the sharpening of nuclear paramagnetic resonances in liquids due to the rapid molecular motions[3].

The observations on copper sulphate[4] are consistent with the hypothesis that the breadth due to magnetic interaction, reduced by exchange in this way, is only about 25 gauss; but that there is, in addition, a broadening caused by the exchange of electrons of cupric ions having different principal magnetic axes, and that this is the main cause of broadening of the resonance, except for certain orientations of the applied field.

There are two non-equivalent sets of cupric ions in hydrated copper sulphate ($CuSO_4.5H_2O$), distinguished by different orientations of the neighbouring oxygen atoms and water molecules. Polder[5] has shown that the magnetic behaviour is well accounted for by the action on the cupric ions of a crystalline field composed of a part with cubic symmetry and one with tetragonal symmetry. Each ion (spin $\frac{1}{2}$), in its ground state, is magnetically uniaxial. In susceptibility measurements copper sulphate is anisotropic with three principal axes as follows: (1) along the direction perpendicular to the principal axes of the two types of ion; (2) and (3) along the bisectors of the angles between them. There is, however, a slight discrepancy between the calculated susceptibilities and the observations of Krishnan and Mookherji[6], which may indicate that a single ion is not exactly uniaxial.

In view of the smallness of the magnetic broadening, it is reasonable to attempt a calculation of the broadening in which only the exchange effect is considered, and the magnetic interaction is ignored. The exchange energy will be assumed to be of the usual 'isotropic' type and not of the 'anisotropic indirect' type discussed in a recent paper by Opechowski[7]. Had the ions all been equivalent, the exchange would have caused no broadening. One may therefore try to treat the slight difference between the ions as a perturbation, and expect reasonably correct results provided the difference in magnetic energy of the two kinds of ions, when they have the same spin orientation, is small compared with the exchange energy. This condition is equivalent to saying that the frequency must be small compared with the frequency at which the absorption curve first shows two resolved peaks, corresponding to the different effective moments of the two kinds of ion: this frequency is about 1 cm.$^{-1}$ for copper sulphate. Alternatively, for higher frequencies, one may treat the exchange interaction as a perturbation. The experimental material available at present refers more nearly to the former condition, and the present note deals only with results calculated on this approximation.

The magnetic energy of a single ion in a magnetic field **H** can be written

$$E_{\text{magn}} = \mu s.\mathbf{g}.\mathbf{H},$$

where s is the spin angular momentum divided by $\hbar$, **g** is a tensor the principal values of which are the *g*-values in the principal directions of the ion and μ is the Bohr magneton. For the spin system in a crystal, the total energy can be written

$$\begin{aligned} E &= \mu\,\mathbf{S}'.\mathbf{g}'.\mathbf{H} + \mu\,\mathbf{S}''\mathbf{g}''\,\mathbf{H} + E_{\text{ex}},\\ &= \tfrac{1}{2}\mu(\mathbf{S}' + \mathbf{S}'').(\mathbf{g}' + \mathbf{g}'').\mathbf{H} + E_{\text{ex}} +\\ &\qquad \tfrac{1}{2}\mu\,(\mathbf{S}' - \mathbf{S}'').(\mathbf{g}' - \mathbf{g}'').\mathbf{H}, \end{aligned} \tag{1}$$

where **S** refers to the total spin of ions of one type, and the superscripts ′ and ″ refer to the two types of ion. E_{ex} is the exchange energy of the system. The third term in (1) is treated as a small perturbation.

If the third term were absent, the energy would be the sum of two commuting parts, and the eigenvalues would be the sum of the eigenvalues of the parts. An oscillating transverse field would cause transitions between states the spin of which in the direction of $(\mathbf{g}' + \mathbf{g}'').\mathbf{H}$ differs by one unit, and which have the same value of the exchange energy. The system would have a single sharp absorption frequency

$$\mu\,|\,(\mathbf{g}' + \mathbf{g}'').\mathbf{H}\,|\,/2h.$$

The effect of the perturbation term, which expresses the difference between the ions, is threefold:

(*a*) It changes the energy-levels of the system, and hence the energy difference of levels connected by the above selection rule. The absorption now takes place over a range of frequencies (for a fixed magnetic field, or conversely, for a fixed frequency, over a range of magnetic field). This is the main effect. The shape of the line from this cause may be expected to be roughly a Gaussian curve.

(*b*) It introduces into the eigenfunctions admixtures of wave functions belonging to other eigenvalues of the exchange energy, thereby allowing weak transitions to states excluded by the original selection rule. This is most marked for states differing only slightly in exchange energy, and gives rise to a 'tail' on the absorption curve, falling off roughly inversely as the square of the distance from resonance. It may also give rise to enhanced absorption at low frequencies and at twice the resonant frequency. This effect increases with magnetic field.

(*c*) The coupling with the oscillating field being unsymmetrical with respect to the variables of the two types of ion, transitions can be induced to states of different exchange energy. This effect is similar to (*b*), except that it shows no marked preference for small differences of exchange energy and is roughly independent of H. It gives a background of non-resonant absorption.

A straightforward application of second-order perturbation methods (the first-order effect is zero) leads to the following expression for the dependence of effect (*a*) on orientation and frequency. Using a notation in which l_1, l_2, l_3 are the cosines of the angles between the magnetic field and the principal magnetic axes, and g_1, g_2, g_3 are the principal g-values, the breadth ΔH_{ex} due to exchange, for fixed frequency ν, is given by

$$\Delta H_{\text{ex}} = \frac{C\nu^2 \begin{bmatrix} 4(g_2+g_3)^4 l_2^4 l_3^4 \\ -4A(\nu)(g_2+g_3)^2 l_2^2 l_3^2 \{g_1^2 l_1^2 (l_2^2+l_3^2) + (g_2 l_2^2 - g_3 l_3^2)^2\} \\ + B(\nu)\{g_1^2 l_1^2 (l_2^2+l_3^2) + (g_2 l_2^2 - g_3 l_3^2)^2\}^2 \end{bmatrix}^{1/2}}{[g_1^2 l_1^2 + g_2^2 l_2^2 + g_3^2 l_3^2]^{5/2}} \qquad (2)$$

where C is a constant depending on the magnitude of the exchange energy but independent of orientation, temperature and frequency, and $A(\nu)$, $B(\nu)$ are independent of angle and temperature, and tend to 1 in the limit of low frequencies (small compared with the exchange frequency, that is, about 0·15 cm.$^{-1}$).

The breadth is to be interpreted as a root mean square deviation from the centre of resonance. In comparing with experiment it should be noted that it refers to the Gaussian part of the peak and ignores the tail. The formula will vary in a more complicated manner with orientation if the individual ions are not uniaxial, but will involve the frequency in the same way.

If one wishes to include the effect of magnetic interaction one may, as a rough estimate, make the assumption that the square of the total breadth is the sum of squares of partial breadths

$$(\Delta H)^2 = (\Delta H_{\text{ex}})^2 + (\Delta H_{\text{magn}})^2$$

and suppose that ΔH_{magn} is not very sensitive to orientation.

It is to be emphasized that (2) is valid only for frequencies small compared with 1 cm.$^{-1}$, and provided $\mu H \ll kT$.

M. H. L. Pryce

Clarendon Laboratory, Oxford.
July 26.

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ROYAL OBSERVATORY, GREENWICH

The Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read on the occasion of the annual visitation of the Observatory on June 5, covers the period May 1, 1947–April 30, 1948, and the state of the Observatory mentioned in various parts refers to the latter date. Although a large amount of the report deals with the usual routine work, certain portions are concerned with the grave difficulties that have arisen in the post-war period, which may not be completely overcome for several years. This short synopsis of the report will deal chiefly with these difficulties.

Stage 1, as it is called, of the move to Herstmonceux was arranged to take place in August and was intended to include the Nautical Almanac Office, the Chronometer Depot, the Magnetic and Meteorological Department, and the secretariat; the Solar Department will wait until the new Solar Building is ready. Even under normal conditions, the removal would have entailed considerable disorganisation to the work of the Observatory; but this disorganisation is greatly increased by the difficulties in the present conditions. No provision has been made in the estimates for the current financial year for the completion of Stage 1 of the move, and the output of the Observatory is necessarily curtailed with every month of delay. As might be expected, some of the instruments are not in use, and there has been great disappointment regarding the performance of one in particular, about which something will be said later.

The 28-in. and 26-in. domes are in a bad state of repair, and it is doubtful whether either is suitable for transfer to Herstmonceux; until this point has been settled, no work on them will be undertaken. The 28-in. and 26-in. telescopes were dismounted in the autumn of 1947, and the former, with the exception of the lens and some minor parts, was transported by road to Herstmonceux, where it is stored in a brick hut. The necessary parts of the drive have been sent to Sir Howard Grubb, Parsons and Co. for alteration to a synchronous motor drive. Practically all the 26-in. telescope has been sent to the same firm, as it was decided that roller bearings in both axes should be inserted. The objectives of these telescopes are still in good condition and remain for the present at Greenwich.

The mirrors of the 36-in. Yapp reflector were aluminized in May 1946; but the instrument remained unused until November. In December the 36-in. mirror was given a light alcohol wash and was then found to be in poor condition. It was used until March 1948, when it was discovered that several areas each about two inches across had lost all their coating, and after a fresh wash, the reflexion coefficient was estimated to be as low as about 30 per cent. The mirror was cleaned and silvered; but surface blemishes remained visible on the glass even after silvering and it is not certain how much of this can be attributed to poor aluminizing and how much to the deposit of chemically active dirt. It is interesting to know that the Cassegrain mirror was, and still is, in good condition, and the contrast between the two mirrors confirms what has been already known from other pairs of aluminized mirrors, one facing up and one down, in the conditions which prevail at Greenwich. The expense and delay involved in sending the mirror away to be aluminized are not warranted while the mirror remains at Greenwich; but as the spectrograph is primarily for use in the ultra-violet region, the effectiveness of the telescope is very much reduced. When an aluminizing plant capable of handling the 36-in. reflector is installed at Herstmonceux, this state of affairs will be remedied, and this is just one among many reasons for accelerating the move to Herstmonceux.

If there be any who expect a greatly increased output from the Observatory in the near future, they will be disillusioned when they read the present report. It is emphasized that the situation which will prevail from the end of Stage 1 until completion of the move will be very disadvantageous in many ways, not least of which will be the marked excess of observers over instruments at Herstmonceux and Abinger. Many valuable years of potential training have been lost already; old observers are retiring and a new and inexperienced staff is increasing. Even if the dismemberment of the Greenwich Observatory could be effected immediately, much ground would have to be made up, and the longer the delay in unification the more serious will be the effects on the standards of observational skill. This is a matter which requires immediate consideration from the authorities, and another matter is of equal or even greater urgency.

While the hostel arrangements will cater reasonably well for the unmarried staff, no arrangements have yet been made for married men. It is almost certain that most married members of the staff, some of whom have had as much as six years war experience, will be faced with a period of at least a year's separation from their families. The continuance of a similar situation through all the later stages of the move must cause grave dissatisfaction and discouragement, and would have an adverse effect on the smooth running of the Observatory. The Astronomer Royal has proposed to the Admiralty that houses should be provided for the senior observing staff, and the necessity for such accommodation, which is fairly normal for observatories, is obvious to everyone who knows that the Observatory at Herstmonceux is in an isolated area. Such provision on the edge of the Observatory property would greatly facilitate the night duties of the observing staff and also reduce the loss of observing hours. It is pointed out that it may be difficult to fill the additional vacancies for senior scientific workers which will occur later, because it is highly probable that many married men will refuse an offer which implies separation from their families. In the words of the Astronomer Royal: "There is evidently a grave risk that the increase in complement, which has been approved in principle, may be nullified in practice through an unrealistic approach to the housing problem, quite apart from the general hardship which is, as yet, the only prospect for existing married staff of the later stages".

The report devotes a little more than a page to the Isaac Newton Observatory which will be erected in the grounds at Herstmonceux. Among the types of observation to be undertaken with the 100-in. telescope are the following: stellar spectroscopy and spectrophotometry, star counts, galactic structure, the investigation of the distribution and extent of obscuring material, spectral classification with a slitless telescope, the determination of radial velocities, and observations of extra-galactic nebulæ. Details regarding optical design are still under consideration, and information will be obtained about the system of control which has been developed for the 200-in. telescope, and also on the methods of driving and control of other large telescopes. Messrs. Pilkington Bros., Ltd., have carried out investigations on the manufacture of large glass mirror disks, and it is proposed to make the 100-in. disk of 'Pyrex' glass and to cast it as a solid disk, the lower face being given a concave curvature of approximately the required amount. It is expected that the casting will be undertaken about March 1949.

The magnetic elements as determined at Abinger for 1947 and also the three preceding years are as follows:

Year	Declination (West)	Horizontal intensity	Vertical intensity	Inclination
1944	10° 07·8′	0·18566	0·43189	66° 44·3′
1945	9 59·5	0·18573	0·43207	66 44·3
1946	9 51·1	0·18569	0·43235	66 45·4
1947	9 43·1	0·18577	0·43246	66 45·2

At the time of writing the above summary of the Astronomer Royal's Report, it was known that there had been a delay in carrying out Stage 1 of the movement to Herstmonceux.

RESISTANCE TO SULPHADIAZINE AND 'PALUDRINE' IN THE MALARIA PARASITE OF THE FOWL (*P. gallinaceum*)

By DR. ANN BISHOP
AND
ELSPETH W. McCONNACHIE
Molteno Institute, University of Cambridge

Acquired Resistance to Sulphadiazine

RECENTLY Bishop and Birkett[1], and Williamson, Bertram and Lourie[2], working independently, have described the development of resistance to the antimalarial drug 'Paludrine' in infections of *Plasmodium gallinaceum* in young chicks. This resistance developed rapidly and increased forty-fold within about four and a half months. With sulphadiazine and quinine, however, Williamson and his co-workers obtained no acquired resistance in *P. gallinaceum*, though the periods of drug treatment extended over two and a half years. Since the publication of their results, Knoppers[3] has described a twofold increase in resistance to quinine in the same species of avian malaria. Bishop and Birkett[4] found that resistance to sulphadiazine could be produced in *P. gallinaceum* in young chicks by methods similar to those with which they had induced resistance to 'Paludrine', though its development was relatively slow and the degree of resistance obtained was not great.

As a result of further treatment with gradually increasing doses of sulphadiazine, we have now obtained a strain of *P. gallinaceum* in young chicks in which the resistance to the drug is thirty-two times greater than that of the untreated strain. Whereas the minimum dose of drug which produces an adverse effect upon the growth-rate of the normal strain, when given twice daily on successive days, is 0·625 mgm./20 gm. of body-weight, in the resistant strain growth of the parasites occurs in birds receiving

20 mgm. twice daily*. It took approximately twelve months to produce this thirty-two-fold resistance to sulphadiazine. The degree of resistance acquired has been assessed at intervals, by comparing the intensities of infections produced by standard inocula (that is, 50,000,000 parasites per chick intravenously) of (*a*), the resistant strain, into groups of chicks receiving doses ranging from 2·5 to 20 mgm. of sulphadiazine twice daily for three-and-a-half days, and (*b*), the normal parent strain, into groups of chicks receiving similar drug treatment. The sulphadiazine-resistant strain produced infections in chicks receiving doses of drug which inhibited the development of the normal strain (that is, 2·5–20 mgm.); but the resulting infections were not as heavy as those produced by the parent strain in untreated birds. The sulphadiazine-resistant strain produced, on the whole, less intense infections in untreated birds than did the parent strain.

In the sulphadiazine-resistant strain of *P. gallinaceum*, exoerythrocytic schizonts were found in chicks during treatment with this drug.

We have proved that this sulphadiazine-resistant strain of *P. gallinaceum* is also resistant to sulphathiazole, sulphanilamide and sulphapyridine.

Bishop and Birkett[1,4] found that in *P. gallinaceum* resistance to 'Paludrine' was retained after five passages through mosquitoes without intervening drug treatment. On two different occasions *P. gallinaceum*, resistant to twice-daily doses of 5 mgm. of sulphadiazine, was passaged through *Aëdes œgypti* and afterwards tested, without intervening drug treatment, by the method outlined above: no loss in drug-resistance was observed. Williamson and his co-workers also observed no loss in resistance to 'Paludrine' after one mosquito passage; but, according to Knoppers[3], acquired resistance to quinine, in the same species of avian malaria, was partially lost after one mosquito-passage.

Experiments by Emerson and Cushing[5] upon acquired resistance to sulphonamides in *Neurospora* suggest a possible explanation of the discrepancy between the results of experiments upon the effect of mosquito transmission. In this organism, as in *P. gallinaceum*, resistance to sulphonamides arises by successive stages. In *Neurospora* the first adaptations to the drug do not involve a genetic change; but gene mutation appears later, after further drug treatment, in the more fully adapted strain. The resistance to quinine described by Knoppers was comparatively slight, being only twofold. In the light of Emerson and Cushing's observations, it is possible that this resistance might be due only partially to gene mutation, and that the degree of drug adaptation not genetically controlled might be lost during development in the mosquito in the absence of the drug. In strains of *P. gallinaceum* in which drug adaptation is more complete, for example, the 'Paludrine'- and sulphadiazine-resistant strains, the drug-resistance may be due wholly to the selection of drug-resistant mutants, with the result that no loss in resistance occurs during the sexual cycle in the mosquito.

Cross-resistance to Sulphadiazine and 'Paludrine'

The work of Bishop and Birkett[1,4], Williamson, Bertram and Lourie[2], and Williamson and Lourie[6] has shown that 'Paludrine'-resistant strains of *P. gallinaceum* are normally sensitive to quinine, 'Pamaquin' and 'Mepacrine', but resistant to the methyl homologue of 'Paludrine', N′-*p*-chlorophenyl-N^5-methyl-N^5-*iso*propylbiguanide. Williamson and his co-workers found that acquired resistance to 'Paludrine' did not confer resistance to sulphadiazine or to pyrimidine precursors of 'Paludrine' (for example, 3349, 2-*p*-chlorophenylguanidino-4-β-diethylaminoethylamino-6-methyl-pyrimidine), and they failed to produce strains of *P. gallinaceum* resistant to 3349.

The sulphadiazine-resistant strain of *P. gallinaceum*, when tested by the method described above, was found to be resistant to 0·1 mgm. of 'Paludrine' (the minimum dose which, when given twice daily, will suppress an infection of the normal strain of *P. gallinaceum*) although it had not been subjected to treatment with that drug.

Further tests for resistance to 'Paludrine' were made with two sulphadiazine-resistant strains of *P. gallinaceum* of more recent origin. These strains, *strain A* and *strain B*, had been isolated eleven weeks previously from the normal untreated parent strain, which was tested simultaneously for resistance to 'Paludrine' and found to be normally sensitive to the minimum effective dose (0·1 mgm.). *Strain A* was passaged twenty-two times during eleven weeks through birds receiving doses of sulphadiazine gradually increasing from 0·625 mgm. to 5 mgm. This treatment was similar to that by which resistance had been induced in the original sulphadiazine-resistant strain. *Strain A* was then tested and proved to be resistant, not only to 1·25 mgm. and, to a lesser extent, 5 mgm. doses of sulphadiazine, but also to 0·1 mgm. and 0·5 mgm. doses of 'Paludrine'.

Strain B, of identical origin to *strain A*, was treated with 5 mgm. doses of sulphadiazine for the eleven-week period. Whereas in *strain A* the infection in the passage birds was acute throughout the whole period of drug treatment, in *strain B* it was allowed to become chronic, passage into new chicks being performed only four times during the eleven weeks. The method by which the strains were maintained in the chicks did not, however, appear to be significant in the development of 'Paludrine'-resistance, as *strain B*, when tested simultaneously with *strain A*, against 0·1 and 0·5 mgm. doses of 'Paludrine', also proved to have become resistant to this drug. Though their reaction to 'Paludrine' was similar, these two strains differed in the degree of resistance to sulphadiazine which they had acquired. Whereas *strain B* was definitely resistant to 1·25 mgm. of this drug, it showed much less resistance to 5 mgm. doses than did *strain A*; but after further treatment with 5 mgm. doses of sulphadiazine, *strain B* acquired a resistance to this dose comparable to that of *strain A*. As yet, these strains have not been tested for resistance to 'Paludrine' in doses greater than 0·5 mgm.

As acquired resistance to sulphadiazine was found to confer resistance to 'Paludrine', the effect of sulphadiazine upon a 'Paludrine'-resistant strain of *P. gallinaceum* was studied. This strain had been in contact with 'Paludrine' for more than eighteen months and had been passaged at frequent intervals, for more than twelve months, through chicks receiving the maximum tolerated dose (1·0 mgm. twice daily) almost daily throughout this period. When tested with doses of 1·25 mgm. of sulphadiazine, it was found to be resistant to this drug also. Whether this 'Paludrine'-resistant strain is resistant to higher doses of sulphadiazine has not yet been ascertained.

As the sensitivity of the 'Paludrine'-resistant strain to sulphadiazine had not been tested previously, it is not known whether resistance to both drugs developed simultaneously, as in the case of the sulphadiazine-resistant strains *A* and *B*, or whether resistance to sulphadiazine developed only after prolonged treatment with 'Paludrine'. That the latter alternative is the more probable is shown by the following observations. The untreated parent strain of *P. gallinaceum* was tested with 1·25 mgm. doses of sulphadiazine and found to have a normal sensitivity to this compound. A substrain was then passaged at intervals of two to three days through chicks treated with doses of 'Paludrine' increasing from 0·025 to 0·2 mgm. After ten weeks treatment the strain was proved to be resistant to 0·5 mgm. doses of 'Paludrine', a dose greater than that with which it had been treated previously, but its sensitivity to the minimum effective dose of sulphadiazine was unchanged. In this strain, therefore, the development of resistance to 'Paludrine' was not accompanied by resistance to sulphadiazine. The strain is being treated further with larger doses of 'Paludrine' in order to discover if, and when, sulphadiazine-resistance develops. The fact that sulphadiazine-resistance did not develop simultaneously with resistance to 'Paludrine' in 'Paludrine'-treated birds, but only appeared in a strain subjected to prolonged treatment with the maximum tolerated dose of 'Paludrine', would explain the failure of Williamson and his co-workers[2,6] to observe resistance to sulphadiazine when their 'Paludrine'-resistant strain was treated with this drug, as their strain had been subjected to 'Paludrine' for a much shorter period than had ours.

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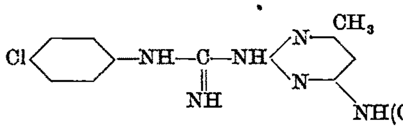
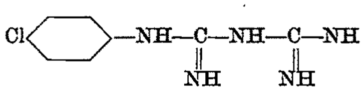
* Throughout this account, the doses of drug are expressed in mgm./20 gm. of body-weight of chick. The doses were given twice daily. The chicks used were four to fourteen days old at the beginning of treatment.

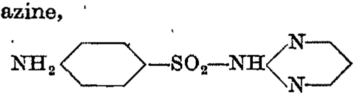
Williamson and his co-workers[2] suggest that the presence or absence of a pyrimidine ring in such compounds as 3349



and 'Paludrine'



may be a factor in determining drug-resistance. Sulphadiazine,



however, also contains a pyrimidine ring, and we have now shown that it, like 'Paludrine', forms drug-resistant strains of *P. gallinaceum* and that resistance between it and 'Paludrine' is reciprocal. On the other hand, Williamson and his co-workers[2] failed to produce resistance to 3349, which has a pyrimidine ring. In these compounds, therefore, the presence or absence of the pyrimidine ring does not appear to determine the formation of drug-resistant strains of *P. gallinaceum*.

It has been shown by Maier and Riley[7] in *P. gallinaceum* and by Marshall and his co-workers[8] in *P. lophuræ* that the antimalarial action of sulphonamides is inhibited by *para*-aminobenzoic acid. We have confirmed this observation on our strain of *P. gallinaceum*; but preliminary experiments suggest that the action of 'Paludrine' is not antagonized by this compound. The demonstration of cross-resistance between 'Paludrine' and sulphadiazine, two compounds of great importance therapeutically, presents a very interesting problem regarding the mechanism of their antimalarial action.

The work has been financed by the Medical Research Council. We are indebted to the Imperial Chemical (Pharmaceuticals), Ltd., for the 'Paludrine' and to Messrs. May and Baker, Ltd., for the sulphonamides.

[1] Bishop, A., and Birkett, B., *Nature*, **159**, 884 (1947).

[2] Williamson, J., Bertram, D. S., and Lourie, E. M., *Nature*, **159**, 885 (1947).

[3] Knoppers, A. T., *Nature*, **160**, 606 (1947).

[4] Bishop, A., and Birkett, B., *Parasitology*, **39**, 125 (1948).

[5] Emerson, S., and Cushing, J. E., *Fed. Proc.*, **5**, 379 (1946).

[6] Williamson, J., and Lourie, E. M., *Ann. Trop. Med. and Parasit.*, **41**, 278 (1947).

[7] Maier, J., and Riley, E., *Proc. Soc. Exp. Biol. Med.*, **50**, 152 (1942).

[8] Marshall, jun., E. K., Litchfield, J. T., and White, H. J., *J. Pharmacol.*, **75**, 89 (1942).

CHANGING ASPECTS OF NUTRITION

SECTION I (Physiology) of the British Association devoted the morning session on September 9 to a discussion of "The Changing Aspects of Nutrition". Prof. J. R. Marrack introduced the subject with a review of work done on the relation of nutrition to infection. He pointed out that we are uncertain which nutrients are particularly involved in defence against infection and how the defences are weakened by malnutrition, particularly in human beings. In experimental animals deprived of vitamin A the ciliated columnar epithelium of the respiratory passages undergoes keratinizing metaplasia. Bacteria that get into the passages are not cleared out by cilia, and the passages are blocked by desquamated cells. In consequence the animals are liable to get broncho-pneumonia. It is not known how frequently this keratinizing metaplasia occurs in the respiratory passages of human beings. When it is found, the nutritionist ascribes it to lack of vitamin A, whereas the morbid anatomist thinks that it is caused by inflammation or irritation.

In the discussion, Dr. H. M. Sinclair said that he had seen bronchiectasis in Holland, which was attributed to lack of vitamin A. In experiments in which human beings have been deprived of vitamin A for more than a year, the subjects were not abnormally liable to respiratory infections; nor do large supplements of vitamin A appear to reduce the frequency or severity of colds.

Cannon and his school have found that the formation of antibodies is impaired in animals that are severely depleted of protein. Gell has recently shown that very ill-nourished Germans formed less antibodies in response to injections of antigens than were formed by well-fed British soldiers. But protein is not the only nutrient that is involved in the formation of antibodies, and other defences are impaired in malnourished animals.

Prof. Marrack suggested that the infecting organisms of those diseases, to which resistance seems to be increased by malnutrition, are exacting organisms that invade the cells of the host. When the host lacks some nutrient, such as vitamin B_1, the metabolism of the host's cells may be so altered that they are no longer congenial to the invader.

Dr. J. W. Howie described experiments designed to show the effects of the less-severe degrees of malnutrition. The number of eggs of parasitic worms was counted in the fæces of a group of ewes fed on pasture and of another group that were given a protein rice concentrate. After a year there were much fewer eggs in the fæces of the group that were given the concentrate. One group of Swiss white mice were given a stock diet and another diet that supplied more protein and calcium. Suspensions of human tubercle bacilli were injected intravenously. In the group that had the higher protein ration, the mean survival time was longer and the extent of invasion of the lungs less than in the group that had the stock diet.

Prof. A. Fleisch discussed the effect of rationing in Switzerland as a large-scale experiment on human requirements. Up to 1943, when rations supplied little more than 2,000 calories a day to a normal adult, health improved, there was less dental caries and weights were maintained. During the period of rationing the amounts of meat in the diet fell and the amounts of potatoes and vegetables rose; the amounts of calcium, niacine, vitamin B_1, and ascorbic acid in the diets were considerably higher than before. When the number of calories fell below 2,000 in 1944 and 1945, weights of adults and children fell, and the hæmoglobin level of a sample group, which was studied over the whole period, fell. Prof. Fleisch thought that the League of Nations standard of requirements for a sedentary adult is unnecessarily high.

Dr. B. S. Platt discussed practical applications of the knowledge of nutrition and the social aspects of nutrition in villages of Central and West Africa. The estimated expenditure of energy was low and approximately equal to consumption. The yields of food crops were low and would barely supply the calories required. In West Africa nutrition suffered more, as groundnuts were grown for sale, and less food could be grown for home consumption. Much time was lost in collecting and preparing food and in drawing water. The problem is to build a new social structure in place of the native structure which is breaking down.

INTERNATIONAL COMMISSION ON LARGE DAMS

CONGRESS IN SWEDEN

THE third Congress of the International Commission on Large Dams was held in Sweden during June 10–17. The opening session was held in the Stockholm Concert Hall (Konserthuset) and the closing session at the Saga Cinema, Trollhättan. At the opening session Mr. G. Westerburg, president of the Swedish Committee of the International Commission on Large Dams, welcomed the delegates from twenty-three nations, and M. A. Coyne, president of the Commission, declared the Congress open.

There were four plenary sessions dealing with the following technical questions:

(1) Critical exposition of the measurement of uplift pressures and stresses arising therefrom; M. W. Schurter, Inspecteur fédéral et chef des Travaux Publics de la Confédération Suisse, acting as general reporter.

(2) Research methods and instruments for the measurement of stresses and deformation in earth and concrete dams; M. Mary, ingenieur en chef des Ponts et Chaussées, France, acting as general reporter.

(3) The most recent precautions to avoid the formation of pipings; Prof. K. Terzaghi of Harvard University, Cambridge, Mass., acting as general reporter.

(4) Experiences arising from the testing and the actual use of special cements for large dams; Prof. B. Hellström, of the Royal Institute of Technology, Stockholm, acting as general reporter.

More than seventy papers ranging over these subjects were presented for discussion, and most of these were available before the meeting and were accompanied by summaries in French and English.

The question of upward water pressure on dams, and what allowances should be made for it, is a problem which has worried designers of new dams for a great many years. The information needed is not only the value per unit surface area of the upward pressure to be allowed in calculations, but also some idea of the extent of the area of the dam over which such upward pressure operates. Of the eleven papers submitted, three, by Harza (U.S.A.), Leliavsky Bey (Egypt) and McHenry (U.S.A.), dealt with the scientific aspects of the problem and arrived at the general conclusion that, within the limits of error of measurement, the upward pressures act on practically the whole geometrical surface in question, whatever their specific values at particular points, whether in a plane intersecting the dam, or in the plane of the foundation. Seven other papers dealt with uplift pressures from the practical point of view, five describing the experimental determination of uplift pressures in existing structures, and two dealing with the influence such pressures have on the design of masonry or concrete dams, particularly with regard to the stresses induced. On the upstream side, the value of the specific upward pressure is equal to the hydrostatic pressure of the water in the reservoir, while on the downstream side it is normally zero. Between these two extreme edges of the cross-section, the uplift pressure varies generally in a linear manner, allowing, of course, for the effect of any structural measures designed to reduce the intensity of the pressure. Needless to say, appropriate structural measures should be adopted to prevent the upward pressures becoming operative in the base of the dam, on the foundation surface, or in the body of the dam itself. The remaining paper in this group, presented by Prof. Myslivec, of Prague, dealt with the important problem of infiltration through earthwork embankments, and with the properties of suitable sealing materials for these.

Nineteen papers were submitted on the second question dealing with research methods and instrumentation. They ranged over many and varied topics such as the measurement of displacements of the soil and of earthworks, the measurement of the pressure of water contained in earthworks, temperature and shrinkage measurements, the deformation of gravity dams and arch dams, and the settlement of earth and rock fills. The reports also provided a useful comparison of the experimental methods and measuring equipment used in different countries. Of particular interest and significance were the observations of the swelling of the soil due to impregnation by water after filling the dam, made by Farnsworth (Australia), on the Nepean Dam, and by André Nizery (of France) on the Sautet and Querlédan Dams.

The phenomenon of piping and seepage provided the subject for fifteen papers in the third group. A dam may fail by piping in two different ways: either the seepage pressure exerted by the percolating water may cause a failure of the soil beneath the dam; or the soil may be removed from beneath the dam by erosion, in which case a tunnel-shaped passage, or pipe, is formed through which the impounded water may escape, with disastrous results. It is natural that most of the papers dealt with the various precautions that have been taken to prevent such failures. Generally, the prevention of the removal of soil from beneath the dam has been achieved in one or other of three different ways, either by constructing a cut-off which would prevent the formation of springs or pipes in the subsoil and reduce the loss of water from the reservoir due to seepage; by covering, by means of a filter layer, the areas within which springs may develop, the layer being graded in such a manner that it would retain all solid soil particles without impeding the discharge of seepage water; or by tapping the flow of seepage water by a row of filter wells, thus preventing the formation of springs on the surface.

Twenty reports were submitted in the last group, dealing with experiences arising from the testing and actual use of special cements for large dams. Six of these reports dealt primarily with methods of testing cement for properties of importance for large dams, such as fineness of grinding, heat evolution and resistance to leaching by pure or slightly acidic waters, and with the properties of concrete such as extensibility and creep. A paper by F. M. Lea summarized British experience. An important paper by P. Håkanson (Sweden) dealt with the general principles for a standard specification of special cements for large dams. Nine other papers recorded experiences with the use of special cements in large dams, while the remaining four dealt with various subjects such as air-entraining agents, reactive aggregate, high alkali cement and expanding cement. The paper by R. F. Blanks and W. H. Price (U.S.A.) summarized the experience in that country with air-entraining agents in concrete. The purposeful entrainment of air in concrete improves its workability, reduces the water required for mixing, improves the durability and resistance to sulphate attack, and permits the use of less cement where strength is not a prime consideration, thus reducing heat generation. The permeability of the concrete is also not increased by air entrainment for the percentages commonly used. Air-entrained concrete is now being used in the construction and repair of large concrete dams in the United States.

On June 12 the delegates left Stockholm on two well-organised study tours which extended as far north as Harsprånget within the Arctic Circle, and terminated at Trollhättan in the south, on June 17. During the tours visits were paid to a number of power plants including those at Nämforsen, with a capacity of 45,000 kW., and completed in 1947; Forsmo, on the Angermanalven, of 70,000 kW. capacity, and nearing completion; Holleforsen, on the Indalsalven, of 120,000 kW. capacity, under construction; Harsprånget, on the River Lule 7 km. from Porjus, where the falls, constituting the largest source of water-power in Sweden, will be utilized in a power plant with an ultimate capacity of 260,000 kW.; Krangede, on the Indalsalven, built entirely in the natural rock and completed in 1936, with a capacity of 210,000 kW.; Stadforsen, also on the Indalsalven, constructed during the years 1936–40, with a capacity of 91,000 kW.; Hammarsforsen; and Vargon on the River Göta completed in 1934 with a capacity of 22,000 kW. A visit was also paid to the very interesting tunnelling operations in progress at the Hjälta plant. At Trollhättan the two power plants were visited, the Olidan plant on the Göta, the oldest State power plant in Sweden, constructed in 1910–20, and the Hojum plant, completed in 1943, with a capacity of 120,000 kW., which is constructed entirely in the natural rock formation. Both the Trollhättan stations are fed by the water from the Great Lake of Vänern.

Visits to several works were included, to the cellulose works belonging to Uddeholms A.B. at Skoghall, and to that of Svenka Rayon A.B. belonging to Kooperativa Forbundet near Älvenas; to the steelworks at Munfors Bruk belonging to Uddeholms A.B. and to the Karlstads Mekaniska Verkstad.

The opportunity was taken at Trollhättan, on June 17, of holding a meeting of the International Sub-Committee on Concrete for Large Dams, at which consideration was given to possible lines for future research. These included fundamental research into the physical structure of concrete, its elastic and plastic properties; the physical properties of concrete in large masses, such as extensibility and cracking, and means whereby the internal strain, temperature and humidity may be measured; the chemical interaction between cement and aggregates in concrete, particularly alkali reaction; surface treatment of concrete for dams and particularly by the application of vacuum treatment, and by the use of absorptive formlining materials; the properties of pozzolanas and natural cements; the preparation of a code of permissible unit stresses for use in dam design, to include a discussion of the minimum economic cement content per unit volume which is necessary to prevent concrete deterioration; and to study factors of safety in relation to computed three-dimensional working stresses.

Throughout the meetings in Stockholm and the subsequent tours the delegates were afforded the most generous hospitality by their Swedish hosts. Particularly memorable occasions were the official banquet held at Stockholm in the Town Hall, and the dinner given by the State Power Board at the Stadshotellet, Trollhättan. NORMAN DAVEY

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, October 4

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. C. Baldwin: "The Work of a Divisional Engineer in Northern Rhodesia".

Society of Chemical Industry (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. H. Baines: "The Photographic Latent Image".

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Wilfred Thesiger: "A New Arabian Journey".

Tuesday, October 5

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Discussion on "Valves for Low-Noise Wide-Bandwidth Amplifiers" (to be opened by Mr. R. J. Ballantine and Dr. A. E. Widdowson).

Society of Chemical Industry, Fine Chemicals Group (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. J. H. Burn: "Fine Chemicals for Medical Use".

Wednesday, October 6

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. A. Ahlstrom and Mr. A. Ullman: "Low Value Heat Recovery".

Society of Public Analysts and other Analytical Chemists (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Scientific Papers.

Royal Aeronautical Society (at the Chamber of Commerce, Birmingham), at 7.30 p.m.—Dr. E. W. Still: "Some Aspects of Power Plant Development".

Thursday, October 7

Mineralogical Society (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. Graeme N. Haldane: Inaugural Address as President.

British Psychological Society, Industrial Section (at the British Council, 3 Hanover Street, London, W.1), at 6.15 p.m.—Miss Anne G. Shaw: "Applications of Motion Study, Past and Present". (The original films of Frank B. Gilbreth and modern films of Motion Study will be shown.)

Royal Institute of Chemistry (at the South-East Essex Technical College, Longbridge Road, Dagenham), at 7 p.m.—Dr. N. Booth: "Careers for Chemists".

Textile Institute, Blackburn Branch (in the Textile Lecture Theatre, Municipal Technical College, Blackburn), at 7.15 p.m.—Mr. J. Foster Beaver: "Technical Training for Industry".

Chadwick Public Lecture (in the Reception Room, the University, Bristol), at 8.30 p.m.—Mr. Asa Briggs: "The Public Health Act of 1948, a Forgotten Centenary".*

Friday, October 8

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Dr. H. Plimmer: "The Reaction of Maleic Anhydride with Non-conjugated Unsaturated Fatty Esters".

Institute for the Study of Animal Behaviour (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Rev. A. E. Armstrong: "Social and Sexual Stimulation amongst Birds".

Physical Society (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 3.30 p.m.—Prof. R. W. Wood, For.Mem.R.S. (Johns Hopkins University): "Spontaneous Deformation of Crystals"; at 5 p.m.—Prof. S. Tolansky: "Current Investigations with Multiple-Beam Interferometry" (Charles Vernon Boys Address).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Manchester Statistical Society, Industrial Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Informal Discussion on "Quality Control in Great Britain and the U.S.A.".

Saturday, October 9

Institution of Chemical Engineers, North-Western Branch (at the College of Technology, Manchester), at 3 p.m.—Mr. W. S. Norman: "Fluid Friction, Heat and Mass Transfer in Turbulent Flow".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head of the Department of Physics and Mathematics, Acton Technical College, Acton—The Chief Education Officer (F/GM), Middlesex Education Committee, 10 Great George Street, London, S.W.1 (October 9).

Research Officer in the Soils Chemistry Section of the C.S.I.R. Division of Soils, Adelaide—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1938 (October 23).

Assistant Chemist at the Divisional Laboratory, Manchester—The Divisional Establishment Officer, National Coal Board, North-Western Division, 47 Peter Street, Manchester 2 (October 23).

Research Officer in the C.S.I.R. Division of Aeronautics, Fishermen's Bend, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1633 (October 23).

University Post-graduate Fellowship in the Department of Anaesthesia, and an Assistant Lectureship in the Department of Physiology—The Registrar, The University, Liverpool (October 30).

Senior Lecturer in Biology in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.2 (Wellington, November 30).

Agricultural Chemist for research work on soil and other problems; an Entomologist who should be capable of identifying and advising on plant diseases; and a Plant Breeder to conduct crop improvement work, mainly on wheat; in connexion with a scheme of agricultural development in Northern Rhodesia—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Laboratory Assistant-Steward (male) for Zoology—The Head, Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3.

Senior Lecturer in Pharmaceutical Chemistry—The Dean, School of Pharmacy, 17 Bloomsbury Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Silicosis, Pneumokoniosis and Dust Suppression in Mines. Proceedings at Conference held in London, April 1947. Pp. v+190+43 plates. (London: Institution of Mining Engineers, and the Institution of Mining and Metallurgy, 1947.) 20*s.*; to Members, 10*s.* [197

Reports of the Progress of Applied Chemistry. Vol. 31, 1946. Pp. 745. (London: Society of Chemical Industry, 1948.) [207

The Journal of the Institute of Metals. Vol. 72, 1946. Edited by N. B. Vaughan. Pp. lvii+732+80 plates. (London: Institute of Metals, 1946.) £3. [207

Quarterly Journal of Experimental Psychology. (Published for the Experimental Psychology Group.) Vol. 1, Part 1, April 1948. Pp. 52. (Cambridge: W. Heffer and Sons, Ltd., 1948.) 8*s.* 6*d.* net; annual subscription, 30*s.* [207

Scottish Council (Development and Industry). Final Report of the Committee on Plastics: Plastics in Scotland. Pp. 16. (Edinburgh: Scottish Council (Development and Industry), 1948.) 2*s.* [217

Journal of Sex Education. (Published every 2 months.) Vol. 1, No. 1, August 1948. Pp. 32. (London: Journal of Sex Education, 127 Harley Street, W.1, 1948.) 2*s.*; annual subscription, 10*s.* 6*d.* [227

House Style: Rules for Compositors and Readers. Pp. iv+52. (Edinburgh: Thomas Nelson and Sons, Ltd., 1948.) [267

Deterioration of Structures of Timber, Metal, and Concrete exposed to the Action of Sea-Water. Nineteenth Report of the Committee of the Institution of Civil Engineers, Being a General Summary of the Experimental Work carried out to date on Timber. By J. Bryan. Pp. iv+49. (London: Wm. Clowes and Sons, Ltd., 1948.) 5*s.* [267

Artificial Human Insemination. The Report of a Commission appointed by His Grace the Archbishop of Canterbury. Pp. 70. (London: S.P.C.K., 1948.) 2*s.* 6*d.* net. [277

Directory of Natural History Societies. By H. K. Airy Shaw. (Pamphlet No. 7.) Pp. 155. (London: Amateur Entomologists' Society, 1948.) 7*s.* 6*d.* [287

Anodic Oxidation of Aluminium and its Alloys. (Information Bulletin No. 14.) Pp. 61. (London: Aluminium Development Association, 1948.) 1*s.* [297

National Physical Laboratory. The Inclusion of Equivalent Metric Values in Scientific Papers. Pp. 16. (London: H.M. Stationery Office, 1948.) 4*d.* net. [297

Other Countries

National Museum of Canada. Bulletin No. 97 (Biological Series No. 26): Botany of the Canadian Eastern Arctic, Part 2, Thallophyta and Bryophyta. Compiled and edited by Nicholas Polunin. Pp. vi+574. (Ottawa: Department of Mines and Resources, 1947.) 1 dollar. [77

Australian Journal of Scientific Research. (Published quarterly.) Series A: Physical Sciences. Vol. 1, No. 1, March 1948. Pp. 119. 7*s.* 6*d.*; 30*s.* per annum. Series B: Biological Sciences. Vol. 1, No. 1, February 1948. Pp. 162. 7*s.* 6*d.*; 30*s.* per annum. (Melbourne: Council for Scientific and Industrial Research, 1948.) [157

Geophysica. No. 1. Pp. 66. No. 2. Pp. 186. (Helsinki: Geophysical Society of Finland, 1935, 1947.) [157

Rubber Research Institute of Malaya. Information Cards (No. 1: Useful General Information; No. 2: Standardizing and Coagulation of Latex; No. 3: Some Estate Chemicals and their Uses; No. 4: Defects in Rubber; No. 5: Defects in Rubber (contd.); No. 6: Manufacture of Pale Crepe; No. 7: Preservation and Testing of Latex; No. 8: Preservation and Testing of Latex (contd.).) Revised April 1948. (Kuala Lumpur: Rubber Research Institute of Malaya, 1948.) 1 dollar. [157

Report of the Scientific Advisory Board for the Year 1947. Issued under the authority of the Governing Body, Indian Research Fund Association, New Delhi. Pp. xii+209. (New Delhi: Indian Research Fund Association, 1948.) 1 rupee. [157

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ASPECTS OF COLONIAL DEVELOPMENT

THE fifth report from the Select Committee on Estimates for the Session 1947–48 (London: H.M. Stationery Office), with its forthright comments on Colonial development, makes its appearance at an appropriate moment. It is based in part on the observations of some of its members as a result of a visit to West Africa, and it has some relevance to the report, published later, of the commission of inquiry into the disturbances and underlying causes of these disturbances in the Gold Coast during February and March of this year. The recommendations and conclusions are equally of interest in relation to the recent report on "Colonial Research 1947–48". They emphasize the value and importance of the work being done by the Colonial Research Council, which has now replaced the Colonial Research Committee, and by the Colonial Products Research Council, the Colonial Social Science Research Council and the committees responsible for medical research, insecticide research, agricultural, animal health and forestry research, as well as the urgent need for the Colonial Economic Research Committee to function effectively.

In all these reports, two factors stand out as determining the successful issue of Colonial welfare and development: the problem of education and that of scientific man-power. Once again it is made manifest that shortage of qualified workers handicaps the work of the Social Science Research Council, of the Medical Research Committee and of the Insecticides Committee, and both the latter Committees realize how closely the effective utilization of results of their work depends on securing the co-operation of the native peoples.

Colonial research cannot, in fact, be pursued without regard to the question of native education, even of literacy at the lowest level. One passage in the Gold Coast report drives this lesson emphatically home. The economy of the Gold Coast rests on its four hundred million cocoa trees. Of them, one tree in eight is now affected by the virus disease known as swollen shoot, and if the disease is unchecked it is estimated that the cocoa industry will have disappeared in twenty years. The Government has accepted the opinion of its advisers that the way to check this incurable disease is by cutting down the diseased trees. Violent popular feeling and resistance to this destruction was aroused, because it was believed to be inspired by malign political motives; and the cutting out of the diseased trees has been stopped.

That passage in the report is pregnant with meaning for the whole future of Colonial welfare and development. While misrepresentation can create this kind of distrust, no mere adjustment of constitution or administration can restore the health of the body politic. The whole economy is put in jeopardy, and it is beyond the power of science or of Government to raise the standards of living of the native peoples, or even to avert a catastrophic fall. The problem of literacy, the programme of mass education, and the restoration or fostering of confidence beyond the power of the agitator to disrupt, must be the first tasks; and until they are undertaken there is no hope that the man of science can make the contribution to native welfare of which he has become increasingly conscious since Lord Hailey published his "African Survey" ten years ago.

Nevertheless, although the first task is to promote understanding, even at this stage the man of science has a contribution to make, as was made abundantly clear on several occasions during the recent meeting at Brighton of the British Association. This point is well brought out by Dr. E. W. Smith in the Frazer Lecture in Social Anthropology before the University of Liverpool delivered in October 1946, and recently brought up to date and published (London: Lutterworth Press, 1948. 3*s.* 6*d.* net). Events have well attested the soundness of the four factors upon which Dr. Smith suggested that the success of projects under the Colonial Development and Welfare Act depends: a sufficient supply of competent men and women to operate the plans; the goodwill and effective co-operation of the native peoples themselves; the wise planning and execution of the schemes by men and women who understand the native environment and the working of the native mind; and the co-operation of the economist, the agriculturist, the medical man, the psychologist, the nutritionist, the educationist and administrator, as well as others in the team-work required to devise and execute detailed schemes for each district. Dr. Smith is arguing above all for the anthropologist to make his vital contribution to the understanding of the native mind, and for the Government to make increasing use of such men in the task of government. His plea for social science to be used as an instrument of social engineering, and for more social scientists for the Colonial Service, is supported by the important section of the Gold Coast report already noted.

That Dr. Smith does not stand alone in his views was indicated in an address given by Sir Harold Hartley in Johannesburg in August at a conference of scientific and technical societies. Sir Harold, after urging a great extension of surveys of the material and human resources, limitations and needs of the relatively undeveloped parts of the world, reviewed the main factors likely to limit world economic advance, and the part of scientific workers in overcoming them. In spite of the huge increases in agricultural output which are potentially possible on the basis of existing knowledge, he said, man is still the limiting factor in peaceful advance. The same conclusion might well be drawn from the fifth report of the Select Committee on Estimates, although it concentrates attention rather on human limitations on the administrative side.

The Select Committee recognizes clearly that co-operation in development involves the association with the planning, of such organised opinion as may exist, of a carefully worked out policy of technical and vocational training related to the needs of a developing country for skilled man-power at all levels, and communal development or 'mass education' to induce the bulk of the population to take an active interest in their own welfare. It considers that the Nigerian Development Plan suffered from the beginning in that too little attention was paid to the need for associating African opinion with the various committees established to deal with it. This has now been to some extent righted, although African representation on the Central Development Committee is still inadequate.

So far as the felling of the diseased cocoa trees was a factor in the Gold Coast riots, it has been suggested that the Government failed to secure that its reasons were fully understood by native opinion, although improper methods of execution were also alleged. To engage the active co-operation of the native people themselves is not always easy, and may indeed involve questions of constitution as well as of administrative method. Communal development is still experimental; and on the information side, as the Select Committee notes, there is need for research into the kind of film appropriate to undeveloped peoples. Support from development funds of a scheme of research for ascertaining the reactions of African audiences is recommended. Similarly, it expresses its approval of the active pursuit of a comprehensive policy for the development of broadcasting throughout the British Empire, and urges that the closest informal contact should be maintained between the Colonial Office Information Department and the British Council in foreign countries.

This question of confidence and information has a bearing also on the part which private enterprise has to play in Colonial development. It is the declared policy of the Colonial Office to encourage private enterprise; but private enterprise cannot play its proper part in development so long as the belief exists among the Colonial peoples that it is unfairly exploiting them; nor, it might be added, while private enterprise elsewhere continues to be condemned by Government spokesmen. The Select Committee refers to local feeling against the United Africa Company in particular, but there is some hope for a settlement which will remove the two main grounds for such feeling.

The matter is not entirely divorced from that of the public development corporation. It is the responsibility of Government to prevent an undue proportion of the trade and industry of any particular Colonial area from becoming dominated by any trading organisation or group, and the Select Committee points out that in spite of the formal assurances of the Overseas Resources Development Act of 1947, it will be necessary to secure that such bodies as the Colonial Development Corporation and the Overseas Food Corporation do in practice respect the interests of the local Colonial people. The obvious danger is that of well-meant authoritarianism. Experience with the Cameroons Development Corporation indicates that special attention must be given to the relationship between such corporations and the local administrative authority.

The problem is in fact essentially one of administration—of securing that justice is not merely done but also seen to be done. The Select Committee makes no specific recommendations here; but the survey it recommends of the overall requirements of the Colonies for capital equipment for Government schemes, public corporations and private enterprise, should by eliminating some causes of friction make a distinct contribution here, as well as in the immediate objective of facilitating real planning in place of the agglomeration of departmental suggestions masquerading as the Nigerian Ten-Year Development Plan, on which the Select Committee makes the caustic comment: "This is not planning". Such a survey is the counterpart of the early investigation also recommended into the additional financial provision likely to be required to complete existing development schemes, and into the need for extending the ten-year period originally contemplated.

By and large, it may well be true that the administrative mistakes which the Select Committee criticizes are in part due to the overburdening of senior officers in the Colonial Service, and the Committee's observations on the shortage of staff should be noted. The Secretary of State for the Colonies stated in the House of Commons on July 8 that, during the last two and a half years, 3,300 men and women had been recruited for the Colonial Service, and on the administrative side the intake of the last two years was equal to that of eleven normal years. Excellent reports had been received on the quality of these recruits, and Mr. Creech Jones paid a warm tribute to the co-operation of the Universities of Oxford, Cambridge, London and elsewhere in training these recruits.

Nevertheless, the Select Committee reports that in May 1948 there were 1,185 vacancies in the Colonial Service, the greatest demand (315) being for men with engineering and architectural qualifications, while 168 administrators, 136 medical men and 110 agriculturists are still required. Apart from the strain on existing staff, it is imperative that immediate steps should be taken to overtake present shortage if Colonial development is to proceed smoothly. The shortage is equivalent to about three years ordinary intake, and has to be viewed in relation to the demand for trained man-power and woman-power as a whole, just as the Select Committee insists capital requirements of the Colonies must be reviewed.

That view presumably will be taken to some extent by the Advisory Council on Scientific Policy as suggested in its first annual report; but in the meantime the Select Committee makes several suggestions to secure the fullest use of available technical and scientific staff without lowering standards of qualifications. The limited number of fully qualified technicians available should concentrate on training staff for technical positions, and schemes should be adopted for recruiting into the forestry, agricultural and veterinary services men without academic qualifications but of good personal qualities and natural aptitude, and which would provide for academic training at a later stage when the pressure on the schools of forestry should have decreased. The requirement of university training as a qualification for recruitment might also be waived, and the temporary seconding of staff from Home to Colonial Service should be exploited to the utmost. Attractive schemes for seconding should be made for all technical services, providing appropriate guarantees in regard to promotion on return to Great Britain, and short-term contracts should be used to the fullest extent to obtain for the Colonies the services of scientific men and technicians with the highest qualifications, and development funds should be used for this purpose.

The Select Committee's recommendations here as well as in regard to salary scales and the provision of refresher courses are in line with those of the Barlow Committee for scientific staff generally. Clearly, to secure the most effective and best balanced distribution of scientific and other trained man-power between Britain and the Colonies involves encouraging mobility to the greatest possible extent, quite apart from the very favourable reactions such interchange has on scientific work itself. In all this the fullest possible encouragement must be given, and the greatest possible use made, of Colonial men and women themselves. Such association at all levels in the Colonial Service must prove a powerful factor in securing the understanding and co-operation of the Colonial peoples in development of their territories, nor should the influence of greater attention to the needs of Colonial students in Great Britain, both in regard to amenities or information, be overlooked.

Mr. Creech Jones' speech in the House of Commons on July 8 shows that the trend of the Select Committee's observations is fully appreciated. He stressed three points in regard to economic policy: the essential requirement of understanding and co-operation from the Colonial peoples themselves, to whom it must be made clear that the development plans are primarily concerned with the improvement of their trade and economic status and with the strengthening of the economies of their territories; the necessity for a sound economic basis for Colonial welfare; and growth of regional co-operation in this field with the French, Belgian and Portuguese Governments. During the past year a series of technical conferences has already taken place and more are planned on problems of technical development, communications, health, etc. The Government has also entered into discussions with the French and other associated Governments on the possibilities of further co-operation in regard to development schemes.

In spite of all this promise of genuine international co-operation in tackling problems of Colonial development in such areas as West and Central Africa, there is one seriously disturbing factor. That is the failure of the Trusteeship Council to reach the standard of constructive criticism set by its predecessor, the Mandates Commission of the League of Nations. The Select Committee's report demonstrates the weaknesses of British planning of Colonial development, and is a challenge to more constructive thinking and realistic planning in the light of inherent limitations of resources of materials and men and women. It is equally a rebuke to the irresponsible criticism and political polemics, with their disregard of the facts and conditions in the trusteeship of Colonial territories which has marred the proceedings of the Trusteeship Council, and is making it a disturbing factor rather than one which promotes the goodwill and understanding upon which Colonial development and welfare depend. Great Britain is faithfully meeting its obligations under the charter of the United Nations Organisation in regard to the provision of statistical and other technical information on economic, social and educational conditions, and the Colonial Office has done well to make the position plain in its recent Memorandum on Information on Non-Self-Governing Territories (London: H.M. Stationery Office, 1948. Colonial No. 228. 1*s*. net).

International co-operation could do something to diminish the present difficulties in Colonial development, particularly in the attack on technical problems, and in such matters as transport. No doubt the help of independent international men of science would be valuable in overcoming prejudices such as those which hamper the eradication of the swollen shoot disease of the cocoa tree. But such collaboration is only possible in an atmosphere of goodwill, and where there is manifest the willingness to make impartial investigation and the comparative study of different Colonial systems which characterized the work of the permanent Mandates Commission of the League of Nations.

CHEMICAL STIMULI AND INSECT BEHAVIOUR

Chemical Insect Attractants and Repellents

By Prof. Vincent G. Dethier. Pp. xv + 289. (London: H. K. Lewis and Co., Ltd., 1947.) 25*s*. net.

INSECTS live in a world of tastes and odours. To understand their reactions to the varied chemical factors in their environment would be a long step towards comprehending their ecology and would provide a firm basis on which to build certain methods of control. It is around these theoretical and practical considerations that Prof. Dethier has written his book on the action of chemical attractants and repellents in the life of insects. Unfortunately, exact knowledge in this field is very limited, and the contributions of the applied entomologist are copious but wholly empirical. None the less, this book should serve a useful purpose in bringing together in one volume what is known of the role of chemical attractants in the feeding, sexual and egg-laying behaviour of insects.

The botany and chemistry of the essential oils of plants and the relation of these substances to the choice of food-plants is reviewed—from the classic work of Verschaffelt on the predilection of Pierid larvæ for plants containing mustard oils to the recent detailed work of the author himself on the feeding habits of *Papilio* species in relation to the essential oils of Umbelliferæ and other plants. The chemistry of fermentation and the products of decomposition of protein and fat are considered alongside the extensive empirical literature on the production of attractants for the codling moth, fruit flies, blowflies and other insects. It is no fault of the author that this subject consists chiefly of lists of facts with few guiding principles. There is a valuable chapter in which the varied types of olfactometers and venturi type flow-meters are described, together with the methods of controlling the molecular concentration of odorous substances and determining the thresholds of response. On the practical side, the use of attractants in devising traps—for sampling populations and timing the application of insecticides or for actually reducing populations—is described in detail; and the whole subject of insect repellents is reviewed.

At the beginning of the Second World War the standard mosquito repellent was still oil of citronella; but commercial firms in the United States had evolved three synthetic repellents: dimethyl phthalate, 2-ethyl-hexane-diol 1,3 (Rutgers 612) and αα-dimethyl-α-carbobutoxydihydro-γ-pyrone (indalone). At great expense, large teams of American workers during the War tested thousands of additional substances; but the only practical outcome was the recommendation to use a mixture of the three named chemicals in the proportion of 6 : 2 : 2. No advances were made in the general knowledge of repellents. Indeed, the most valuable contribution in this field during the war years was the paper by Christophers[1], working almost single-handed; a paper which appeared too late for inclusion in Prof. Dethier's book.

The writing of this book was completed while the author was serving with the Armed Forces overseas. It has not been possible, therefore, for him to include certain recent ideas which go far to clarify thought on some of the fundamental questions involved. It has been pointed out by J. S. Kennedy that repellency is not a reaction but a change in distribution; and this altered distribution may be brought about in a variety of ways. For example, the author states categorically that D.D.T. possesses "no repellent qualities whatsoever". But slight D.D.T. poisoning causes excitation, and this in turn leads to such a change in distribution that insects are, in fact, strikingly repelled from buildings treated with D.D.T. Similarly the author ascribes the change of host plant by aphides at different seasons to physiological changes in the insect resulting in altered taste preferences. But it is becoming increasingly clear that the nutritional value of the host plant, as determined by the physiological condition of its foliage, may play a part at least as great as do specific flavours in inducing feeding and multiplication and so the building up of aphid populations.

V. B. WIGGLESWORTH

[1] *J. Hyg.*, **45**, 176 (1947).

PROCESS CHEMISTRY FOR THE CHEMIST

Chemical Process Principles

By Prof. Olaf A. Hougen and Prof. Kenneth M. Watson. Part 2: Thermodynamics. Pp. xv + 437–804 + xvii–xlviii. 30*s*. net. Part 3: Kinetics and Catalysis. Pp. xv + 805 - 1107 + xvii - xlviii. 27*s*. net. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.)

THESE volumes consider process problems of a physico-chemical nature and they do not contain any detailed discussion of equipment, of selection of materials for construction or of mechanical design. As the majority of chemical engineers in Great Britain first graduate in chemistry and only later specialize in their chosen subject, this approach should be of particular interest to them.

The treatment rests heavily upon recent American development as is shown by the number of references to American literature, which comprise 90 per cent of the total.

Part 2 opens with the consideration of the second law and quickly proceeds to the discussion of entropy and thermodynamic relationships. Modern methods are used throughout, as is exemplified by the inclusion of Shaw's method for making thermodynamic transformations.

Subsequent chapters consider the application of fundamental principles to problems in the compression and expansion of fluids, power generation and refrigeration. The treatment is developed for solutions and mixtures of various types by introducing the chemical potential, fugacity and activity concepts. This approach leads naturally to a study of vapour-liquid equilibria and to the fitting of experimental data to expressions such as the Van Laar equation. A chapter treats chemical equilibria and contains B. F. Dodge's useful discussion of the feasibility of a chemical reaction. The concluding section may be quoted as an example of the bold use which is made of fairly advanced recent methods for the solution of practical problems. These forty-seven pages deal with the calculation of thermodynamic properties from molecular structure by the method of group contributions and also by the more refined statistical methods.

Part 3 treats the subject of the kinetics of industrial reactions, which has rarely been considered elsewhere, and is thus in contrast with Part 2, where the development is along the lines that American thermodynamics has been following for many years. Encouraged by the recent advances in the theory of absolute reaction-rates the authors have applied the conceptions to the study of homogeneous, heterogeneous and catalytic systems of industrial importance. Particular attention is given to the interpretation of pilot-plant data. Economic considerations are emphasized and problems are included in the establishment of the optimum conditions of operation.

In this volume also the emphasis is on American publications. Frequent references are made to the International Critical Tables for experimental data and not to the original works.

Reactions are studied in terms of the general mechanism and in this way surface reactions are considered from the viewpoint of adsorption and dissociation, but there is no discussion of types of catalyst.

Calculations drawn from rather limited fields are often treated in considerable detail, for example, the work on codimer. The study of catalytic reactions culminates in the section on catalytic reactor design, where the authors state, "It is seldom practicable or possible to develop complete data prior to the design of plant, and the engineer is forced to improvise and extrapolate fragmentary data to conditions far outside the range of his past experience. It is in such cases that sound fundamental principles are of the greatest value in breaking down the available information into component effects and contributions of such simplicity that their individual trends can be estimated with fair assurance".

Homogeneous reactions in flow systems and also uncatalysed heterogeneous reactions such as the nitration of benzene, the combustion of coke, water softening and gas absorption are studied from this aspect.

In America during the recent War there were many examples of the scaling up of processes from the laboratory bench to large-scale production without using plant of an intermediate size. Volume 3 is valuable in indicating how this important subject can be tackled.

Numerous problems are set in both parts. The binding of the books is pleasing, and the quality of the paper is good by modern standards.

E. F. G. HERINGTON

MECHANISM OF NUCLEAR PHYSICS COUNTERS

Electron and Nuclear Counters

Theory and Use. By Prof. Serge A. Korff. Fourth printing. Pp. xi + 212. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 18*s*. net.

ELECTRICAL methods of counting the products of atomic disintegration have become widely used in many fields in recent years, and are no longer a tool for the specialist in nuclear physics alone. The Geiger-Müller counter for β- and γ-rays in particular has found increasing application in connexion with the 'tracer' technique. A monograph on this subject is therefore particularly welcome, especially as other works on this subject are by now out of date.

The present book is intended for the users of counters as well as the nuclear physics specialist, and the amount of fundamental physical knowledge assumed is not unduly large. Some acquaintance with the processes of ionization, recombination, etc., is assumed; but this should not deter the non-physicist from perusing the book. The author is an acknowledged expert in research on the mechanism of the Geiger-Müller counter, and, as one would expect, the volume contains a full and detailed account of the processes taking place in such a counter. The behaviour of proportional counters and integrating ionization chambers are also described reasonably fully, but the reviewer feels that the section on ionization chambers for counting is rather brief. The 'gridded' ionization chamber, now often employed when the measurement of the size of the ionization pulse is important, receives no mention, nor does the use of very pure inert gases to give 'fast' chambers in which the formation of negative ions is negligible.

While we would recommend perusal of this book to persons whose only contact with Geiger counters is as a user, it must be admitted that it is not a complete guide to counting technique. Such important matters as statistical errors in counting and the design of experiments to obtain maximum accuracy in a minimum time, for example, are much less fully treated than is the mechanism of the discharge. This book will not enable the non-physicist to dispense with specialist assistance in matters such as calculating the correction for absorption of particles in the counter window. It must also be admitted that the section on electronic circuits is only indicative of the type of circuits which can be used; design of circuits requires a deeper knowledge of circuit theory than can be given in a volume of this size. A few modern techniques, such as circuits for the recording of delayed coincidences with variable delay-time, receive no mention, and the reviewer has detected a few definite mistakes in the circuit diagrams. In a few places throughout the book, too, the derivation of the formulæ used is not completely clear, and another minor criticism is the use, without definition, of the term 'pre-dissociation'; in view of the importance attached to this process in self-quenching Geiger counters, we feel the term should have been explained.

It is recognized that it is difficult to produce a satisfactory book in a field in which research is still active, and in particular in a field where, as in Geiger counters, much past work has been of the empirical, 'cook-book' variety. Within the compass of the present volume, and granted its emphasis on the internal mechanism, it would be difficult to suggest any important improvements. The need for such a book is undoubted, and this one will be of use to the specialist and the general user of counters alike.

C. H. WESTCOTT

ON UNDERSTANDING SCIENCE

On Understanding Science

An Historical Approach. By James B. Conant. (The Terry Lectures.) Pp. xv + 146. (London: Oxford University Press, 1947.) 10*s*. 6*d*. net.

IN this book the President of Harvard University addresses himself to the problem of preparing suitable university courses (whether for graduates or undergraduates is not clear) for the purpose of producing an understanding of science in those whose future work is not to be scientific. He gives reasons why he thinks this important. By "understanding science" Dr. Conant means the acquiring of the special point of view which the successful investigator in a field of experimental science naturally attains, and he considers that this end can be achieved better by the presentation of selected 'case-histories' of particular advances in science than by a philosophical analysis of science as a whole. As illustrations of such case-histories he chooses the investigations of the pressure and elasticity of air in the seventeenth century, the discovery of the galvanic battery, and the development and overthrow of the phlogiston theory. These are outlined, with frequent comments on appropriate digressions which the teacher might make to emphasize salient points.

The definition of science which is implied in these considerations is that "as a first approximation, we may say that science emerges from the other progressive activities of man to the extent that new concepts arise from experiments and observations, and the new concepts in turn lead to further experiments and observations"; and among the most important of the characteristics of scientific investigation that are to be brought out are the influence of new techniques of experimentation and their connexion with the practical arts, the evolution of new concepts from experiment, the difficulties of experimentation and the significance of the controlled experiment, and the development of science as an organised social activity. Dr. Conant does not make the common modern error of transforming the fact that science *has* a social function into the illusion that science *is* a social function, and he is careful to distinguish the history of science from the history of technology; it is the former alone with which he is concerned. The book includes very useful bibliographies relating to the chosen case histories.

Taken as a whole, the book is both important and timely. The examples are admirably chosen and presented. It is claimed that the effort proposed would be a pioneer one, and so far as the United States is concerned (it is evident from various passages that this limitation is in Dr. Conant's mind) this may very well be so, although in Britain something similar has been in operation for some time. Perhaps experience of the working of the scheme might have led Dr. Conant to reconsider his contrast between the historical and philosophical approaches to the understanding of science. These can be made to supplement one another, and there is reason to hold that a course in the philosophy of science based on its whole history will lead to a better understanding of science than the mere recapitulation of selected past events alone, and will correct the error, almost inevitable when science is presented by means of special cases, of confusing casual with intrinsic characteristics. For example, such a course would suggest that the continuously progressive element in science is the growth of the field of correlated observations, and not, as Dr. Conant suggests, "changing concepts and evolving conceptual schemes". Newtonian mechanical science progressed enormously for more than two hundred years with scarcely any changing concepts and evolving conceptual schemes. Again it might help to elucidate the difficulty which arises when Dr. Conant emphasizes the (questionable) "differences in method between the observational sciences . . . on the one hand, and the experimental sciences . . . on the other", but draws all his case histories from the latter.

Such points, however, though important, are of secondary importance. It is much to be hoped that Dr. Conant's book will be widely read and will bear fruit.

HERBERT DINGLE

DESTRUCTION AND REHABILITATION OF AN ISLAND FAUNA

The Fauna of Krakatau, 1883–1933

By K. W. Dammerman. (Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen, Afd. Natuurkunde, Sectie 2, Deel 14.) Pp. xii + 594 + 11 plates. (Amsterdam: N. V. Noord-Hollandsche Uitgevers Mij., 1948.) n.p.

PRIOR to 1883 there existed in the Sunda Straits between Sumatra and Java three small islands, the largest of which, Krakatau, was composed of three active volcanoes, Perboewatan, Danan and Rakata. From May 20 until August 28, 1883, a series of volcanic eruptions succeeded one another until with a final and stupendous explosion the two volcanoes, Danan (400 m.) and Perboewatan, disappeared entirely, and Rakata (800 m.) was split right through the middle, one half of it together with the other two volcanoes sinking into the depths of the ocean, while a cavity 270 m. deep was made in the sea-bed. The main island was originally 9 km. long by 5 km. in breadth with a surface area of 33 sq. km., of which 22 sq. km. sank beneath the sea. Thirty-six thousand people in Java and Sumatra were killed by the resulting sea wave.

In October 1883 Verbeck visited the area and reported that the three islands were completely bare and covered with a hundred feet thick layer of ash and pumice which had exterminated the flora and fauna. The ground was still hot, and scalding steam issued from crevices.

The total destruction of the fauna and flora of Krakatau offered an excellent opportunity for studying re-colonization. Unfortunately very little was known of the previous fauna and, still worse, biologists failed to take advantage of the opportunity presented until too late. Cotteau landed on May 27, 1884, and found that the only sign of animal life was a minute spider; but in 1889 Selenka, who visited the island, found to his astonishment a rich fauna of insects and even giant lizards.

Dr. K. W. Dammerman now presents us with a comprehensive analysis of the work done on this problem of the re-colonization of Krakatau. He has himself made frequent collecting visits to the island, and has for many years specialized on the subject. In the first part of the book the fauna of the island is compared with that of surrounding islands. The re-colonization of other desert areas such as the Katmai volcano in Alaska and the volcano of Jorullo in Mexico is compared with that of Krakatau. The succession of biocœnoses, the sequence of animal categories in the islands and methods of dispersal are all studied in turn. The derivation of the fauna is also discussed. Part 2 (taxonomic part) consists of the complete annotated list, arranged systematically, of the animals now found on the Krakatau islands. Some of these are illustrated by text figures. The same list is repeated in tabular form without annotations to show at a glance the distribution of each species in the various islands in 1908, 1921 and 1933 respectively. The book concludes with an extensive bibliography and excellent photographic plates.

THE CANINE CULT

Dogs in Britain

A Description of all Native Breeds and most Foreign Breeds in Britain. By Clifford L. B. Hubbard. Pp. xii + 471 + 8 plates. (London: Macmillan and Co., Ltd., 1948.) 21*s*. net.

GREAT BRITAIN, per head of population, contains more dogs in private ownership than any other country in the world. Dog-breeding in Britain is a big industry, dog-showing a bigger, dog-owning a passion. Yet there is a profound ignorance about dogs, about everything to do with dogs, in Britain. Too many people own dogs because it is 'the right thing' to do, and not because they either love them or understand them: too many people breed freaks because it pays to do so. It is, in fact, not far from the truth to say that we are a nation of dog-owners and not, as we like to make out, a nation of dog-lovers.

How near to the truth that statement is can be seen from a study of canine literature. There is a small but excellent specialist Press; there are a number of specialist booklets devoted to individual breeds: there is one encyclopædic volume at a high price, a price beyond the reach of most dog-owners: there is a vast assortment of illustrated literature of a popular and definitely sentimental type; and it has always been the same. There is, therefore, a great opportunity for an all-round book about dogs; one that does not sentimentalize; one whose illustrations do not portray the dog as something rather more than human, stressing its 'fetching' ways to the exclusion of all else; one that both entertains and instructs. Mr. Hubbard has seized the opportunity. His book, most reasonably priced, will meet a long-felt want.

This book is uniform with those two excellent volumes by L. J. F. Brimble, "Flowers in Britain" and "Trees in Britain", which means that it is lavishly illustrated in colour and half-tone, yet in rather less than five hundred pages the author has managed to cover almost every aspect of the modern dog-world. Origins, breeding, training, management, breeds and varieties, diseases and ailments, all are treated authoritatively but simply. Mr. Hubbard never becomes involved, never ceases to be anything but practical, never ceases to entertain. He has, too, the wide view. He is not content to deal only with the popular British breeds, but also gives details of many foreign breeds, few specimens of which are to be seen here, but which in their own countries are as popular as the cocker spaniel is in the English suburbs.

On the practical side—on breeding, training, management, and on the health and care of the dog—what he has to say, and the way in which he says it, is beyond praise. His chapter on the dog in literature and art (in which he had the assistance of Mr. Stuart Tresilian, who was also responsible for the beautiful coloured plates, and Mr. Stuart Raye) cannot fail to appeal to anyone with a fondness for dogs. All those who have at any time "given their heart to a dog to tear" will read this section again and again.

Mr. Hubbard will not, however, find universal acceptance for all his views on the origin of the dog, or for all he has to say on the very interesting (but surely, more complicated) subject of the wild dogs of the world. In particular, it is certainly over-simplifying matters to dismiss the pariah dog as semi-wild, if, by that, is meant feral. Pariah is a word that has come to be loosely used in English. That there are feral dogs infesting the Middle and Far East is beyond question; but there is also a quite distinct form (some authorities recognize two types) of truly wild pariah. These are matters, however, for the specialist with zoological leanings, and do not affect in any way the great value of the book for the non-specialist dog-owner and -lover.

But on another matter, of great concern to all dog-owners and -lovers, Mr. Hubbard has allowed his enthusiasm to run away with him. He speaks of dog specialists as "cynologists". He even goes so far as to describe Dr. John Caius, the learned founder of Caius College, Cambridge, as "the Elizabethan cynologist", and, further, to put the generic separation of dog and fox to the credit of advance in "cynological study". It was due, of course, to nothing of the sort. But it is the word that is disturbing. It has no place in the dictionary, and it should have no place in the world of dogs, for if it is to be accepted what are we to call the specialists in horses, cats, pigs, and other domestic animals?

Enthusiasm is, however, a good fault. To read this beautifully illustrated and produced book is to catch much of the author's enthusiasm. It should have, and will thoroughly deserve, a great welcome from the dog world, for there is no one—specialist no less than novice—who will not be the better for reading it.

BRIAN VESEY-FITZGERALD

RESEARCH SERVICES IN EAST AFRICA*

By Dr. E. B. WORTHINGTON
Scientific Secretary, East Africa High Commission

A PROVISION of the Colonial Development and Welfare Act of 1945 was to earmark up to a million pounds a year for ten years from the British Treasury for research in and on behalf of the Colonial Empire, and in consequence there has been much activity both at home and overseas in designing systems which will enable these funds to be spent in the best way. The purpose of this article is not to recapitulate the work at the London end, centred on the Colonial Office, because this is summarized in the published annual reports of the Colonial Research Committee (now Council) and other advisory committees and councils concerned, and has already been noticed from time to time in *Nature*. The object is to describe how the new system is working out in a Colonial region, with the advice and assistance of the London authorities.

For this purpose East Africa is taken as the example for several reasons. It comprises three contiguous territories, Kenya, Tanganyika and Uganda, with the island Protectorate of Zanzibar adjoining, so that its components do not suffer from separation by wedges of territory administered by a foreign power, as in the case of the West African region. East Africa has advantages over its neighbouring region of Central Africa, because all its component territories are ultimately responsible to the British Parliament through the Secretary of State for the Colonies, whereas Central Africa has to combine two such territories, Northern Rhodesia and Nyasaland, with Southern Rhodesia which has Dominion status and is therefore responsible only to itself and does not qualify for grant aid under the Colonial Development and Welfare Act. A further reason for taking East Africa as the example is that, in addition to the territorial Governments, there has been since April 1948 a form of regional Government, the East Africa High Commission, which has its own 'Central Assembly' and secretariat, and is directly responsible for a number of scheduled services, among which inter-territorial research and other scientific activities take a prominent place. The East Africa High Commission has a scientific secretary whose duties are specially concerned with creating a framework within which science can be pursued with a reasonable degree of freedom in the main subjects involved.

Inter-territorial research in East Africa may be said to date from the Ormsby-Gore Commission of 1924, as the result of which the old German scientific station at Amani in Tanganyika was developed into an Agricultural Research Institute having functions in the whole region. Many other Commissions, notably the Hailey Survey of Africa during 1934–37, emphasized the need for more research and for closer co-operation in research. Nevertheless, until the War, investigations were arranged mainly on the basis of technical departments of territorial Governments, within which very few officers could be sufficiently freed from routine duties to undertake research in the true sense. In addition to Amani, however, one or two inter-territorial institutions had been established, notably the Central Veterinary Research Institute at Kabete in Kenya, and the Tsetse Fly Research Institute at Shinyanga, which, though primarily headquarters of the Tanganyika Tsetse Department, operated in the adjacent territories as well. During the War, isolation of research workers tended to become more acute; but latterly visits from a number of men eminent in particular scientific spheres have resulted in recommendations, most of which have now been bound into a general scientific framework. The stage is set, therefore, for a big improvement in research, designed to provide a more adequate background of knowledge on which to base development in East Africa.

I would be the last to claim that what we have planned will be sufficient for more than a few years to come. It is significant in this connexion to compare the research plan for East Africa with that of a neighbouring region comparable in size, namely, the Belgian Congo. In the group of subjects concerned with primary production from the soil, the Institut National pour l'Étude Agronomique du Congo Belge has an annual subvention towards recurrent expenditure of more than a hundred million francs, 3 per cent or so of the whole expenditure on public services in the country. In addition, the Belgian Government has established in 1948 the Institut des Recherches Scientifiques en Afrique Centrale for long-term research in other subjects, with a capital sum of 450 million francs. By comparison, the expenditure on research in East Africa, including grant aid from Colonial Development and Welfare funds, is not expected to reach even 1 per cent of total public expenditure during the next few years. This suggests a scientific deficiency in the British as compared with the Belgian Colonial system which must be made good in course of time.

In the scheme for East African research the first principle being applied is to separate research from executive responsibility wherever possible. Much of the research is being arranged, therefore, in a series of organisations with functions extending over the whole region; and these will be advisory to the executive technical departments, such as those concerned with agriculture, veterinary work, forestry, tsetse control, public works, which will remain responsible to the separate territorial Governments.

The advantages of pooling a good part of the research effort in this way will be several: first, greater efficiency, including savings on capital expenditure and personnel; secondly, better recruiting prospects, because inter-territorial research organisations will offer wider scope to young scientific workers; thirdly, easier arrangements for seconding specialists to and from centres of research in Great Britain and the Dominions; and fourthly, better service to the territorial Governments and those interested in using the results of research.

Five inter-territorial research organisations are being established now, concerned with the following subjects: agriculture and forestry; veterinary science and animal husbandry; tsetse flies and trypanosomiasis; fisheries; scientific and industrial research. These do not cover by any means the whole field. They are restricted to the main productive subjects, not because we attribute less weight to subjects of social importance, such as health, sociology and education, but because research on these is at present being arranged direct by the authorities at the Colonial Office, with the East Africa High Commission serving in the capacity of local agent rather than controlling authority. There are, however, several branches of research on social subjects of a long-range character attached to Makerere College in Uganda, which is tending to become the East African University.

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* This article summarizes a fuller document on the subject which was laid on the table at the first meeting of the Central Assembly of the East Africa High Commission in April 1948.

It is not intended that every scientific man in East Africa will become part of an inter-territorial research organisation, because it will be necessary for each of the main executive departments, being part of the territorial Governments in each territory, to retain its own group of specialists for routine and advisory work. Whereas the research organisations are likely to initiate new lines of investigation, it is expected, moreover, that territorial departments will become intimately concerned as soon as a branch of research reaches the technological stage, when initial results require testing under a variety of practical field conditions.

The research organisations themselves will be responsible direct to the East Africa High Commission; but each will maintain close contacts on one hand with the territorial technical departments concerned, and on the other with the respective council or committee at the Colonial Office. Ultimately it will no doubt be necessary to have a hierarchy of councils and committees in East Africa, bringing a wide variety of experience to bear on the lines which research should follow. We are not starting with this, however, but are adopting the principle of not holding meetings unless there are important matters for discussion and decision. In practice, of course, many conferences and meetings have to be held, but the permanent system of advisory and executive bodies is being allowed to grow up naturally, following rather than preceding the initiation of actual research.

Certain principles apply to each of the five research organisations enumerated above, and to others which may be established. The concept of the 'Research Organisation' rather than the 'Research Institute' is important as implying that the work will pervade the whole of East Africa and not be concentrated in one building. In each case a headquarters of the organisation is being established at some convenient place, and some activities involving extensive facilities and costly apparatus will inevitably take place at headquarters. But the headquarters will be easy to get away from as well as to reach; and the object of each research organisation will be to conduct research on behalf of East Africa wherever it can be pursued most efficiently. This may be at a scientific centre in Great Britain or a Dominion, at the headquarters of the organisation in East Africa, at a territorial laboratory or out-station, or in a tent in the bush. Another important point is that our research organisations will be staffed by members of the new Colonial Research Service which is expected to be inaugurated in the near future. The terms of service will involve contributory pensions, so that staff will be transferable without difficulty to and from scientific centres elsewhere, particularly those which subscribe to the F.S.S.U.

Considering the five research organisations in more detail, their designation by initials seems inevitable, and in each case the subject is preceded by E.A. (East Africa) and followed by R.O. (Research Organisation). The largest is E.A.A.F.R.O. (Agriculture and Forestry), which is directed by Dr. B. A. Keen, and will have also Dr. H. H. Storey, who is returning to active research in Africa after valuable work as secretary for agricultural research at the Colonial Office. This organisation, which will absorb the existing staff and facilities at Amani, is intended to grow during five years to more than forty qualified men of science and a similar number of other European staff. Its main divisions will be concerned with soils, fertilizers, crops and pastures, pests and diseases, animal husbandry, sylviculture and forest products. A new headquarters is to be established at a convenient site in a healthy climate some fifteen miles from Nairobi, where a thousand acres of good land have been made available for the purpose by the Kenya Government. In addition, it is intended to have outstations distributed through East Africa, ultimately one in each main ecological zone, using where possible the existing agricultural and forestry experimental stations of the territorial departments. One section, concerned with taxonomic botany, will have special duties associated with the Royal Botanic Gardens at Kew in helping to prepare a much-needed Flora of East Africa, and the main herbarium will be established at the Coryndon Museum in Nairobi, where it will be easy for reference. For the initial capital expenditure on E.A.A.F.R.O., some £280,000 are being made available from Colonial Development and Welfare Research funds, and the aggregate recurrent expenditure for the first five years is estimated at £297,000, of which £165,000 is likewise to come from Colonial Development and Welfare Research funds, the balance being subscribed by the East African Governments.

Next in the list is E.A.V.R.O. (Veterinary), directed by Dr. E. G. White. In staff this will grow to about half the size of E.A.A.F.R.O. It is concerned with all aspects of animal disease, animal health and husbandry, and the production of biological products, which is already a service extending through a good part of the African continent and elsewhere. A part of E.A.V.R.O. concerned with disease is developing from the former Central Veterinary Research Institute and will continue to be located at Kabete, near Nairobi, where additional buildings are being erected. A new part, concerned with animal husbandry, will have headquarters side by side with those of E.A.A.F.R.O., seven miles from Kabete. Capital expenditure on this organisation is expected to be £125,000 provided from Colonial Development and Welfare Research funds, and recurrent expenditure for the first five years about £399,000, £94,000 coming from Colonial Development and Welfare Research funds, £80,000 from the East African Governments and the balance from the sale of biological products.

E.A.T.T.R.O. (Tsetse and Trypanosomiasis) is at present in two sections. Tsetse research is based at Shinyanga in Tanganyika, in charge of Mr. W. H. Potts, with a staff of ten scientific workers and a similar number of other Europeans; human trypanosomiasis research is some thirty-five miles away Tat inde in charge of Dr. H. Fairbairn, with three men of science. Expenditure for the next five years is estimated at £218,000, of which two-thirds is voted from Colonial Development and Welfare Research funds and the balance provided by the East African Governments. These two centres have been in existence for many years, and some reorganisation is expected, including the binding together of the tsetse and trypanosomiasis research with the separate department of Experimental Tsetse Reclamation, which is in charge of Mr. Napier Bax.

E.A.F.R.O. (Fisheries) is at present quite small, dealing only with research on lakes and rivers. Its director is Mr. R. S. A. Beauchamp, who will have four or five scientific workers on his staff, and the headquarters are at Jinja in Uganda, at the point where the Nile originates from Lake Victoria. Capital expenditure of £64,000 and recurrent expenditure for five years of £51,000 are provided in whole from Colonial Development and Welfare Research funds. It is hoped that a fisheries research unit will soon be added for the marine waters of East Africa, and there is also recently established in Kenya a small station on the slopes of Mt. Kenya for investigating the special problems of streams and trout fisheries.

E.A.S.I.R.O. (Scientific and Industrial) will, it is hoped, be one of the most important of the research organisations, its subjects including buildings, roads, secondary industries, food processing and water pollution. Only a part of it yet exists, the East Africa Industrial Research Laboratory, situated in Nairobi, in charge of Mr. H. B. Stent. This organisation is intended ultimately to form a kind of local counterpart of the Department of Scientific and Industrial Research in Great Britain. Clearly, it will not be able to undertake extensive researches of a fundamental character except in special cases which demand proximity to local conditions. Wherever possible, problems arising in East Africa would be passed on to larger centres of research such as those established in Britain by the Department of Scientific and Industrial Research.

There are many scientific subjects of importance to Colonial development which are not covered by these research organisations. To mention a few: meteorology is looked after by the East African Meteorological Department, which includes research in its purview wherever it can be fitted in with the regular activities of recording and disseminating information. Hydrology is another subject of basic importance, and the beginnings of its study on a regional basis exist in a newly established hydrological survey of the Nile Basin within East Africa, necessary in connexion with the project for converting Lake Victoria into the largest reservoir in the world. Geology is still a function of territorial departments which, however, are coming into closer line with each other, aided by annual conferences which have been inaugurated in 1948. The same applies to work on the fauna, for which again annual meetings between game wardens have been started. There is much research progressing on insecticides with particular reference to their use against tsetse flies, this being the responsibility of the Colonial Insecticides Committee in London, which maintains a research unit in East Africa and is initiating a series of trials with aircraft in 1948. The problem of locusts is another subject on which research in East Africa is part of a wider service, in this case international in character. Archæology, in which East Africa has outstanding wealth, still awaits more extensive and more permanent facilities. Finally, there is great need for research on economics and statistics, and the East African Statistical Office, which, like the research organisations, is responsible to the East Africa High Commission, is already in existence and likely to expand.

SCIENTIFIC ASPECTS OF COLONIAL DEVELOPMENT

THE president of the British Association for the Advancement of Science, Sir Henry Tizard, referred in his inaugural address at the Brighton meeting to "our bounden duty, and the only certain way of safeguarding our future so long as we remain a large food-importing country, to develop our Colonial territories, particularly the under-populated African colonies, where the increase in population that would follow the control of disease and the increase of food supply would open fresh markets for international trade". The president of Section E (Geography) of the Association, Lord Rennell of Rodd, speaking of "Geography as a Social Science, with special reference to Africa", said, "For our own good name, the social geographer must be called on to play his very large part in adapting our changing conceptions of African administration, and in seeking to rationalize the mess which western European nations, including we ourselves, have made in the African continent". His address was followed by a discussion in Section E on the scientific aspects of colonial development, to which a number of the younger geographers, several with experience of work and conditions in the Colonies, contributed. While recognizing that geography is only one of many sciences which could be, and must be, applied to the problems of the Colonies, the geographers were all agreed that their subject has a very definite and distinctive contribution, though one which has not hitherto been given adequate recognition by those in authority.

As to the nature of the contribution, there was considerable discussion. Some believed in the existence of a 'colonial geography', recognized, according to one speaker, by the governments and universities of all the Colonial Powers, except Great Britain, and particularly by France and the Netherlands: but a majority emphasized that colonial territories call for precisely the same type of geographical investigation as any other part of the world, and that the geographer's particular task is the study of the regional characteristics of different areas. Such a study requires the correlation of numerous branches of science, ranging from geology to social anthropology. One speaker recommended the formation of a single colonial institute, forming a part of one of the Universities of Oxford, Cambridge or London, which would not only be responsible for the training of administrative and technical officers for the Colonies but also would undertake, or be cognizant of, colonial research in most, if not all, branches of knowledge. In an institute of this type, the geographer, with his interest in widely different aspects of environment and society, would have an important role. Another speaker suggested that insufficient use is made at present of the very considerable geographical knowledge of officials and others who have lived for long periods in the Colonies.

Lord Rennell described geography as "both the science and the art which deals with mankind on the earth on which we live". It studies in particular the interaction of physical facts on one hand, and economic, social and political conditions on the other. The influence of physical environment upon human activity is generally most noticeable among more backward people—though even here there is no such thing as 'environmental control'; and it is, therefore, particularly appropriate that geographers should concern themselves with tropical regions. Increasingly it is being recognized that the economic development of the tropics cannot come about except by the conquest of disease, the raising of standards of living, and the institution of comprehensive programmes of drainage and irrigation, road-building and port development. The blind belief in the inherent fertility of the tropics has at long last disappeared: and projects like the groundnut scheme in East Africa can succeed only after the most careful study of the facts of geology and topography, temperature and rainfall, natural vegetation and soil types. These facts are rightly studied by specialists—by geologists, meteorologists, plant ecologists, soil scientists, and the like. Too often, though, the interactions of these facts are inadequately considered, since they lie in the province of no particular specialist: and it is here that the geographer believes that he has a place in the scientific hierarchy, since by the nature of his training he is specially equipped to look out for interconnexions. He is not content with the facts of either geology or meteorology or botany, taken by themselves, in any particular area. He wants the complete picture—made up of physical conditions and human responses—or, as he puts it, the 'regional geography'.

The work of many of the economic and other missions to British Colonies in recent years would have been greatly facilitated if less time could have been spent in fact-finding, and more attention paid to the elaboration of concrete development programmes. Had the regional geography of British Colonies been studied as fully as that of, say, France —or even as inadequately as that of Great Britain itself—these missions would have had at least a basis on which to build. As it is, the regional geography of the Colonial Empire remains unwritten, apart from the isolated work of pioneers such as Clement Gillman in Tanganyika Territory. In this connexion the new colonial universities and colleges have an important contribution to make to our geographical knowledge of the world.

More than one speaker stressed the need for a colonial atlas, in the preparation of which geographers would take a prominent role: such an atlas would include distribution as well as topographical maps. The French and Dutch colonial atlases were quoted as excellent examples, and reference made to the successful efforts of Section E of the British Association in pushing forward the preparation of a National Atlas for Great Britain. It was suggested that as a first stage, maps might be prepared for groups of British territories, full use being made of the technique of mapping from air photographs and of the resources of the Directorate of Colonial Surveys.

Lord Rennell concluded by stating that facilities are now available for geographers to an extent never known before, and that the Colonial Office has recently asked specifically for trained geographers for research investigations in the Colonies. It is now open to geographers to make as effective a contribution to the study of the problems of colonial development as they have made at home, through the Land Utilisation Survey and in other ways, to the problems of agriculture and of town and country planning. Their fellow-scientists will judge the validity of the geographers' claim by the quality of their work in the colonial field and by the distinctiveness of their contribution.

NATURE OF INCENTIVES

As might have been expected, the discussion of 'incentives' in the meeting at Brighton of Section J (Psychology) of the British Association afforded yet another opportunity for attempting to define the nature and extent of the responsibility of scientific workers for industrial efficiency. From various points of view, industry was challenged to try out new techniques and policies of management, and men of science were challenged to develop new concepts and procedures in the organisation of research.

Mr. Nigel Balchin, who opened the symposium, expanded his now well-known thesis that under present social conditions the traditional incentive of financial rewards has broken down, and that in future industry must rely upon entirely different motives for the maintenance of optimum effort. "If we have," he said, "on one hand a perfectly reasonable demand for a high material standard of life, which can only be supplied by productive effort, and on the other an equally reasonable demand for happiness in activity, the only possible solution is *to make work the happy activity*." Since we do not yet know how this is to be done, the first responsibility of the man of science is to engage in research into basic principles. Psychologists should stop 'trying to run other peoples factories' and concentrate on research into general principles.

The main themes of the second paper (that of the present writer) were in more than one way complementary to those of Mr. Balchin. There is, of course, much that we do not know; but, it was argued, there is also much that we know well enough but do not act upon. Research in this field, the results of which would be applicable, cannot be conducted entirely outside the factory but depends on close collaboration between scientific workers with more than a superficial knowledge of industrial administration and managers with more than a superficial knowledge of scientific method. One field in which such collaboration would be especially fruitful, both in the application of existing knowledge and in the promotion of fresh research, is that of 'target setting' both on a national scale and in the detailed procedures of time and method study. Evidence of the ripeness of this particular harvest could be adduced from recent trends of thought in scientifically minded exponents of time-study procedures and from the increasingly open-minded and experimental mood of industry itself in this regard. *Target*, the monthly bulletin of production publicity of the Central Office of Information, is full of reports of new incentive experiments, the results of which should be well worth scientific observation and assessment.

Following up a point first made by Mr. Alec Rodger in the conference at Leamington of the Division for the Social and International Relations of Science of the British Association, it was further suggested that among the preconditions of the effective application of existing technical knowledge is the application of existing knowledge of another kind—of principles governing human relations in industry, on which there is a surprising unanimity of opinion among moral philosophers, political reformers and religious teachers of every school, party and sect. For example, the often quoted precept of Immanuel Kant that "every man should be treated as an end and not merely as a means" is one that in principle admits of translation into scientific terms and into terms of industrial practice. So translated, it might be worth submitting to tests acceptable to the statistician and methodologist as theoretically sound, and acceptable to management as workable in practice.

An even more fundamental challenge to science and management would seem to have been implied by the argument of the third contributor to the symposium. According to Mr. Adam Curle, who approached the subject from the point of view of an anthropologist, the very existence of an incentives problem is symptomatic of a malady in modern society. In primitive societies necessary work is as automatic as eating or sex ; and our present problem is nothing less than that of recreating these conditions. This, of course, is not to be achieved by a mere regression to the original order. The need is for a new social order "in which the anxious tensions resulting in withdrawal and isolation from the group can be reduced". We need to provide the conditions of a 'psychological' as well as those of a constitutional democracy. Then the incentives problem would again disappear. Nothing very specific was suggested as to the way in which this might be done; but it would depend on close collaboration between social scientists of many different kinds. The results obtained in army resettlement units, it was suggested, gives some indication of the lines along which to work.

Mr. Alec Rodger, through what at first appeared to be an excursion into lexicography, raised an issue of the greatest moment. The term 'incentive', he pointed out, is commonly used by industrialists and defined in dictionaries by reference to incitements that are essentially passing rather than permanent in effect. On the other hand, the preceding speakers had appeared to be almost exclusively concerned with the conditions that continuously maintain an optimum level of effort throughout the working weeks and years. "Admittedly we need long-term programmes for the improvement of morale, for in the long run this is the only manner in which high industrial productivity is likely to be properly established and sustained ; but in our present plight we cannot disdain to use any device which shows promise of yielding quick results." An example of the sort of research which was needed was quoted from some studies of the Social Survey which had given indications that different types of motivation operate at different intelligence levels.

Speaking with intimate and first-hand experience, Mr. Rodger had things to say on the functions of the psychologist in relation to management and administration. The root of the problem, he suggested, lies in the fact that the technical adviser will often miss the opportunity both to understand the principles on which his colleagues work and of dealing with critical situations unless at the decisive moment he is prepared to do the job himself, since he can act with insight and confidence when they cannot.

The discussion as a whole, however inconclusive and however limited in suggestions likely to yield 'quick results' it may have seemed, served a useful purpose in revealing something of the total dimensions of the problem. There is clearly, and by general agreement, a need for expansion and intensification of research and development in which a due balance is preserved between the advance of knowledge and the application of what is already known. There is need for advances both in fundamental research and in the development of practical techniques. It is probably through the development of managerial techniques for using what is already known that the 'quick results' are most likely to be obtained. But it is here, more than anywhere else, that Mr. Rodger's distinction needs to be kept in mind. There is a widespread view among industrial psychologists that the benefits derived from temporary incitements are often paid for dearly through their subsequent effects in fatigue and reaction. If they be correct in this opinion, the use of such expedients can be defended only in an emergency the passing nature of which can be predicted with some assurance. Here, as elsewhere, the best results are likely to be achieved by those who combine a sense of the need for quick results with the wider and the longer view. Perhaps this combination is not to be found in any single scientific or managerial group ; and the need will only be met by the kinds of collaboration concerning which all the speakers were agreed. It is accordingly somewhat sobering to reflect that in spite of the widespread interest in the problem, the number of workers actually engaged in relevant research at this time is extremely small.

C. A. MACE

TRANSMISSION OF EFFECTS FROM THE ENDINGS OF NERVE FIBRES

A DISCUSSION on the transmission of effects from the ends of nerve fibres occupied an afternoon session of Section I (Physiology) of the British Association on September 9. Sir Henry Dale introduced the discussion by saying that we may agree on the assumption that the liberation of one or another chemical substance with a specific stimulating action is the means by which, in vertebrates, nerve impulses are transmitted from the endings of all efferent fibres of the peripheral nervous system, whether pre- or post-ganglionic fibres of the involuntary nerves, or motor fibres of the voluntary nerves. But there remains a wealth of problems still open to discussion concerning details of such a process.

Since two of the speakers were dealing with the extension of this theory to the vast complex of synaptic junctions in the central nervous system, Sir Henry Dale first discussed this problem. The exciting possibilities presented by studies in this field, he said, have acted as both a stimulus and a deterrent. When, more than twenty years ago, he told Sir Charles Sherrington, then already in retirement, about the evidence that had been obtained at that time in his laboratory for the transmitter function of acetylcholine at preganglionic and voluntary motor nerve endings, Sir Charles' immediate reaction was to insist that a process observed at peripheral synapses must furnish some kind of analogy for events at those of the central nervous system. Referring to the experimental attempt of Dr. W. Feldberg to distinguish central synapses at which transmission may be cholinergic from others at which it is not, Sir Henry Dale said that such a differentiation raises the question as to what the transmitter may be at these others. For it is difficult to suppose that synapses in the central nervous system can differ among themselves so fundamentally in function that transmission at some should be cholinergic and at others involve no kind of chemical agent. Referring to the experiments of Mr. J. W. S. Pringle and Mr. G. M. Hughes, by which the discussion is extended to the nerve ganglia of the ventral chain in an insect, he again pointed out that we should scarcely expect to find that the transmission across synaptic junctions in an insect's ganglion would involve a process fundamentally different in kind from that which is effective at vertebrate synapses.

Turning to the recent developments of evidence for the nature of the transmitter substances themselves in the peripheral vertebrate system, Sir Henry Dale discussed several outstanding and very acute problems in this field of research. For cholinergic transmission the released agent is acetylcholine itself, but there has never been the same certainty with regard to the transmitter of adrenergic fibres, adrenaline. "This problem has recently acquired a new aspect through the evidence produced by U. von Euler, that the sympathomimetic agent extractable from sympathetic nerves or from the spleen, appears, indeed, to be chiefly *nor*-adrenaline rather than adrenaline, and Gaddum's finding that the substance released in the spleen when its adrenergic nerve is stimulated is likewise, for the most part, the primary amine. One is tempted to speculate whether a renewed investigation of the suprarenal gland might not reveal *nor*-adrenaline as a constituent of its medulla as well as its long known N-methylated homologue, adrenaline." We should further keep in mind that the list of the transmitters, even at the peripheral cytoneural junctions, should not yet be regarded as finally restricted to the two concerned with the recognized cholinergic and adrenergic processes of transmission. Histamine may have to be considered as contributing, at least, to the so-called antidromic vasodilator effect, a possibility envisaged by Lewis and his co-workers and supported by evidence from Ungar and others.

The next problem taken up concerned the presence of the transmitter substances and the relevant enzymes for their synthesis and destruction along the whole course of a nerve fibre. According to Sir Henry Dale, it does not seem possible to accept the suggestion so vigorously urged in recent years by Dr. Nachmansohn and his associates. According to these speculations, acetylcholine would not only be responsible for the transmission from nerve ending to a secondary neuron or an effector cell, but also for the propagated nerve impulse along the nerve fibre. "Such a conception offers, of course, the kind of intellectual satisfaction which many minds obtain from a simplifying and co-ordinating generalization. There is, however, a remarkable lack of unequivocal evidence to support it directly, while the ingenuity of its supporters is sorely taxed to discover even plausible ways of escape from the facts which contradict it." Only some nerve fibres are cholinergic. The theory postulates a stimulating depolarizing action of acetylcholine on the nerve fibres. But as Lorenté de Nó has shown recently, the nerve fibre in continuity is as indifferent to acetylcholine-chloride, even in isotonic solution, as to cane sugar, provided only sufficient physostigmine, or other anti-cholinesterase, is added, to prevent the esterase in the nerve from hydrolysing the acetylcholine, and thus liberating acetic acid ions from it in a harmful concentration. We may, however, have to consider the possibility, put forward with all reserve by Sir Henry Dale, that the transmitter which we find distributed along the fibres represents a kind of reserve needed for the regular and immediate replenishment of the depots at the endings, and that the passage of impulses along the fibres to their endings would somehow facilitate a drift of the transmitter down them in the same direction.

The last problem dealt with by Sir Henry Dale concerned the presence or absence of the transmitter substances, not along the nerve fibres, but in the protoplasma or neurosoma of the nerve cells themselves from which the axons in question originate.

Prof. F. R. Miller, of the University of Western Ontario, then described his discovery of the central stimulating actions of acetylcholine and eserine, effects which are consistent with the suggestion, made so early as 1934 by Sir Henry Dale, that acetylcholine may be concerned in the transmission at central synapses. Even in the experiments with eserine, acetylcholine is probably the actual stimulating agent, because the central actions of eserine, like its peripheral ones, are also probably more or less fully accounted for by its power of inhibiting cholinesterase, the enzyme which destroys acetylcholine, thus leading to its accumulation at the synapses.

The technique adopted by Prof. Miller in these experiments consisted in soaking small pieces of filter paper in a solution of acetylcholine or eserine and applying them to the cerebral cortex of cats and rabbits. Eserine applied in this way to the centres for the fore- or hind-limbs evoked within a few seconds motor effects of rapidly increasing intensity in the corresponding limb of the opposite side. The cortical electrogram was modified. The normal large slow waves were replaced by small fast waves suggesting an asynchronous firing of cortical neurons. Acetylcholine similarly applied to a previously eserinized cortex induced large 10 per second spikes in the cortical electrogram, together with motor effects in the muscle units, as shown with the cathode ray oscillograph by Miller, Stavraky, Woonton, Wilkey and Luke. According to Miller, each 'acetylcholine spike' suggests a synchronous firing of a number of cortical neurons under the influence of "cells with short axons", each of which controls a number of pyramidal cells.

Particularly striking were more recent experiments in which Prof. Miller applied dilute solutions of acetylcholine, with the same technique, to the floor of the fourth ventricle. These experiments were performed on decerebrate cats which had received an injection of eserine. The local application of acetylcholine stimulated the inspiratory centre, and later on caused convulsive discharges from the hypoglossus nucleus, shown by powerful retractions of the tongue. These effects, like the comparable stimulating actions of acetylcholine on the spinal cord, described by Bülbring and Burn, were abolished by atropine.

Dr. W. Feldberg remarked that he approached the problem of central synaptic transmission by acetylcholine in a different way. Miss M. Vogt and he studied the synthesis of acetylcholine in various relatively small but well-defined areas of the brain and medulla. An analysis of the distribution of the enzyme system responsible for the synthesis of acetylcholine in the central nervous system led them to the conclusion that acetylcholine is not the universal central synaptic transmitter, and that often, although by no means always, the arrangement of neurons in the afferent and efferent nervous pathways is such that cholinergic and non-cholinergic neurons alternate with each other. For example, in the voluntary motor pathway, the finding of a high enzyme concentration in the anterior horns, the motor nuclei of the cranial nerves and the anterior roots suggests the cholinergic nature of the lower motor neuron. On the other hand, the low values encountered in the pyramidal tracts indicate that the upper motor neuron is not cholinergic. In the motor area of the cerebral cortex an intermediate value was found. This might suggest that cholinergic neurons converge on the pyramidal cells. Similarly, the low values found for the posterior roots and their central continuation, the funiculi gracilis and cuneatus, are in agreement with the conception that the first neuron of the afferent sensory pathway is non-cholinergic. However, the relatively high values obtained for the nuclear masses in which these sensory fibres end might be evidence for the cholinergic nature of the second neuron in the sensory pathway.

The third neuron, originating in the thalamus and leading to the cortex, is probably non-cholinergic, as suggested by the low values found for the fibres in the posterior parts of the internal capsule, which at least in man is said to contain the thalamic radiation. Another example was provided by the optic pathway. The retina contains large amounts of the enzyme which synthesizes acetylcholine, whereas the optic nerve is practically free from it. This suggests that acetylcholine is the chemical transmitter at one or more of the synaptic junctions in the retina. Among these junctions may be that to the ganglionic layer from which the non-cholinergic optic nerve originates. The optic fibres end mainly in the lateral geniculate body, and the high enzyme values found for this region may indicate a cholinergic nature of the third neuron in this pathway. Dr. Feldberg stressed the fact that, however attractive such a pattern of a succession of alternating non-cholinergic and cholinergic neurons may be, it would be dangerous to have a conception which is too simplified and diagrammatic. We must realize that if there are two different kinds of neurons in the central nervous system, then on purely statistical grounds there should be a great incidence of such an alternation.

The great number of problems involved in the process of central synaptic transmission and their complexity were brought to light by beautiful experiments on cockroaches reported by Mr. J. W. S. Pringle and Mr. G. M. Hughes. They had passed weak polarizing currents laterally through the metathoracic ganglion of the cockroach. This affected the flexor-extensor balance in such a way that the leg on the negative side flexed while that on the positive side extended. With longitudinal stimulation, ascending currents flexed the legs on both sides of the cockroach and descending currents encouraged extension. It is interesting that Skoglund had observed similar reaction patterns in corresponding experiments on cats. Mr. Pringle and Mr. Hughes suggest that the weak polarizing current excites internuncial fibres and not the motoneurons, because preparations in which only a single nerve was left attached to the ganglion did not show this differential effect when the polarizing current was applied between ganglion and nerve. In these preparations the negative electrode on the ganglion excited, and the positive inhibited, any resting discharge in the larger motor fibres, irrespective of whether the nerve supplied flexor or extensor muscles.

Concerning the problem of chemical transmission, they pointed out that the evidence available shows that the motor nerves to the muscles are not cholinergic in the Arthropoda. On the other hand, acetylcholine may well have a transmitter function at the central ganglionic synapses, because its application to these ganglia causes a discharge of impulses in the motor nerve fibres. It is further possible that the differential effect of polarizing current is due to the fact that in Arthropoda, as in other organisms, two types of transmitter substances are involved in central synaptic transmission.

At the end of the meeting, Prof. R. J. S. McDowall showed a few slides from his recent experiments on the rat's diaphragm preparation, in which he had obtained a curare-like block of neuromuscular transmission as an effect of lack of glucose.

OBITUARIES

Dr. William Cullen

By the death, at the age of eighty-one, of Dr. William Cullen, a prominent figure and a vivid personality has been lost to a wide circle of men actively engaged in the varied pursuits which are related directly and indirectly to chemical technology, to metalliferous mining and to metallurgy.

It would be difficult to enumerate the manifold activities with which his name has been identified over the past fifty years; but these are happily recorded, for the most part, in the numerous papers and addresses which he had contributed to the various scientific and technical bodies with which he was associated. His earlier work was published under the auspices of the Chemical, Metallurgical and Mining Society of South Africa, of which he became president in 1905. In later years, the *Transactions of the Institution of Mining and Metallurgy, the Institution of Chemical Engineers* and *the Society of Chemical Industry* have been enriched by his contributions. By each of these bodies in turn he was elected to the presidential chair.

Dr. Cullen's life-work can be divided into two periods. The first was that of his earlier work in South Africa, commencing with his appointment, in the later stages of the 1899–1902 War, as general works manager, at Modderfontein, of the British South African Explosives Co. While retaining his close association with South African affairs to the end, particularly in regard to educational matters, the second period of his career dates from the time of his return to Great Britain in 1915, when, in association with the late K. B. Quinan and W. McNab, he was entrusted by Lord Moulton (then directing the Department of Explosives Supply) with the design and lay-out of new explosives factories called for by the exigencies of the First World War.

A Scotsman, reared in the hard school of the west coast and the Clydeside, Cullen received his early training in Glasgow, successively at Hutcheson's Grammar School and at what was then the Andersonian College (now the Royal Technical College). As a chemist, he became a member of the staff of Nobel's and later of Kynochs. It was this early experience of the chemistry of explosives that fitted him for the very prominent part he was destined to play in the vast developments which occurred in the mining industry in South Africa following the termination of the War of 1899–1902. The necessity had already been recognized and to some extent met, for the independence from outside supplies of industrial explosives, and it fell to Cullen's lot to promote this independence in step with the growing and pressing demands.

In these surroundings Cullen found scope for his wider interests and inherent sympathies. The admirable spirit of co-operation, and the refreshing freedom from secrecy regarding experience and knowledge of technical matters, which he found to exist among those directing the mining industry were fully in accord with an outlook which may be regarded as one of his happiest characteristics. Two matters in particular caused him grave concern. First, the appalling mortality, at that time, among those engaged in underground mining, and secondly, the widespread neglect to provide technical training for the younger members of the community. To both these problems Cullen gave unremitting thought and attention, which persisted, in one form or another, to the end of his life.

As the direct outcome of his own responsibilities, Cullen sought for more precise information regarding the nature of the gases resulting from the explosives which, at that time, were in general use underground. The previous neglect of this aspect of blasting operations was attributed by Cullen to a lack of contact between the manufacturers and the users of explosives, but "there," he said in one of his addresses, "we lived next door to each other." The results of the investigations, with relatively crude appliances and despite the serious hazards which close sampling involved, shocked them all. Ready, as he always was, to face up to unpalatable facts, he pursued these investigations in collaboration with his colleagues, T. Donaldson, E. Weiskopf and W. Waters. Discussions, following the publication of their results, lasted many months. Public conscience was aroused, and the Government took note. A commission was appointed (at which Cullen was an important witness) and the matter was followed by further work.

Although these inquiries did not attempt to go to the root causes of silicosis, as subsequent work has done, they, nevertheless, did much towards eliminating the hazards of poisoning from carbon monoxide and the oxides of nitrogen by establishing on a firm basis the need of an 'oxygen balance' in regard to all explosives used underground. Cognizance of this important requirement was taken all over the world. At the same time, Cullen was not unmindful of the unsolved problems of ventilation in mines; and the stimulus thus given to the need for greater attention to this matter has helped towards the immense advances which have now been made in this direction.

In regard to education and training, both in South Africa and in Great Britain, Cullen lived to see many of his cherished hopes and aspirations realized. As a member of the original Transvaal Council of Education and as an active participant in the work of the Transvaal Technical Institute, he helped to pave the way for the foundation of the University of the Witwatersrand. Recognition of these services was made in 1925, when the University conferred upon him the honorary degree of LL.D. He continued to represent the interests of the University in Great Britain. Of many ways in which he sought to promote its welfare, perhaps the outstanding service was the part he played, under the chairmanship of the Earl of Athlone, in making good, so far as possible, the losses sustained by the Library of the University as the result of the disastrous fire on Christmas Eve of 1931.

In addition to his unremitting services on the councils of those institutions and technical bodies over which he had in turn presided and of which he was later elected to honorary membership, he was an indefatigable lecturer and speaker on matters which came within his wide experience. As recently as 1944 he was called upon to preside over the deliberations of the Science Masters' Association.

Such were the activities of a man of far-seeing vision and buoyant disposition with a unique experience of men and affairs, one who has left a mark on generations of chemical technologists, mining engineers and metallurgists, and one to whom they could look with confidence at all times for guidance, encouragement and enduring friendship.

S. W. SMITH

Sir Thomas Crozier

MAJOR SIR THOMAS HENRY CROZIER, formerly His Majesty's Chief Inspector of Explosives at the Home Office, died at Folkestone on September 26 at the age of eighty. Born at Monkstown, County Dublin, on February 26, 1868, he was educated at the United Services College, Westward Ho, and the Royal Military Academy, Woolwich, and was gazetted to the Royal Artillery in 1888. He held the posts of chief instructor in ammunition and explosives at the Ordnance College and afterwards chief instructor in artillery at the Royal Military Academy. He retired from the Army on April 17, 1908, when he was appointed one of His Majesty's inspectors of explosives at the Home Office.

On October 5, 1914, he rejoined the Army and served in "A" Battery of the 58th Brigade, Royal Field Artillery, 11th Division, Mediterranean Expeditionary Force. He was eventually invalided, and on recovery and after urgent representations by the Home Office owing to the greatly increased pressure of work, he rejoined the Explosives Department of the Home Office in October 1915. On February 12, 1926, he was appointed His Majesty's chief inspector of explosives. His work was rewarded on June 3, 1930, by the conferment of a knighthood. He retired on March 30, 1931.

During Sir Thomas's term of office in the Explosives Department, low-freezing explosives were introduced into general use in Great Britain, and the Petroleum Act, 1926, and the Petroleum (Consolidation) Act, 1928, were passed. Regulations were made for the conveyance by road of petroleum spirit, carbon disulphide and for the 'permanent' gases compressed in a metal cylinder. He was associated with a number of committees dealing with petroleum, dissolved acetylene, fire extinguishers, permitted explosives, classification of explosives used by the Fighting Services, carriage of dangerous goods in ships, welded containers, and cylinders for permanent and liquefiable gases. During the years 1927 and 1928, in conjunction with the late Prof. J. S. S. Brame, he carried out, on behalf of the Minister of Transport, a public inquiry into the modifications of the petroleum spirit by-laws proposed to be made by the Port of London Authority.

During the Second World War, the work of the Explosives Department increased considerably and, in consequence, Sir Thomas Crozier was asked to rejoin the Department, which he did on June 1, 1940. He relinquished this temporary appointment on September 30, 1944, owing to ill-health.

NEWS and VIEWS

Prof. F. E. Fritsch, F.R.S.

After forty-one years as head of his Department, Prof. F. E. Fritsch retired from the chair of botany, Queen Mary College, London, on September 30, in his seventieth year. Though scarcely expected in boyhood to live to twenty, his already long and remarkable career has been an arduous one, its keynote continuous application sustained by a powerful sense of the absolute value of knowledge and work. In 1905, during his first appointment as assistant professor (1902–10) at University College, London, he obtained his D.Sc. (London), started a year's additional work at Birkbeck College and completed with Boodle the well-known translation of Solereder's "Systematic Anatomy". In 1907, when Queen Mary College (then East London College) was first recognized as a school of the University of London, he was appointed to take sole charge of the newly initiated Botany Department, becoming in 1910 its full-time professor with one assistant. His eight years collaboration with Salisbury from 1912 onwards resulted in the five familiar and ubiquitous joint text-books, and were shortly followed by his appointment to the University chair. His large and continuous output of contributions to algal and other botanical literature, even including the re-writing of West's "British Freshwater Algæ" which appeared revised in 1927 and the production of his largest work, "The Structure and Reproduction of the Algæ" (2 volumes, 1935 and 1945), though testifying to his unremitting industry, betray only a fraction of the activities he found possible concurrently with routine work and the steady development of his Department, which were rewarded in 1932 by election as a fellow of the Royal Society. He took an active share in the foundation in that year of the British Freshwater Biological Station at Wray Castle, on the Council of which he has acted as chairman ever since. His gift for diplomatic organisation and management has rendered him invaluable on numerous committees, including the Library, Scholarships and Central Research Fund Committees of the University of London.

To Prof. Fritsch himself this milestone of retirement will make comparatively little difference. Mentally vigorous as ever and still looking forward, he will continue to act on all these Committees in London, and by the courtesy of Prof. F. T. Brooks and his successor, Prof. G. E. Briggs, he is being enabled to continue his algal work in highly congenial surroundings at the Botany School, Cambridge. His friendly personality, equable disposition and philosophic outlook have ever made him an entirely congenial colleague. With his retirement Queen Mary College loses its longest servant, and the whole staff will miss the cheerful presence of an esteemed personal friend.

Wave-lengths for Broadcasting

Following the meeting held by the International Telecommunications Union in Atlantic City in 1947 (see *Nature*, May 29, 1948, p. 863), a series of subsidiary conferences is being held in various parts of the world to deal with the allocation of radio wave-lengths for various purposes. According to *The Times*, a three-months conference in Copenhagen has just reached agreement on a new plan for the distribution of the long and medium wave-bands for European broadcasting stations. The new convention, which has been signed by twenty-five countries, will come into effect in March 1950, and will mean that many of the B.B.C.'s transmitters will have to change their operating frequencies. The allocation of short waves for sound broadcasting purposes will be decided by a conference which is to meet at Mexico City on October 22.

The last effective plan for the allocation of broadcasting wave-lengths to the European countries was made at Lucerne in 1933 (see *Nature*, December 2, 1933, p. 848, and January 20, 1934, p. 94); since then, the claims of some countries, particularly those which were less technically advanced at that time, have greatly increased. But the number of wave-length channels available has not increased, and so agreement on a new allocation has only been possible by some nations accepting less than their full requirements. The Lucerne plan gave the United Kingdom one long and ten medium wave-lengths; but in order to carry on its services, the B.B.C. has taken into use another long and two additional medium wave-lengths, which had been allocated to other countries. The new Copenhagen plan gives the United Kingdom one long and thirteen medium wave-lengths, and in some cases increased power may be used. These are considered to be sufficient for the B.B.C. programmes to be carried on substantially as they are at present.

German Scientific Text-books

Dr. Julian Huxley writes: "Students of biological evolution will, I think, be interested to hear something about the new book by Dr. Bernhard Rensch, 'Neure Probleme der Abstammungslehre', published by Ferdinand Enke Verlag, Stuttgart, 1947, which I have recently received and read. It appears to me to be a most valuable work, which treats of the method, and especially the course, of evolution, in a comprehensive way. Its most original feature is the number of tables it contains, giving quantitative expression to various rules of evolution. It is also interesting in that the author, though working in complete isolation during the War, has arrived at conclusions in general similar to those reached by American and British specialists in the subject during the same period.

"It may be also useful to set forth the methods by which this, and other German books, may now be obtained. Anyone wishing to purchase books published in Germany may do so by placing his order through any bookseller, who may then apply directly to the publisher in Germany. The transaction is administered through the Joint Export and Import Agency of Military Government and payment can be made in the currency of the country in which the original order is placed. The delay in obtaining the book may be a matter of some weeks, or, of course, considerably longer if the publisher has not previously obtained a licence for export from the Joint Export and Import Agency. However, many publishers who foresee a demand outside Germany for a particular book will have obtained the required licence soon after the appearance of the book in Germany."

Chemical Names, Formulæ and Ciphers

The system of notation of organic chemical compounds described by Dr. G. M. Dyson has quickly been followed by a second, and those who missed the original lecture in Birmingham last October will now be able to study at leisure what Messrs. Gordon, Kendall and Davison describe as a universal notation covering inorganic and organic chemistry and the chemistry of ions, free radicals and transition complexes ("Chemical Ciphering." Pp. 46. London: Royal Institute of Chemistry. 4s. net). The claims are thus even larger than those of Dr. Dyson, and a logical proof of the validity of the ciphering is appended, given the definition of a chemical species as a set of atoms individually stated, in which given pairs of these atoms are linked together by directed bonds and the net charge of the set, and of any discrete ions contained in it, are specified. The authors claim, moreover, that the system is expressed in the language of "basic chemistry", and in accord with modern trends in the theory of molecular structure. Whether the system can be mastered by a chemist in about an hour, as they also claim, is at least doubtful; and if they under-estimate the intellectual effort required to comprehend and apply their system, they have probably also under-estimated the willingness of chemists as a body to make such an effort.

That factor has to be weighed against whatever advantages a cipher notation can offer. The crucial question is the reality of those advantages. Is there, for example, any real hope that mechanical methods, such as punched cards, will be sufficiently widely used to justify the considerable financial investment involved. If universal use is probable, what are the real advantages of an entirely new cipher notation over some extension of the Richter - Stelzner formula system, for such purposes? So far as systematics are concerned, what in economic terms are the advantages gained by a new system over the thoroughgoing application, for example, of the International Rules? A large part of the confusion and ambiguity in organic chemical nomenclature is due to the failure to apply those rules systematically and universally, and the very conservatism which has prevented such a relatively simple reform does not encourage optimism about the universal acceptance of systems involving so much larger an intellectual effort as well as a break with past practice.

Nigerian Livestock Mission

The Secretary of State has sent a mission to visit West Africa to investigate the livestock industry in Nigeria and the Cameroons under British mandate, with particular reference to meat production. The Mission will also engage in discussion where necessary with the authorities of the neighbouring French territories on problems of mutual interest. The leader of the mission will be Sir Frank Ware, formerly animal husbandry commissioner to the Government of India, and the members will be Mr. Thomas Shaw, a director of Messrs. Zwanenberg-Organon, Ltd., and Mr. Gilbert Colville, who has special experience in the breeding-up of African cattle. Arrangements are being made for local officers of the veterinary, agricultural and geological departments to be attached to the mission. The mission will probably pay a further visit to West Africa in February or March to see the country and the cattle at the end of the dry season. During its first visit, the mission is spending a few days in the Gold Coast to discuss problems in connexion with the cattle industry there.

Irrationality of the General Cubic Threefold

Reference has already been made in these columns (*Nature*, March 31, 1945, p. 385) to the proof by Prof. G. Fano, formerly of Turin, of a long-conjectured and important result in algebraic geometry. It has been known for nearly a century that the plane curve with equation $f_3(x, y) = 0$, where f_3 denotes a cubic polynomial, is in general irrational, that is, its points cannot be set in one-to-one algebraic correspondence with the points of a line; in fact, its co-ordinates are expressible as elliptic functions of a single parameter. In contrast to this the general cubic surface, given by an equation $f_3(x, y, z) = 0$, is rational, and the method of representing the surface biunivocally on a plane was obtained so long ago as 1866. It was thus natural to inquire whether the general cubic threefold, given by an equation $f_3(x, y, z, t) = 0$, is rational or not; the question posed by the Italian geometers some sixty years back long resisted all attempts at solution, and hence became one of the celebrated problems of geometry. In 1942, Fano (then in his seventieth year) at last established its irrationality; from Switzerland, where he was living as an exile, he communicated the discovery to the Pontifical Academy of Sciences, and this, after various delays, has now been published with cognate researches ("Commentationes", **11**, 635; 1947). Fano's proof, though conceptually simple, involves considerable detail, and, in fact, marks the conclusion to a long chain of investigations, dating from 1907, when Fano showed that the general quartic threefold $f_4(x, y, z, t) = 0$ is irrational. It is interesting to note that the entire programme of the research was foreshadowed in a communication made to the International Mathematical Congress held at Bologna in 1928; this has now been carried out in all its details.

The Little Ringed Plover in London

In 1947 little ringed plovers (*Charadrius dubius curonicus*) bred in the London area for the fourth year in succession, and there was a remarkable increase in numbers (*British Birds*, **41**, No. 2; February, 1948). Eight nests were found, and four other broods seen. Because of the possibility that at least two pairs changed their sites after disturbance the exact number present is unknown; but there were certainly eleven and possibly fourteen pairs. Although the majority of the birds were again in Middlesex, there was an extension of range to three other counties and first breeding records were obtained for Essex (four pairs), Kent and Berkshire (one pair each). It is probable that the apparent sudden increase from four pairs in 1946 to a minimum of eleven pairs in 1947 is in part due to a lack of observation in previous years. It is curious that the known breeding range in Britain is, so far, restricted to Tring (where it bred in 1938 and 1944) and the London area (where it has bred annually since 1944). This may simply be due to lack of observation in other suitable places.

Turkish Technical Review

The first issue (dated August 1948) has appeared of the *Turkish Technical Review* (*Teknik Dergi*), a monthly periodical which is claimed to be the first independent journal of that character published in Turkey apart from those coming from State institutions. It consists of forty-eight pages of text, with introductory notes by the Turkish Minister of Transport, by Prof. Tevfik Taylan, president of the Technical University of Istanbul, and the editors. There is an article on modern military tanks, another on jet motors and gas turbines, a description (translation) of a lathe with electronic control, an article (translation) on the application of plastics in chemical apparatus and a section on textiles. In addition, there are the usual notes, abstracts of technical papers, reviews of books, notes on patents, etc., and the first page of a technical dictionary (English–Turkish–French–German). In each issue of the journal the contents page is to appear in the same four languages, and translations of any particular article will be prepared on request. The address of the new journal is: *Teknik Dergi*, Divanyolu Caddesi No. 16/3, Sultanahmet, Istanbul.

British Museum (Natural History)

THE galleries of fossil reptiles, fishes and plants in the Geological Department of the British Museum (Natural History) will be re-opened to the public on October 11. Most of the skeletons of the larger fossil animals had been dismantled and packed away in 1939, while others which could not be moved suffered damage during the War. The re-assembling and repair of all these specimens is still in progress; but the work is now sufficiently advanced to permit visitors to see once more the dinosaurs, the plesiosaurs and the ichthyosaurs. In the fossil fish gallery there is a series of dioramas of the fish-life of various geological periods from the Devonian onwards, and in Gallery VII there is a special exhibit illustrating the early history of palæontology. The rearrangement of the fossil plant gallery is not yet complete, but the student will find an adequate series of specimens exemplifying the plant life of the past.

Lighting Exhibition at the Science Museum

MANY of the exhibits in the "Darkness into Daylight" Exhibition at the Science Museum, London, which closed on October 6, were contributed by the Electric Lamp Manufacturers' Association; these have now been handed over to the Museum for incorporation in the permanent collection on illumination which is being re-modelled. The objects range from six dioramas illustrating the development of domestic lighting from medieval to modern times to a complete historical survey of the development of the fluorescent lamp. In addition, there is a working model illustrating stage lighting, many experimental and newly introduced types of lamp and several interesting demonstrations. The new illumination section of the Science Museum is being built in three sections. In the first, historical portion, the aim is to give a picture of the sequence in which lighting developed from prehistoric to modern times by a series of well-lit exhibits interspersed with a series of dioramas. The second section, most of which is in existence, illustrates by means of push-button demonstrations the principles upon which good illumination depends. The final section will be devoted to modern developments in discharge tubes and fluorescence. It is hoped to open the new section to the public early next year.

Navigation through the Ages

THE Institute of Navigation (c/o Royal Geographical Society, 1 Kensington Gore, London, S.W.7) is organising, with the Royal Geographical Society, an exhibition of "Navigation through the Ages", to be held during December 17–January 20. The exhibition will be opened by the Duke of Edinburgh, and in connexion with it there will be three meetings of the Institute: "Radio and Position", by Sir Robert Watson-Watt (December 17); "The Navigator's Story", by Prof. E. G. R. Taylor and Prof. W. M. Smart (December 20); three films on radio systems, with a commentary by R. F. Hansford (January 10).

University of London: Appointments

THE following appointments in the University of London have been announced: Prof. L. Dudley Stamp, professor of geography at the London School of Economics and Political Science since 1945, to the University chair of social geography tenable at the School; Mr. J. V. Dacie, to the University readership in hæmatology tenable at the Postgraduate Medical School of London; Dr. C. L. Foster, to the University readership in biology tenable at St. Mary's Hospital Medical School.

Irish Chemical Association

AT the annual general meeting of the Irish Chemical Association, held in Dublin on September 22, the following officers and Council for the 1948–49 session were elected: *President*, Prof. T. S. Wheeler; *Vice-President*, D. Crowley; *Hon. Secretary*, G. F. O'Sullivan; *Hon. Treasurer*, J. G. Belton; *Council*, Dr. V. C. Barry, Dr. T. G. Brady, Prof. W. Cocker, Prof. T. Dillon, W. V. Griffiths, Miss M. MacNeill, N. V. Nowlan and F. T. Riley. Prof. Wheeler will deliver his presidential address, "The Training of a Chemist", in the Department of Chemistry, Trinity College, Dublin, at 7.45 p.m. on October 20.

Announcements

DR. RICHARD E. SHOPE, of the Rockefeller Institute for Medical Research, has been appointed associate director of the Merck Institute for Therapeutic Research. Dr. Shope is an authority in the field of experimental medicine and is known for his work on the virus of swine influenza. To provide Dr. Shope with special facilities for the study of animal pathology, a new building is being constructed in Rahway, N.J., by the Merck Institute.

DR. W. C. PRICE has been appointed to the University readership in experimental physics tenable at King's College, London, as from January 1, 1949. In 1937 Dr. Price became demonstrator in physical chemistry at the University of Cambridge, and during the War he worked at the Royal Aircraft Establishment, Farnborough, and for the Ministry of Supply and Ministry of Aircraft Production. Since 1943 he has been senior spectroscopist at the I.C.I. Physical Chemistry Research Laboratory, during which time he spent a session at the University of Chicago as research associate.

THE third commemoration day lecture at the Imperial College of Science and Technology will be delivered by Prof. Herbert Dingle on October 25. The title of Prof. Dingle's lecture will be "Some Reflexions on the History of Science".

MR. LEONARD CUNDALL, senior geography master at the Henry Thornton School, London, has been appointed a lecturer in the Department of Education of the International Wool Secretariat. He will lecture on wool to schools and adult educational bodies in the north of England and Scotland. Mr. Cundall, who graduated at the University of Leeds, has been chairman of the Secondary Schools' Standing Committee of the Geographical Association and of the Committee of the Assistant Masters' Association, which produced the "Memorandum on the Teaching of Geography" including the development of the wool industry in the West Riding.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Two New British Minerals

A WHITE mineral coating joint-faces in quarries in the Northampton Ironstone (Inferior Oolite) was long ago recorded as allophane. During the six-inch geological survey of that ironstone field during 1939–44 comparable material was widely recognized, and this note is published with the concurrence of the Director of the Geological Survey and Museum.

Exceptional developments were observed at the Lodge Pit of the Irchester Ironstone Co., two miles south of Wellingborough. Here the white material is present in its usual form as a wall coating associated with limonite and gypsum; but there are also widened joints or fissures up to one foot across occupied by white mineral enclosing fragments of oxidized ironstone. The white matrix of this fissure breccia includes compact, white mineral with a conchoidal fracture and a white plastic clay-like mineral.

Preliminary optical examination by Dr. J. Phemister had suggested the presence of more than one mineral, and it was noteworthy that the plastic material rapidly loses water in air and crumbles to a white powder which on wetting does not regain its plastic character. The air-dried material is fine-grained, anisotropic, with a mean refractive index close to 1·510.

X-ray examination reveals two predominant powder patterns, one corresponding to the fully hydrated mineral with longest spacing 12·9 A.; and a second pattern, easily distinguished from the first, with a longest spacing of 9·2 A. The pattern of the fully hydrated mineral was obtained free from that of the air-dried mineral by X-ray examination of a wet sample which had been kept in contact with water and sealed in a lithium-glass capillary. A few specimens yielded the X-ray halo pattern characteristic of allophane (hydrated aluminium silicate), and halloysite was also identified.

The silica percentages recorded by Mr. C. O. Harvey in the following partial analyses, made in the Geological Survey Chemical Laboratory, of two air-dried samples (Nos. 1 and 2) probably correspond to admixture of up to 5 per cent of allophane.

Chemical analyses of the new basic aluminium sulphate, basaluminite

	1	2	Composition for calc. $2Al_2O_3.SO_3.10H_2O$
	%	%	%
SiO_2	2·4	3·6	—
SO_3	15·6	14·2	17·2
Al_2O_3	43·0	41·3	44·0
Fe_2O_3	0·3	0·2	—
P_2O_5	tr.	1·0	—
Water (by difference)	38·7	39·7	38·8

The composition of the air-dried material is close to that of the mineral felsobanyite; but powder photographs of specimens of the latter in the British Museum collections are quite different from those of the Irchester minerals. It is suggested that the air-dried mineral should be called basaluminite to distinguish it from aluminite $Al_2O_3.SO_3.9H_2O$. The water content of the fully hydrated mineral with the longest spacing 12·9 A., for which the name hydro-basaluminite is suggested, is still unknown. Specimens maintained under conditions of constant temperature and humidity approach constant weight very slowly. Hydro-basaluminite loses approximately 50 per cent by weight at 16° C. in ten days, before it reaches constant weight and yields only the powder pattern of basaluminite.

As the plastic mineral can only be preserved indefinitely in the presence of water, it may well be that if suitable precautions are taken in the collection and preservation of other clays and clay-like substances other hydro-varieties of known minerals may be discovered.

F. A. BANNISTER

Mineralogy Department,
British Museum (Natural History),
South Kensington, S.W.7.

S. E. HOLLINGWORTH

Geology Department,
University College,
London, W.C.1.

July 12.

Structure of Co_2Al_9

IN an earlier note[1] the determination of the unit cell and space-group of the phase which exists in equilibrium with the restricted solid solution of cobalt in aluminium was described. The ideal composition was shown to be represented by the formula Co_2Al_9. The space-group is $P2_1/a$, and recent work has given more accurate values of the parameters, as follows: $a = 8{\cdot}5565 \pm 0{\cdot}0005$ A., $b = 6{\cdot}290 \pm 0{\cdot}005$ A., $c = 6{\cdot}2130 \pm 0{\cdot}0005$ A., $\beta = 94{\cdot}760° \pm 0{\cdot}005°$.*

From X-ray data obtained with molybdenum $K\alpha$ radiation it has proved possible to determine the structure by Fourier methods. Patterson projections on (010) and (001) together with a Patterson–Harker three-dimensional section at $(x\frac{1}{2}z)$ gave an indication of the positions of all twenty-two atoms in the unit cell. These positions were then confirmed, and the parameters refined, by two-dimensional Fourier synthesis. Final values of the parameters are:

Atom	x	y	z	
Co	0·333	0·615	0·265	± 0·001
Al_0	0	0	0	
Al_1	0·268	0·962	0·405	
Al_2	0·231	0·290	0·089	
Al_3	0·999	0·193	0·389	
Al_4	0·042	0·615	0·216	

The structure can be described as consisting of layers of aluminium atoms lying approximately in the planes $(0yz)$, $(\frac{1}{4}yz)$, etc., with cobalt atoms lying between the planes, slightly nearer to the planes at $x = \frac{1}{4}, \frac{3}{4}$. This layer structure is related to the habit of the crystals, which grow as plates parallel to the (100) plane. Each Co has a regular array of nine nearest neighbours—four in the plane $(\frac{1}{2}yz)$, four in the plane $(\frac{1}{4}yz)$ and one in the plane $(0yz)$, say; and these polyhedra of Al atoms are arranged with shared edges and corners in the $(0$ and $\frac{1}{2}yz)$ planes, and shared edges in the $(\frac{1}{4}, \frac{3}{4}yz)$ planes. Observed values of interatomic distances lie for Co-Al within the range 2·38–2·52 A., and for Al-Al within the range 2·70–3·00 A.; the former are low compared with Pauling's predicted values[2], while the latter agree reasonably well.

An estimate of the number of electrons contained within the Co peak in the $(h0l)$ and $(hk0)$ Fourier syntheses, based on the assumption that the electron density between atoms is zero, indicates that the cobalt atom has of the order of two electrons more than its normal number of 27. This is in agreement with Raynor's theory[3] that in the alloys of transitional metals with aluminium, the transitional metals act as electron acceptors by filling up their atomic orbitals[4]. Also the radius of a Fermi sphere, corresponding to a number of electrons per unit volume calculated on the basis of Raynor's theory of electron acceptance by cobalt, is 1·948 A., which agrees well with the spacings of 1·959 A. and 1·939 A. of the strongest two lines on the powder photograph of Co_2Al_9.

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* Note that here the x and z axes have been interchanged, compared with those given in ref. (1).

The structure will be described in detail elsewhere.

A. M. B. Douglas

Crystallographic Laboratory,
Cavendish Laboratory,
Free School Lane,
Cambridge.
July 6.

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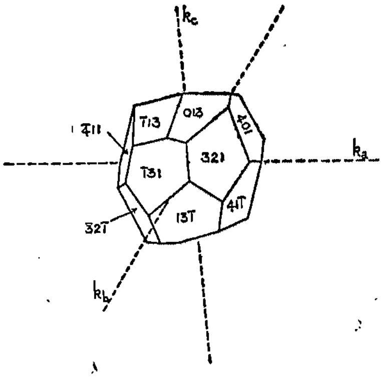
[1] Parker, A. M. B., *Nature*, **156**, 783 (1945).
[2] Pauling, L., *J. Amer. Chem. Soc.*, **69**, 542 (1947).
[3] Raynor, G. V., *Phil. Mag.*, **36**, 770 (1945).
[4] Pauling, L., *Phys. Rev.*, (11), **54**, 899 (1938).

It is most gratifying to note the agreement of the results of Mrs. Douglas' determination of the crystal structure of Co_2Al_9 with the theory that, in aluminium-rich alloys, transitional metal atoms absorb electrons by filling up their atomic orbitals[1]. This work emphasizes the importance of crystallographic studies in the development of alloy theory.

Mrs. Douglas shows, in her letter, that the radius of the Fermi sphere, calculated according to the theory of electron acceptance, is in agreement with the spacings of the strongest two lines in the diffraction pattern. Since Mrs. Douglas very kindly informed us of her crystal structure results prior to publication, it was possible to make an independent examination of the Brillouin zone structure of the compound, which confirms her findings.



The strongest two lines in the diffraction pattern appear to result from the overlapping of reflexions from the ($\bar{4}11$), (321), (401), (013), ($\bar{1}13$) and ($\bar{1}31$) planes. In k-space these planes define a closed volume of the form shown in the accompanying diagram. The perpendicular distances of these planes from the origin of k-space lie between the closely similar values of 0·2543 recip. A. (for planes of the type $\bar{4}11$ and 410) and 0·2570 recip. A. (for planes of the type $\bar{1}31$ and $\bar{1}13$). Fermi spheres having these radii correspond respectively to 2·1 and 2·15 electrons per atom; the 'average' Fermi sphere, with radius equal to the mean perpendicular distance of all six planes from the origin, corresponds with 2·12 electrons per atom. The bounding planes of the Brillouin zone are therefore touched by the Fermi sphere when 2·12 electrons per atom are present. This is in very close agreement with the value of 2·125 electrons per atom, characteristic of the experimentally determined composition of Co_2Al_9 crystals extracted from aluminium-rich aluminium–cobalt alloys[2], the number of electrons per atom absorbed by cobalt[1] being taken as 1·71. These results add further support to the view that compounds of this type are properly to be regarded as 'electron compounds'[3].

G. V. Raynor
M. B. Waldron

Department of Metallurgy,
The University,
Edgbaston,
Birmingham 15.
Aug. 1.

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[1] Raynor, G. V., *Phil. Mag.*, **36**, 770 (1945).
[2] Raynor, G. V., and Pfeil, P. C. L., *J. Inst. Metals*, **73**, 609 (1946–47).
[3] Raynor, G. V., and Waldron, M. B., *Proc. Roy. Soc.* (in the press

Decay of Barium-139

The isotope Ba^{139} is radioactive with a half-life of 85 min. decaying to La^{139} by β^- emission. This activity was first reported by Pool and Cork[1]. Kalbfell and Cooley[2], using absorption methods, have reported a continuous β-spectrum with a maximum energy of 1 MeV. accompanied by γ-radiation of energy 0·6 MeV., while Born and Seelmann-Eggebert[3] report a maximum β-energy of 2·3 MeV. also by an absorption method.

In the present experiments investigation of the activities was made by means of a thin-lens β-ray spectrometer and by absorption and coincidence techniques.

Ba^{139} was produced by bombarding fused barium nitrate with 7 MeV. deutrons in a cyclotron. After bombardment the barium was separated from lanthanum and sodium and precipitated in the form of amorphous carbonate. (Lanthanum activity is produced by Ba-dn-La reaction and Na^{24} by Al^{27}-$n\alpha$-Na^{24} reaction with the aluminium target plate.) After this separation the β- and γ-radiation both decayed with a period of 84 ± 1 min. and no contamination could be detected over five half-life-times.

Fig. 1 shows the momentum distribution of the β-spectrum obtained in the β-ray spectrometer. This

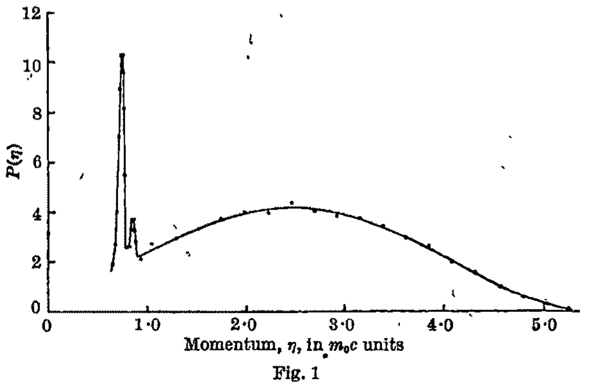

Fig. 1

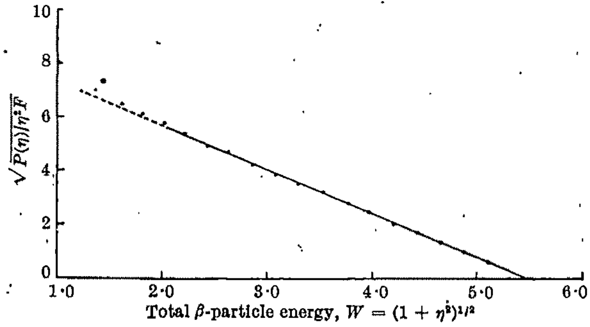

Fig. 2

spectrum was obtained using a source of thickness 3 mgm. cm.$^{-2}$ and about 1 sq. cm. in area deposited on thin aluminium foil. The spectrometer resolving power was about 15. A Fermi plot of this spectrum is shown in Fig. 2. This indicates a maximum kinetic energy of 2·27 ± 0·02 MeV. In addition to the continuous β-spectrum two conversion electron groups were found having energies of 126 ± 0·5 keV. and 159 ± 2 keV. These groups correspond to the K and L electrons from the conversion of a γ-ray of 163 ± 0·5 keV. in the product nucleus. From Fig. 1 it is estimated that the ratio of conversion electrons to β-particles is 5 ± 1 per cent and the ratio $N_K/N_L \sim 6$.

Fig. 3 shows the absorption curve obtained using lead absorbers and a brass γ-counter, the β-particles being absorbed in polythene. The majority of the radiation has a mass absorption coefficient of 1·38 cm.^{2} gm.$^{-1}$ corresponding to the 163 keV. γ-ray. About 10 per cent of the counting rate appears to be due to a harder γ-ray of energy 1·05 ± 0·1 MeV. By the use of calibrated β- and γ-counters the intensity of the γ-radiation was estimated. Expressing these intensities as a percentage of the total number of disintegrations, the number of quanta escaping is estimated as 26 ± 3 per cent for the 163 keV. γ-ray and ∼ 0·6 per cent for the 1 MeV. γ-ray. An attempt was made to confirm the energy of this harder γ-ray by means of Compton recoil electrons in the β-ray spectrometer; but the relatively low intensity available together with the short life-time prevented any useful results being obtained by this method.

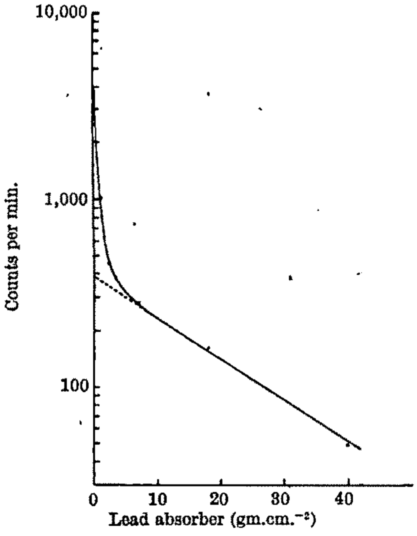

Fig. 3

Coincidences were obtained between β-particles and γ-rays and between β-particles and conversion electrons. From the latter the percentage of conversion electrons was estimated and the result was in good agreement with that obtained by the spectrometer. The product nucleus is La^{139}, which has a spin of 7/2 in the ground-state, and it was thought that the 163 keV. level might have a measurable metastable life-time. No such life-time could be detected with our equipment, which had a lower limit of 10^{-7} sec.

L. R. SHEPHERD
J. M. HILL

Cavendish Laboratory,
Cambridge.
July 17.

[1] Pool, M. L., and Cork, J. M., *Phys. Rev.*, 51, 1010 (1937).

[2] Kalbfell, D. C., and Cooley, R. A., *Phys. Rev.*, 58, 91 (1940).

[3] Born, H. T., and Seelmann-Eggebert, W., *Naturwiss.*, 31, 210 (1943).

Preparation of Pure Iron-59 of High Specific Activity

THE preparation of Fe^{59} by (slow n,γ) reaction on potassium ferrocyanide has been described by Dewhurst and Miller[1]. The reaction is of the Szilard – Chalmers type, so that the active iron could be obtained by precipitation on aluminium hydroxide at specified pH; three precipitations were necessary to obtain 'a clean 47-day activity'.

We have irradiated hydroferrocyanic acid in the Harwell low-energy pile (G.L.E.E.P.), this compound being chosen to avoid formation of the short-lived K^{42} which emits very penetrating β- and γ-radiation and which is produced in far greater amount than is the Fe^{59}, when potassium ferrocyanide is irradiated. From the irradiated hydroferrocyanic acid, which is blue, Fe^{59} may be obtained very simply by extraction with dry, dilute ethereal hydrochloric acid in a Soxhlet apparatus.

After irradiation for a month (slow neutron flux 2·5 × 10^{10}/sq. cm./sec.), the activity of the solid was determined before and after extraction with a Geiger – Müller tube having a window thickness of 4 mgm./sq. cm. It was found that 50 per cent of the total activity remained. The activity of the hydroferrocyanic acid was too low (70 counts/min./mgm.) to permit an absorption curve, owing to self-absorption, so that it is not possible to state how much of the total activity is Fe^{59}. The other 50 per cent of the total activity was accounted for in the ethereal extract, so that no loss of activity, say as gaseous products, occurred.

Most of the activity which could be extracted was extracted in the first hour; after two and a half hours no further extraction occurred. The blue colour partially faded during extraction.

The ethereal extract was taken just to dryness and the greenish-black residue digested with water for two hours

(*a*) The aqueous extract contained at least 90 per cent of the activity extracted by the ether and was proved to be radioactively pure Fe^{59} by its absorption curve[2].

(*b*) The residue was partially soluble in alcohol. Removal of the alcohol from the extract left a black oily material which carried the remaining 10 per cent of the extracted activity. An absorption curve showed this to be almost pure C^{14}.

(*c*) The residue from the successive aqueous and alcoholic extractions was greenish-black and carried very little, if any, activity.

The amount of iron extracted during this process is small, about 300 μgm. per gm. of hydroferrocyanic acid, as determined spectroscopically. Parallel experiments showed that this iron is not produced by irradiation, but is extracted also from unirradiated hydroferrocyanic acid. The specific activity of the Fe^{59} is therefore about 1·5 mc./gm. It is hoped to repeat and extend these experiments, and also to obtain higher specific activity, with samples irradiated in the bigger pile now in operation at Harwell.

A. W. KENNY
W. R. E. MATON

Ministry of Supply,
Atomic Energy Research Establishment,
Harwell, Didcot.
July 30.

[1] Nat. Res. Coun. Canada Report, C.R.C. 351.

[2] Cf. Livingood and Seaborg, *Phys. Rev.*, 54, 51 (1938). Deutsch, Downing, Elliott, Irvine and Roberts, *ibid.*, 62, 3 (1942).

Distribution of Ice-Particle Nuclei in the Free Atmosphere

CWILONG[1] has determined the highest temperatures at which ice forms in the cloud produced by adiabatic expansion in a Wilson cloud chamber. He found a threshold temperature of $-41{\cdot}2 \pm 0{\cdot}2^\circ$ C. for air which had been cleaned by repeated expansions, and of $-32 \pm 1{\cdot}0^\circ$ C. for outdoor air at Oxford. He has since repeated the experiments with outdoor air on the Jungfraujoch[2], and on the Atlantic and Pacific Oceans[3]: he found the clean air threshold on all but one occasion.

During the past year an apparatus similar to that used by Cwilong has been fitted to a Halifax aircraft of the Meteorological Research Flight at Farnborough, and measurements have been made in flight on four occasions. On each flight the threshold temperature for the free air was determined at two or three levels. On two of the flights there were pronounced anticyclonic inversions at about 5,000 ft., while on the other two the *radio-sonde* ascents showed no marked inversions, though stratus cloud or a haze-top showed that the air was stratified.

The clean air threshold was found in all measurements above the inversions, the stratus, or the lowest haze-top, while the measurements below these levels gave -33° C. to -35° C. On one occasion two haze-tops were observed, and the clean air threshold was found above the lower. The greatest height at which the threshold has been observed to be above -41° C. is 8,000 ft., while the lowest at which the clean air threshold has been found is 6,000 ft. These results were obtained in winter and early spring, and they suggest that the nuclei active at -32° C. are only present in air which has recently been in contact with the surface.

The greatest height reached was 18,000 ft., and there the threshold was measured as -44° C. Clean air from a compressed air cylinder was also examined at this height, and gave -44° C. It is not certain whether this is a true variation of the threshold or an instrumental effect. The expansion ratios were controlled to give final temperatures accurate to $\pm 0{\cdot}5^\circ$ C., and the apparatus will detect nuclei present in concentrations of 10/litre.

I am indebted to the Director of the Meteorological Office for permission to make the flights, and publish the results, and to Dr. Frith of the Research Flight for his unfailing helpfulness in the air and on the ground. Prof. G. M. B. Dobson suggested this research, and it is a pleasure to acknowledge his continued interest and many valued suggestions.

H. P. PALMER

Clarendon Laboratory,
Oxford.
July 3.

[1] Cwilong, B. M., *Proc. Roy. Soc.*, 190, 137 (1947).

[2] Cwilong, B. M., *Nature*, 160, 198 (1947).

[3] Cwilong, B. M., *Nature*, 161, 62 (1948).

Frictional Electrification of Sand

A VERY simple experiment seems to have a meteorological significance.

A small plate about one square inch in area was attached to the insulated quadrant of a Dolezalek electrometer. A cupful of fairly dry sand was then poured through a funnel and allowed to fall some three feet to the floor. The electrometer plate was three yards away from the dropping sand. The passage of the sand through the funnel took about half a minute, and while it was dropping there was no effect on the electrometer; but soon after, the electrometer began to show a deflexion which continued to increase for three or four minutes. This deflexion corresponded to the plate receiving positive charge. Having reached a maximum deflexion of a volt or so, the deflexion commenced to decrease, and continued to do so for a few more minutes and finally came to rest near its original zero position. In this stage the plate must have been receiving negative charge. That this decrease was not due to faulty insulation was checked by another experiment in which the plate was momentarily earthed when the deflexion reached its maximum, and it then charged up negatively in the last few minutes.

As the whole phenomenon occurs after the sand has ceased to drop, any explanation based on induction must be ruled out and the plate must have received positive charge through the air in the first few minutes, and an approximately equal amount of negative charge in the last few minutes. What is the source of these charges and why do the positive arrive first? The sand in its passage through the funnel gets charged negatively by friction, as is easy to show by letting a little of it fall into a metal cup connected to the insulated quadrant of the electrometer, and the question is therefore where does the positive charge come from? It was thought at first that the falling sand might, by friction, electrify the air, producing positive and negative ions which diffuse at different rates. There are several reasons against this, and the main one is that the kinetic energy of the ions would only be sufficient to charge up the plate to a very small fraction of a volt. The particles must, therefore, be very much larger, and one is driven to the conclusion that they are dust particles of the sand itself. Furthermore, they must be a mixture of small particles with a positive charge and larger particles with a negative, because the carriers of the positive diffuse, or are carried by convection, quicker than the carriers of the negative.

The frictional effect of the funnel always charges the sand negatively whatever the size of the particles, so the final conclusion reached is that the sand rubbing on itself must produce positive charges on the smallest particles and negative charges on the larger.

The electrometer had an approximate capacity of 50 E.S.U., and considering the smallness of the collector plate and its large distance from the dropping sand the total amount of charge produced by the sand is surprisingly large. The meteorological application is, of course, obvious. When sand is blown about on a big scale, very large charges must be produced, and the different rates of diffusion or convection separate the charges. The comparative largeness of the particles means that the motion is little interfered with by the electrostatic forces due to the charges on the various particles, so that the diffusion or convection will result in very large potential differences being set up.

Many years ago, on the Salonika front, I noticed that when a dust storm was approaching my wireless station the aerials started sparking violently when the dust cloud was some way off; sparking then ceased for a while, to recommence with equal violence when the storm hit the camp. This has an uncommon resemblance to the electrometer experiment, the first sparking being due to particles too fine to be visible.

E. W. B. Gill

Electrical and Clarendon Laboratory,
Oxford.
July 16.

Influence of Reactive Feedback Networks on the Response of Galvanometers

In the course of an investigation into servo circuits and self-balancing systems in general I had opportunity to examine the effect of reactive elements in the negative feedback networks of electronic amplifiers on the response characteristics of current measuring instruments. Detailed mathematical analysis revealed a number of facts which make it appear probable that a reactive feedback circuit can be used as an alternative to other negative feedback circuits in galvanometers, such as the twin-coil meter[1] or the mirror-and-photocell instrument[2,3,4], without interference with the mechanism of the instrument itself.

If a voltage v is applied to an electronic amplifier of gain A in the output of which is connected a network consisting of the resistances R_1 and R_2, the condenser C and the inductance L, and if also the voltage appearing on the junction between L and C is fed back in series with and negatively to the input voltage, then the frequency response of the amplifier is made to depend on the characteristics of the feedback circuit (Fig. 1). If the output is connected to a current instrument, via a buffer stage, the response of the pointer will depend both on the voltage-time function of the input and the characteristics of the feedback circuit. In this case, the differential equation governing the deflexion-time function is an inhomogeneous one of the fourth order, the forcing function being the input voltage v. If, however, the damping and frequency of the feedback circuit and those of the meter are made equal, for example, by suitable choice of values of the circuit constants, the equation reduces to one of the second order. This equation is similar to the one governing the meter deflexion itself (that is, in the absence of the feedback network), except that the coefficient of the zero order term now contains an additional term proportional to A. The effect of this feature is that while the damping remains unaltered, the natural frequency calculated from the equation can be increased freely by the simple expedient of suitably adjusting the gain of the amplifier. The mathematical treatment bears considerable resemblance to the resonant shunt method of influencing the response of galvanometers, which is, indeed, a special case of the present device[5,6,7].

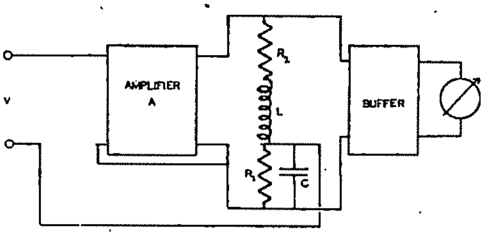

Fig. 1

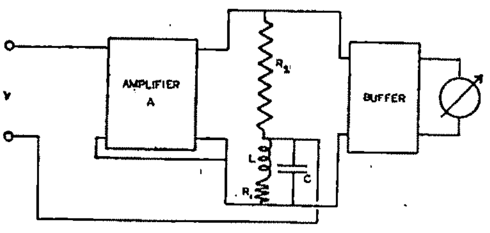

Fig. 2

The result is formally identical with the conditions obtaining in any of the other electrical or electro-optical feedback galvanometers quoted in the references; in the present case, however, there is no need for any additional mechanical attachments to the instrument or any modifications of its internal design. If the instrument is originally overdamped, it can be brought back to 'dead beat' conditions by a simple gain control operation. A preliminary experiment to check the theory was carried out with an Evershed and Vignoles recording milliammeter, the dashpot of which was filled with glycerine. A directly coupled amplifier was adjusted until dead beat conditions were re-established. In this way it was possible to make the response of the meter extremely fast, the response time being of the order of 1/10 sec.

Another possibility of using reactive feedback networks to influence the response of a meter lies in placing the inductance L into the other arm of the network (Fig. 2). Here the conditions are exactly analogous. The galvanometer equation, adapted to include the special feature of the feedback circuit, is again of the fourth order, reducing to one of the second order, if the feedback network is 'tuned' in frequency as well as damping to the galvanometer. But now the coefficients of both the zero and first-order term contain an expression proportional to A. Thus the apparent damping as well as the apparent frequency is affected, the latter being reduced as A is increased. This circuit is therefore particularly useful in conjunction with underdamped instruments. It returns them to conditions of critical damping or, if desired, to over-critical behaviour.

It is probable that similar circuits to the ones discussed can be used for affecting the characteristics of a meter in any desired way, by suitably combining reactive and resistive components or by a sequence of circuits of the types mentioned, one feeding into the next and finally into the meter. The possibility of a general mathematical approach is being investigated.

A detailed paper is to be published shortly.

P. Savic

Royal Naval Scientific Service.

June 3.

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Biological Properties of a Substance Isolated from Wheat Middlings and of Hydroxymethylfurfuraldehyde

Following on the description many years ago[1] of a growth-inhibiting constituent of yeast, a number of plant extractives[2] and pure substances[3] have been reported to possess similar activity. A distinctive feature in the case of most of them is that in cultures *in vitro* the growth of connective tissue cells is inhibited, but not that of epithelia. From this the conclusion was drawn that such action, if exerted *in vivo*, would lead to the retardation of growth in young animals since this depends upon the growth of their connective tissue, without interference with the vitality of such other tissues as the skin and blood-forming organs, the cells of which continue to multiply throughout normal life. A further inference was made that the growth of tumours might similarly be inhibited, since this too depends upon a parallel growth of stroma. These expectations were, in fact, to some extent realized[4], but owing to the unsatisfactory nature of the material used the experiments were unconvincing.

It now appears that action of this kind is not specific, being shown in varying degree by a number of aldehydes[5,6], lactones[3,7] and other substances[8] containing unsaturated groups.

In the course of further attempts to isolate the naturally occurring agent from plant sources a substance has been prepared from wheat middlings which is clearly of carbohydrate nature but has not yet been completely identified. In very brief outline the process is the following. Wheat middlings are quickly extracted with 80 per cent alcohol (½ hr. stirring; all processes must be expeditiously conducted), the extract concentrated under diminished pressure below 60° to a small volume, washed with benzene, concentrated below 60° nearly to dryness, washed again with benzene, and excess absolute alcohol then added. The sticky solid precipitated is then twice extracted with hot absolute alcohol and the insoluble residue triturated with cold 95 per cent alcohol. The substance is then taken up in hot 95 per cent alcohol and the solution is evaporated under low pressure. A modification of this procedure has been employed in later experiments but the statements in the text apply to material made as described. Tested on young rats, it has been found to arrest growth at a daily dose of about 1 mgm., given by the mouth. The effect is immediate and ceases directly administration is discontinued.

During the progress of the work the probability seemed to emerge that a characteristic structural feature was a furanose group, for the product was convertible by acid to hydroxymethylfurfuraldehyde. This substance had already been found effective in arresting the growth of rats, at a dose of about 2 mgm. per day, and similar activity was shown by the relatively insoluble polymer which tends to form spontaneously when hydroxymethylfurfuraldehyde, prepared in the pure state from cane sugar, is kept.

When tested on rats bearing the Walker carcinoma, all these three substances have been found to cause retrogression of the tumours, taking effect in about a week. The dose necessary for the purpose is considerably larger, namely, about 15–45 mgm. per rat per day in the case of hydroxymethylfurfuraldehyde; in all three cases it was noted that at this high level of dosage the increase of body-weight is no longer arrested but, if anything, accelerated.

In a future communication more details will be given and, it is hoped, an indication of the precise nature of the active substance which we have isolated from wheat middlings, or, in some experiments, from malt extract. The two are not necessarily identical though they appear to have similar properties.

We wish to express our obligation and thanks to Sir Robert Robinson for stimulating help and advice.

T. B. Heaton
G. M. Robinson

Department of Pharmacology, and
Dyson Perrins Laboratory,
University of Oxford.

July 20.

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Assay of *nor*Adrenalin and Adrenalin in Extracts of Nerves and Tissues

Recent investigations have shown that the sympathomimetic activity present in several organs and in large amounts in adrenergic nerves, for example, the splenic nerves of cattle, is chiefly due to lævo-*nor*adrenalin or *l*-arterenol, which has been identified by quantitative biological and colorimetric tests (Euler[1,2]). By using the cat's blood pressure in conjunction with the fowl's rectal cæcum (Barsoum and Gaddum[3]) as test preparations, showing activity ratios for *l*-adrenalin and *l*-*nor*adrenalin of 1 : 2–4 and 20–30 : 1 respectively, adrenalin has been detected in extracts of spleen, and splenic nerves, in amounts corresponding to 1–4 per cent of that of *nor*adrenalin.

The biological assays have been facilitated by using a method of purification, depending on adsorption of the sympathomimetic activity on aluminium hydroxide (Shaw[4]). In order to increase the amount recovered with this method, the aluminium hydroxide, instead of being added as such, was formed in the trichloracetic acid extract of the organs by adding aluminium sulphate and sodium hydroxide. Adsorption was carried out at *p*H 7, and was practically complete even with small amounts of aluminium hydroxide. The washed precipitate was dissolved in sulphuric acid, and the aluminium sulphate removed by precipitation with four volumes of ethanol at *p*H 3·5. About 70 per cent of the sympathomimetic activity was recovered by this procedure, and, since the extracts were only slightly coloured, and showed almost no contamination with other substances likely to interfere with the tests, it could be used directly for biological and colorimetric assays. The relative proportions of adrenalin and *nor*adrenalin were the same as in the crude extracts. For spleen and splenic nerves from cattle, the following ranges of figures may be regarded as representative.

Tissues (cattle)	*l*-adrenalin-HCl	*l*-arterenol-HCl	
Splenic nerves	0·2 – 0·5	10–20	μgm./gm.
Spleen	0·05–0·12	2–4	,,

U. S. v. Euler

Physiology Department,
Karolinska Institutet,
Stockholm.
Aug. 3.

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Alloxan Diabetes in Dogs with Renal Pedicles Clamped

Jiménez Díaz, Grande Covián and De Oya[1] have reported that in dogs in which the vessels of both kidneys were clamped, the intravenous injection of alloxan in doses of 80–100 mgm./kgm. failed to produce either the hyperglycæmia or uræmia observed in controls in which the clamping was omitted. They postulated that "contact between alloxan and the kidney is apparently necessary for the display of the full diabetogenic effect". However, diabetes was observed on injecting alloxan during clamping of both renal pedicles in rats[2,3] and rabbits[4]. Recently, Jiménez Díaz and Souto Candeira[5] postulated that "alloxan produces some kind of renal injury which accentuates diabetes. . . . In conclusion, the kidney is apparently not necessary for the production of alloxan diabetes, but renal injury produced by alloxan would contribute to accentuate it."

Experiments were performed on dogs anæsthetized with 'Nembutal' (33 mgm./kgm. intraperitoneally). Alloxan was injected intravenously (75 mgm./kgm.) in 25–45 sec. The fasting blood sugar-level was determined before and 24–48 hr. after the injection of alloxan. Some of the animals died before the end of 48 hr., so these have not been considered as valid. Out of fifteen controls thirteen developed diabetes after alloxan injection. The clamping of both renal pedicles followed by the alloxan injection had a clear protective effect since only two dogs out of eleven developed a full diabetic condition (see accompanying table).

Diabetes due to intravenous injection of alloxan (75 mgm./kgm.) in dogs anæsthetized with 'Nembutal' (33 mgm./kgm. intraperitoneally)

Procedure	Diabetic
Controls	13 out of 15
Renal pedicles clamped	2 ,, 11
Renal vessels clamped	3 ,, 8
Renal nerves clamped	2 ,, 9
Spleen vascular pedicle clamped	0 ,, 6
Renal denervation and clamping	1 ,, 7
Bilateral nephrectomy before alloxan	5 ,, 5
Bilateral nephrectomy 2–12 hr. after renal clamping and alloxan	7 ,, 11

When clamping was limited to the vessels (both renal arteries and veins), excluding nervous structures, only three out of eight dogs which were injected with alloxan developed diabetes. Likewise the clamping of both renal pedicles, excluding only the vessels, protected seven out of nine dogs so injected.

Alloxan injected immediately after denervation of both renal pedicles, leaving the renal arteries and veins intact (without clamping), also protected six out of seven dogs.

Alloxan injected after bilateral nephrectomy caused an intense diabetes in all of five dogs. The same result was observed in seven out of eleven dogs in which bilateral nephrectomy was performed 2–12 hr. after clamping and injecting alloxan.

Finally, after injecting the alloxan after clamping the vascular pedicle of the spleen and maintaining the vessels clamped for 15 min. after the injection, all of six dogs failed to develop diabetes.

These results confirm the observation that alloxan injection, immediately after clamping of both renal pedicles in the dog, fails to produce diabetes although microscopically lesions of variable degree in some β-cells of the islets have been found. The same protection has been produced: (*a*) by clamping either the renal vessels only or the nervous structures; (*b*) injecting the alloxan after denervation of both renal pedicles leaving intact the vessels; (*c*) injecting the alloxan after clamping the vascular pedicle of spleen.

Furthermore, the injection of alloxan after bilateral nephrectomy was followed by a full diabetic condition. Thus it seems that the presence of intact kidneys is not necessary in order to obtain diabetes after alloxan injection.

However, uræmia seems to increase the severity of alloxan diabetes, since when nephrectomy is performed 2–12 hr. after the alloxan injection in dogs with both renal pedicles clamped, diabetes developed in seven out of eleven dogs.

The results of these experiments suggest the possibility that some kind of vasomotor reflex in the pancreas can be elicited from the renal pedicles due to clamping, as was suggested by Gold[2]. In order to confirm this hypothesis, several experiments were carried out, injecting 3 c.c. of indian ink into the descending aorta, using a cardiac catheter introduced through the left carotid artery. The pancreas was removed 3 min. after the indian ink injection. The results were as follow: in four control dogs the pancreas showed a dark colour of variable intensity due to the indian ink injection; but in four dogs in which both renal pedicles were clamped immediately before the injection, the pancreas showed its normal colour or was just a little darker. Microscopical examination of the islets in the controls showed many capillary vessels with plenty of indian ink, while in the islet vessels of the clamped animals scarcely any indian ink was observed. These experiments seem to confirm the hypothesis suggested by Gold that a vaso-constrictor reflex in the pancreas can be elicited by the mechanical procedure of clamping, and thus prevents injected alloxan reaching the islets in sufficient concentration to produce destruction of β-cells and diabetes.

B. A. Houssay
C. Martínez

Instituto de Biología y Medicina Experimental,
Costa Rica 4185, Buenos Aires.
July 2.

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Effect of Hypophysectomy on Glycogen Deposition in Isolated Muscle

RESULTS of experiments previously reported from this Institute in 1944 [1] indicated that when extracts of the anterior pituitary gland were administered to rats, insulin did not exhibit its usual action in promoting glycogen deposition in muscle as studied on the rat's diaphragm according to the technique of Gemmill[2]. In 1945 Cori *et al.*[3] reported the results of experiments on the effect of anterior pituitary extract and of insulin on hexokinase activity in tissue extracts obtained from rats.

It was found that when anterior pituitary extract was either injected into the intact animal or added to tissue extracts, hexokinase activity was inhibited. However, when insulin was added to such extracts, it appeared that this latter hormone released hexokinase from the anterior pituitary extract inhibition. Further, Cori considered that insulin *per se* did not enhance hexokinase activity.

As our investigations were carried out on intact muscle, it is difficult to make any strict comparison with the experiments of Cori.

It seemed, however, that any direct effect of insulin on hexokinase activity would be best investigated on hypophysectomized animals. Thus the inhibiting effect of the anterior pituitary on the hexokinase activity would be abolished, resulting in increase of glycogen deposition as compared with normal animals; and if a further increase occurred as a result of the addition of insulin it would be reasonable to assume that insulin exerted a direct action on hexokinase activity.

On the other hand, insulin should have no effect on the deposition of glycogen in the diaphragm of the hypophysectomized rats if its action were limited to the release of anterior pituitary inhibition.

In our experiments the methods employed have been reported in previous papers[1,4]. Hypophysectomy was performed according to the technique of Thompson[5]. Ten to fourteen days were allowed to elapse between the operation and excision of the diaphragm. A summary of the results obtained are shown in the following table.

Normal rats Mean of 28 animals			Hypophysectomized rats Mean of 20 animals		
Glycogen %			Glycogen %		
Without insulin (*a*)	With insulin (*b*)	Increase (*c*)	Without insulin (*d*)	With insulin (*e*)	Increase (*f*)
0·269	0·53	0·261	0·364	0·766	0·402

For columns (*a*) and (*d*) $t = 4 \cdot 19$ P 0·001
(*c*) and (*f*) $t = 5 \cdot 6$ P 0·001

From these results it appears that hypophysectomy increased the hexokinase activity in the isolated diaphragm of the rat and that it is further enhanced by the addition of insulin. Thus we are of the opinion that insulin has a direct effect on hexokinase activity.

We would like to express our sincerest thanks to Mr. A. F. Doutch for the statistical analysis.

J. BORNSTEIN
J. F. NELSON

Baker Medical Research Institute,
Alfred Hospital, Melbourne.
July 26.

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Cytochemical Demonstration of Ketosteroids

IN a number of cytochemical papers[1,2] it has been claimed that α-hydroxyketones, such as deoxycorticosterone, give a purple colour with reduced fuchsin in Feulgen's 'plasmal' reaction. In this reaction the material under test is treated with cold saturated aqueous mercuric chloride solution, then with reduced fuchsin. According to Dempsey *et al.*[3], aqueous mercuric chloride oxidizes the hydroxyketone to an aldehyde, which then reacts with reduced fuchsin.

We have now studied this reaction with three pure samples of deoxycorticosterone, one kindly supplied by Prof. T. Reichstein, Pharmazeutische Anstalt der Universitaet Basel, one kindly supplied by the British Drug Houses, Ltd., and the other prepared by one of us (C. W. S.) by hydrolysis of a sample of deoxycorticosterone acetate kindly supplied by Dr. F. T. Hewett, Organon Laboratories, Ltd., London, S.W.19. The sample prepared from the acetate was purified by sublimation at 0·001 mm. and recrystallized from ether.

With none of these samples have we been able to obtain any evidence of oxidation of deoxycorticosterone to an aldehyde by aqueous mercuric chloride.

We conclude that this technique cannot be relied upon to demonstrate the cytological location of α-hydroxyketones. Our experiments have been restricted to one such compound; but the facts of organic chemistry indicate that the α-hydroxyketo-grouping in deoxycorticosterone may be regarded as typical, and only atypical α-ketols, if any, will react as postulated by Dempsey and Wislocki.

R. J. BOSCOTT
ANITA M. MANDL

Department of Anatomy,
Medical School,
Birmingham 15.

J. F. DANIELLI
C. W. SHOPPEE

Chester Beatty Research Institute,
Royal Cancer Hospital (Free),
Fulham Road, London, S.W.3.
June 25.

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p-Aminobenzoic Acid a Growth-Factor for Certain Brewer's Yeasts

MOST of the single-cell strains of English brewery top fermentation yeasts so far examined grow well at 25° C. in forty-eight hours in a synthetic glucose-mineral salts medium, containing $(NH_4)_2HPO_4$ as the sole source of nitrogen and biotin, pantothenic acid and inositol as accessory growth factors ('bios').

However, two single-cell strains, isolated from different breweries, failed to grow even after six days incubation at 25° C. in the medium containing the three factors mentioned above and in addition riboflavin, aneurin, nicotinic acid and pyridoxin. The missing factor proved to be *p*-aminobenzoic acid, addition of 0·01 μgm. per ml. of which induced heavy growth in the presence of other essential bios factors. One strain, designated 'Yeast 45', required biotin as an essential growth factor in addition to *p*-aminobenzoic acid, pantothenic acid (or β-alanine) being strongly stimulatory, but not essential for good growth. The other strain ('Yeast 47') required both biotin and pantothenic acid (or β-alanine) in addition to *p*-aminobenzoic acid as essential bios constituents, while inositol and a mixture of riboflavin, aneurin, nicotinic acid and pyridoxin each has a stimulatory effect.

While *p*-aminobenzoic acid is recognized as a growth factor for many organisms, of which *Acetobacter suboxydans*, *Clostridium acetobutylicum*, *Lactobacillus arabinosus* and *Neurospora crassa* have been employed for microbiological assays of *p*-aminobenzoic acid, I am not aware that strains of brewer's yeast exacting towards *p*-aminobenzoic acid have been reported. The response of 'Yeast 45' and of 'Yeast 47' to *p*-aminobenzoic acid is so striking as to suggest that either organism may prove suitable for the microbiological assay of the vitamin.

CYRIL RAINBOW
Department of Industrial Fermentation,
University, Birmingham 15.
June 29.

A Test for Mutagenicity of Methylcholanthrene

RECENT results by Strong[1,2] and by Carr[3] on mice, and by Demerec[4] on *Drosophila*, have focused interest on a possible connexion between mutagenicity and carcinogenicity, which in the past has often been claimed on theoretical grounds. While Auerbach[5] failed to produce mutations by injection of 1 : 2 : 5 : 6 dibenzanthracene into *Drosophila*, Demerec obtained positive results with a number of carcinogens, including dibenzanthracene and methylcholanthrene, when these were administered to the flies in the form of aerosols. Still a different possibility of administration is by addition of the carcinogen to the food of the larvæ, since fluorescence tests carried out by Fabian and Matoltsy[6] have shown that methylcholanthrene given in this way enters into the gonads. An experiment using this method was under way when Demerec's first results were published, and its outcome will be briefly presented. The food contained powdered methylcholanthrene in a concentration of 0·01 per cent. No live yeast was added to the culture vials, in order to avoid complications through offering the larvæ an alternative supply of untreated food. Fluorescence tests showed that methylcholanthrene or a fluorescent derivative of it had penetrated into the gonads of the imagines which emerged in the treated vials. In spite of this, no evidence for mutagenic action of methylcholanthrene was obtained in tests for sex-linked lethals. Only two lethals were found in 1,012 chromosomes from treated ♂♂ (compared with one in 1,007 control chromosomes), and three in 1,026 chromosomes from treated ♀♀ (compared with two in 1,014 control chromosomes).

The discrepancy of this result with that obtained by Demerec seems to prove the superiority of the aerosol method for this type of experiment. However, closer inspection of the data makes this doubtful. According to the data shown by Demerec at the Eighth International Congress of Genetics, aerosol treatment with methylcholanthrene produced 25 lethals in 4,671 treated *X*-chromosomes, as compared with 28 in 10,006 control chromosomes, a statistically significant difference. On the other hand, there is no significant difference between Demerec's positive and our negative result in the treated series. It may well be that the feeding method, when done on a comparably large scale, might be as effective in demonstrating the mutagenic capacity of methylcholanthrene as the aerosol method. Whatever method is used, it seems obvious that only experiments involving very large numbers of cultures will be able to reveal mutagenicity in substances of either low mutagenic potency or else low power of penetration to the chromosomes of the germ cells.

S. BHATTACHARYA
Institute of Animal Genetics,
Edinburgh.
Aug. 16.

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Fungal Mutations Obtained with Methyl Xanthines

IN studying the ability of various chemicals to induce mutations in fungi, we found a very striking effect of the two purine compounds, caffeine and theophylline, which seems to be of interest from several points of view.

Most of the experiments were performed with the ascomycete, *Ophiostoma multiannulatum*, conidia of which were treated with the chemicals under test. Since we looked for specific actions, only clear-cut physiological mutations implying biochemical deficiencies were isolated and identified. The technique is described in another paper[1].

Of the purine compounds tested, caffeine and theophylline showed the strongest activity. An addition of 0·05–0·15 per cent caffeine to a growing conidial culture causes a decrease in the multiplication rate of the conidia. With 0·2 per cent or more of caffeine, growth is completely inhibited, and the conidia are killed at a rate which seems to be a function of the concentration of caffeine present. The corresponding figures for theophylline are 0·2–0·5 per cent and 0·6 per cent respectively.

In platings made from such cultures with inhibited growth, where most of the conidia have been killed, as well as from conidial suspensions in pure caffeine solution, a great number of morphologically deviating monoconidial mycelia appeared.

For certain reasons we chose to examine the possible mutagenic effect of these substances in concentrations which just inhibit the growth, and slowly kill the conidia. It was found that under the experimental conditions, caffeine reached its maximal mutation-producing effect in five days, when 0·2 per cent conidia were still alive. The same seemed to be valid for theophylline.

This technique probably does not exclude the possibility of nuclear divisions (in spite of the inhibited growth), and the mutations found are, therefore, if they are induced, not certainly to be looked upon as 'zero-point mutations' in the sense of Demerec and Latarjet[2].

As appears from the accompanying table, about the same percentage of biochemical mutations was obtained from all the four platings of conidial suspensions treated with caffeine for 5–8 days, namely, c. 1 per cent. Theophylline produced a poorer yield, *c.* 0·6 per cent. These values are, in comparison with those obtained with other chemicals, very high. X-ray irradiation usually gives in *Ophiostoma* 1·8 per cent biochemical mutations, and nitrogen mustard has sometimes given up to 1·3 per cent. Untreated,

	Number of mutants isolated after treatment with							
	0·2 % caffeine					0·6 % theophylline		
	Treatment in days				Total	Treatment in days		Total
	5	6	7	8		4	6	
Factor required :								
Reduced sulphur	—	—	—	—	—	—	1	1
Arginine	1	3	—	—	4	1	2	3
Lysine	1	1	1	—	3	—	1	1
Methionine	1	—	—	—	1	—	1	1
Other amino-acids	1	—	1	—	2	—	1	1
Hypoxanthine	3	1	1	1	6	—	—	—
Uracil	—	—	—	—	—	—	1	1
Inositol	7	5	5	2	19	2	5	7
Niacin	4	3	—	1	8	—	—	—
Biotin	—	1	—	—	1	—	—	—
Not identified	—	—	—	2	2	1	1	2
No. of mutants	18	14	8	6	46	4	13	17
Conidia isolated	2264	1202	880	398	4744	635	2174	2809
% living conidia	0·20	0·08	0·04	0·03	—	0·38	0·25	—
% mutant conidia	0·8	1·1	0·9	1·5	1·0	0·6	0·6	0·6

growing conidial cultures of *Ophiostoma* from which the conidia for these experiments were taken have never been found to contain more than 0·06 per cent biochemically deficient conidia; in most control experiments none was found.

Of the other methylated purines which we have so far synthesized, only 1,7-dimethyl hypoxanthine has been tested, which produced a weak, statistically not definitely significant, action similar to that described above.

Although it seems most likely that caffeine and theophylline act as real mutagens, as for example nitrogen mustard, the possibility of a selective effect through differential killing has to be considered[3]. A fact that perhaps speaks in favour of this latter interpretation is the distribution of the mutants among the different physiological types, the vitamin-deficiencies (especially inositol-less mutants) being much more numerous than in irradiated or nitrogen mustard treated material[4].

A further elucidation of the phenomenon appears to be desirable for several reasons. Caffeine and theophylline occur in some plants in considerably higher concentrations than those active in our experiments. Of these two substances, at least caffeine interacts, as we have found, in an interesting way in the fungus cell with adenine, one of the chemically closely related amino-purines, which are essential constituents of the nucleo-proteins.

This investigation of the physiological and genetical effects of methyl xanthines, and other purine compounds, is being continued.

NILS FRIES
BENGT KIHLMAN

Institute of Physiological Botany,
University of Uppsala.

July 3.

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[2] Demerec, M., and Latarjet, R., Cold Spring Harbor Symp. on Quant. Biol., 11, 38 (1946).

[3] Witkin, E. M., Cold Spring Harbor Symp. on Quant. Biol., 12, 256 (1947). Fries, N., *Hereditas*, 34, 338 (1948).

[4] Fries, N., *Nature*, 159, 199 (1947).

Yeast and Rickets

SOME years ago, Brause, Kon and White[1] proved that an addition of high amounts of dried yeast in the ration of pigs produced rachitogenic symptoms. During the feeding practice in our Institute with chickens, we sometimes found that an addition of 2 per cent of dried yeast in the mash (about 1 per cent calculated on the total ration) resulted in a somewhat retarded growth, particularly if the animals did not need the supplement of the B-vitamins provided by this product.

In the light of this experience, we were highly interested in the communication by Hoff-Jørgensen[2], in which he ascribes the unfavourable properties of dried yeast to the presence of a specific phytase-inhibiting substance.

In order to repeat his experiments, we worked with a phytase preparation, made according to the directions of Adler[3]. The splitting of phytin (Ciba) was measured after incubation at 30° C. at pH 5·6 for 1–2 hr., by determining the increase in inorganic phosphorus as well as by direct phytic acid–phosphorus determinations. At the beginning of the incubation periods, 50 ml. of reaction mixture contained 12·5 mgm. of phytin and 12·5 mgm. of the phytase preparation. The splitting was calculated as a percentage of the phytic acid originally present.

The yeast extract was prepared by shaking 4 gm. of dried brewer's yeast with 30 ml. of 0·2 N hydrochloric acid for 2 hr. The centrifugate was brought with dilute sodium hydroxide to pH 5·6 and the volume was made up to 100 ml. 12·5 ml. of this extract (containing approximately 4 mgm. of inorganic phosphorus) was used per 50 ml. of reaction mixture. In addition, determinations were made after adding 4 mgm. of inorganic phosphorus in the form of potassium dihydrogen phosphate.

The results are summarized in the accompanying table.

Percentage splitting of phytic acid after 2 hr. Figures in brackets: after 1 hr.

Buffer	Addition	Splitting (per cent)	
		Calculated from increase in inorganic phosphorus	Calculated from direct phytic acid–phosphorus determinations
Acetate	None	34	66
,,	12·5 ml. yeast extract	20	37
,,	4 mgm. inorganic phosphorus (as KH_2PO_4)	24	39
Citrate	None	38 (23)	87 (47)
,,	12·5 ml. yeast extract	19 (8)	65 (31)
,,	4 mgm. inorganic phosphorus (as KH_2PO_4)	— (10)	65 (32)

As the figures show, we could not confirm the presence of a specific phytase inhibitor in yeast. The inhibition by the yeast extract can be explained fully by taking account of the presence of inorganic phosphorus.

Moreover, it is interesting to note that the results calculated from direct phytic acid determinations are much higher than the results calculated from the inorganic phosphorus determination. This is due to the fact that lower phosphoric acid esters of inositol are not precipitated with the ferric chloride reagent in the circumstances of the McCance and Widdowson method for phytin determination. It shows that the ester bonds in inositol-pentaphosphoric acid, tetraphosphoric acid, etc., are not hydrolysed easier than the first bond which had been split in the phytin molecule.

Most of the experimental work for this investigation was done by Miss M. W. Muÿen. I am indebted to Dr. J. Grashuis for his interest.

TH. J. DE MAN
"de Schothorst" Institute for the Study of
Animal Nutrition,
Hoogland, Holland.

[1] Brause, R., Kon, K., and White, E. G., *J. Comp. Path.*, **53**, 161 (1943); **54**, 88 (1944).

[2] Hoff-Jørgensen, E., *Nature*, **159**, 99 (1947).

[3] Adler, L., *Biochem. Z.*, **75**, 319 (1916).

USING purified enzyme preparations and certain samples of dried yeast, we have met with the same difficulties as has Dr. de Man in reproducing our first results. We found, however, that the inhibition increased the longer the duration of the experiment, and that the inhibition was considerable when rye bran and dried yeast were incubated together overnight before the adding of the substrate. Experiments show that phosphatases from the bran under these conditions split considerable amounts of inorganic phosphate from phosphoric acid compounds present in yeast. It seems to be this inorganic phosphate which is responsible for our finding of an inhibition of phytase by yeast.

E. HOFF-JØRGENSEN
Biokemisk Institut,
Københavns Universitet.

Stimulation of Adventitious Root Formation by Fungal Metabolic Products

IN an attempt to elucidate the contradicting views concerning the nature and properties of *Fusaria* metabolic products responsible for cotton and tomato wilts, certain substances (stimulating for adventitious root formation) have been detected in the fungal filtrates. These experiments have been originally carried out with the aim of testing the two following points.

(1) The response of healthy cotton cut shoots to the metabolic products of either a specific pathogen (*Fusarium vasinfectum*) or a non-specific pathogen (*Fusarium lycopersici*). Two Egyptian varieties of cotton were used for this purpose: one is a wilt-resistant variety, 'Ashmouni', and the other is a susceptible one, 'Giza 26'.

(2) The response of healthy tomato cut shoots to the metabolic products of either a specific pathogen (*Fusarium lycopersici*) or a non-specific pathogen (*Fusarium vasinfectum*). Two varieties of tomato were used, namely, 'Pritchards' and 'North Dakota'.

The filtrate was obtained by growing the fungus in Richard's solution for twenty-eight days at 30° C. The solution was then freed from the fungus, and was passed through a Berkefeld filter. The fungal filtrate was then divided into three portions: (*a*) a portion was kept unheated; (*b*) a portion was boiled for fifteen minutes; (*c*) a third portion was treated with 96 per cent alcohol. A creamy white precipitate is obtained, which is filtered off and dried; an aqueous solution of the precipitate has been prepared. The remaining precipitate-free filtrate has been distilled under vacuum to remove the excess of alcohol, and was afterwards kept for forty-eight hours at 60° C. to remove the last traces of alcohol.

Freshly cut healthy shoots were dipped in either the unheated or the boiled fungal filtrate, in the solution of precipitate, in the precipitate-free filtrate, or in the precipitate plus the precipitate-free filtrate. Control experiments were also made by using fresh Richard's solution and sterilized tap water. The treated cut shoots were left at ordinary laboratory temperature (18–20° C.) and examined at regular intervals.

An interesting phenomenon has been observed when the cotton shoots (of the resistant 'Ashmouni' variety) were placed in the unheated *Fusarium vasinfectum* filtrate; adventitious roots started to appear on the fourth day (Fig. 1). No similar phenomenon has been seen, however, with the susceptible 'Giza 26' variety on any experimental treatment of the fungal filtrates.

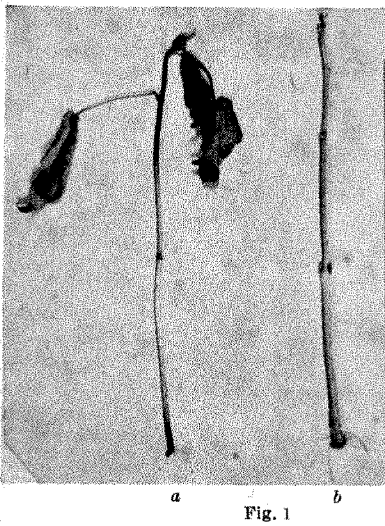

Fig. 1

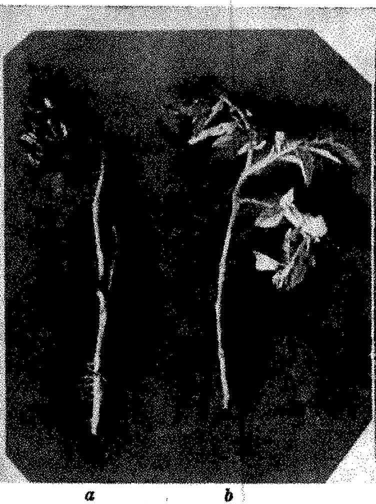

Fig. 2

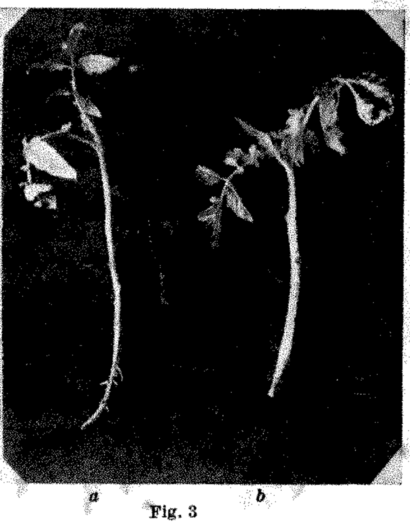

Fig. 3

Fig. 1. Cut shoots of 'Ashmouni' cotton growing on: (*a*) boiled *Fusarium vasinfectum* filtrate, and (*b*) unheated filtrate of the same fungus

Fig. 2. Cut shoots of 'Pritchards' tomato grown in: (*a*) aqueous solution of precipitate from *Fusarium lycopersici* filtrate, and (*b*) pure Richard's solution

Fig. 3. Cut shoots of 'North Dakota' tomato grown in: (*a*) aqueous solution of precipitate from *Fusarium lycopersici* filtrate, and (*b*) pure Richard's solution

Unlike cotton, the adventitious root formation, in the cut shoots of the two experimental tomato varieties, was found to be stimulated as a response to the metabolic activity of either the specific or the non-specific *Fusarium* species; the presence of the active principle—responsible for root stimulation—is only restricted, however, to the solutions of precipitates. Although adventitious root formation was induced in both tomato varieties, yet their development in 'North Dakota' was not so vigorous as that of the 'Pritchards' tomato variety (Figs. 2 and 3).

The fungal metabolic products responsible for root stimulation seem to be thermolabile and filterable through a Berkefeld filter. Further detailed studies concerning the possible nature and detailed properties of these substances are still in progress.

M. A. Mostafa
M. S. Naïm

Faculty of Science,
Fouad I University,
Cairo.

Blood System of the Gut of *Arenicola marina*

During the course of my present investigation into the functional anatomy of the gut of *Arenicola marina*, I have found that Ashworth[1] describes the sub-intestinal blood vessels (sinuses) along part of their length only. He states that these vessels "commence just behind the heart and may be traced to the level of the twelfth setæ, behind which point they disappear". In dissection, with the use of a binocular microscope, it is possible to trace out these vessels, which have been renamed the sub-enteric vessels, along the whole length of the gut. Indeed, they are visible with the naked eye. This observation I believe to be of importance as it shows that the same basic pattern underlies the blood system in all parts of the gut. Serial sections have confirmed this point.

The blood system of the gut of the lugworm appears to be as follows.

The dorsal vessel runs along the dorsal surface of the gut, starting as a network of vessels near the anus and dividing into several branches under the prostomium. Along its entire length this vessel gives off branches to the complicated blood-sinus system lying in the walls of the gut.

The ventral vessel runs underneath the gut beginning as a plexus of vessels surrounding the proboscis and breaking down into a plexus near the anus. This vessel, unlike the dorsal vessel, has no connexion with the blood sinus of the gut.

Four definite longitudinal tracts can be distinguished in the blood plexus in the gut wall: (*a*) two sub-enteric vessels; (*b*) two lateral enteric vessels. The former are very fine and run along the gut from the œsophagus to the anus on either side of the mid-ventral line. The latter are confined to the œsophagus and the front half of the stomach. In segment 7 the lateral enteric vessels are enlarged to form the 'auricles' which pulsate. The enteric vessels communicate on either side with the ventral blood vessel by two thick-walled muscular ventricles.

The four longitudinal tracts are linked to each other and with the dorsal vessel by means of primary transverse tracts, which lie between the rows of pouches in the stomach region. The primary tracts are linked with one another by finer secondary tracts.

The work mentioned here was carried out partly at University College, London, and partly at the Imperial College of Science and Technology, under the supervision of Mr. G. P. Wells, to whom I tender my sincere thanks.

Doris M. Kermack

Department of Zoology,
Imperial College of Science and Technology,
Prince Consort Road,
London, S.W.7.
Aug. 10.

[1] Ashworth, J. H., L.M.B.C. Monograph "Arenicola" (1904).

Extrafloral Glands of Cucurbitaceæ

I have already pointed out[1] that quite a good number of species of Cucurbitaceæ are provided with well engineered devices for exudation of surplus water and waste substances. These plants, being primarily moisture loving, have structures especially suited to exudation of aqueous fluids which are absorbed in quantity in excess to the requirement, physiological conditions being very favourable for rapid absorption. The genera *Coccinia*, *Luffa*, *Lagenaria*, *Momordica*, *Cucurbita*, etc., develop extrafloral nectaries. In *Coccinia cordifolia* (Linn.) Cogn. a few glistening glands are present on the lamina round about the basal region of the midrib on the adaxial leaf surface; in *Luffa acutangula* (Linn.) Roxb. and *L. cylindrica* (Linn.) Roem. these glands are often found scattered all over the lamina besides a special fleshy glandular probract being developed at the base of the peduncle of the male and female inflorescences; in *Lagenaria vulgaris* Ser. (*Lagenaria leucantha* (Duch.) Rusby) two bilateral glands are present at the remote end of the petiole and in *Momordica cochinchinensis* (Lour.) Spreng. a few are found at the petiole end or on the lateral marginal costa at the leaf-base; in *Cucurbita pepo* Linn., *C. maxima* Duchesne and *C. moschata* Poiret minute club-shaped glands do develop at the abaxial leaf surface.

The structure of the extrafloral glands is well planned for efficient discharge of waste substances. The essential parts of a gland are the: (1) supply tissue (Figs. 1 and 2, *ST*), (2) filter tissue (Figs. 1 and 2, *FT*), and (3) external excretory tissue or osmotic tissue (Figs. 1 and 2, *ET*). The conducting elements—the vessels and the tracheids—are arranged all round the glands for translocation of catabolic substances in solution to the vital supply tissue. This supply tissue is made of somewhat elongated cells with a distinct nucleus in each cell. As the supply tissue is charged with sufficient fluid, it filters through the single-layered lignified bilaterally thickened

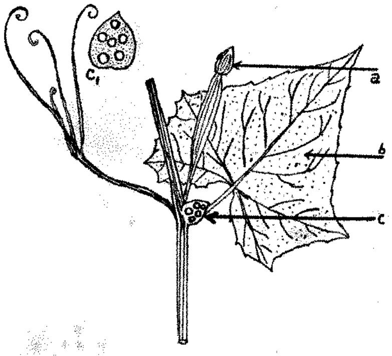

Fig. 1. Portion of a flowering branch of *Luffa acutangula* (L.) Roxb. (*a*) Female flower; (*b*) leaf; (*c*) glandular fleshy probract (× 1); (c_1) probract (× 2)

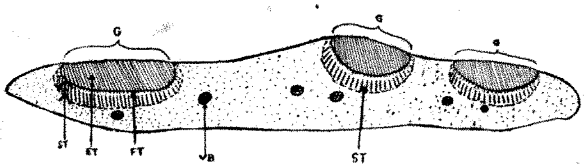

Fig. 2. *Luffa acutangula* (L.) Roxb. Transverse section of a probract passing through three glands (diagrammatic, × 20). *G*, Gland; *V.B.*, vascular bundle; *F.T.*, filter tissue; *E.T.*, external osmotic tissue; *S.T.*, supply tissue

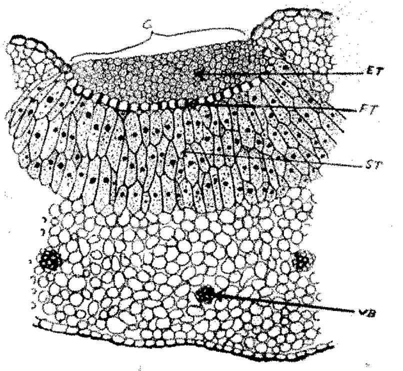

Fig. 3. *Luffa acutangula* (L.) Roxb. Transverse section of a part of the same probract as in Fig. 2. (× 100)
G, Gland; *V.B.*, vascular bundle; *F.T.*, filter tissue; *E.T.*, external osmotic tissue; *S.T.*, supply tissue

filter tissue. An interesting biological significance is attached to this characteristic filter tissue having selective influence on the exudate. Filter tissue guards against the passage of essential nutritive substances through it and permits only waste substances to filter through. The activity of secretion is greatly influenced by the presence of sugar in the secreting cells which acts as osmotic substance. (The sugar is obtained by photosynthesis.) The rate of secretion is also greatly influenced by temperature and sunlight. The secretory activity increases with the rise of temperature and decreases with the fall of it. Most active secretion is marked during the warmer part of the day.

That the extrafloral nectaries are concerned with the vital functions of the plant is evident, due to their presence in the developing organs of the plants. The sugary secretion from the gland also attracts ants and insects and possibly helps in the biology of pollination. Ants are the commoner visitors. They probably perform a defensive function too.

The investigation is in progress, and details will be published in due course.

H. L. Chakravarty

Royal Botanic Garden,
Edinburgh.
Aug. 9.

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New Colour and Fluorescence Reactions in the Steroid and Synthetic Œstrogen Series

By using suitable solvents as diluents in the reaction mixture to modify the phosphoric test for natural œstrogens[1], new and apparently specific colour or fluorescence tests have been found for *trans trans* $\Delta^{5:6}$-androstenediol-3 : 17, dienœstrol, 17-ethinyl œstradiol, 17-methyl androstenediol-3 : 17, *d-l*-equilin, œstriol, 16-keto œstradiol, œstrololactone acetate, and Westerfeld's lactone acetate. The use of low temperatures in two of these reactions may be advantageous in the examination of biological extracts. Conditions have been found for the quantitative estimation of androstenediol and dienœstrol. Further work on the quantitative estimation of the other compounds is in progress and will be published elsewhere.

Series A. Natural œstrogens and related phenols. The compound dissolved in 0·2 c.c. glacial acetic acid is mixed with 1·8 c.c. 88 per cent w./w. phosphoric acid, allowed to stand at room temperature for at least one hour prior to dilution with 3 c.c. cold glacial acetic acid. Resulting colours and fluorescence are noted before and after dilution with acetic acid. Some of the results are shown in the accompanying table. Œstriol gives a much more intense green fluorescence if propylene glycol is substituted for acetic acid and the mixture heated at 100° C. for ten minutes. Similar heating with acetic acid instead of propylene glycol gives a mauve-coloured solution with a pale greyish-blue fluorescence in ultra-violet light.

Substance	Colour of fluorescence in ultra-violet light	Comments
Œstrone, equilenin, dihydroequilenin	Green	
α-Œstradiol	Blue-green	
16-keto-œstradiol	Light-green	
3-Hydroxy-16-keto-equilenone	Yellow-green	Oxygen at 17 position is not necessary for fluorescence development
$\Delta^{14:15}$-Hydroxy-16-ketoequilenone	,, ,,	,, ,,
1-Keto 2-methyl 7-hydroxy 1.2.3.4-tetrahydrophenanthrene 2-acetic acid	Light-green	Steroid structure not essential for green fluorescence.
β-Naphthol	Weak-green	,, ,,
α-Naphthol	No appreciable fluorescence	
17-Ethinyl œstradiol	Orange	Fluorescence is rapidly quenched during addition of more acetic acid. A deep pink unstable colour then develops
d-l-Equilin	Pink, with additional acetic acid	Blood-red colour. Stable for many days
Acetate of Westerfeld's lactone	Brilliant green-blue on heating (with additional acetic acid) at 80° C. 5 min.	On addition of the cold acetic acid a pale pink colour developed
Acetate of Jacobsen's œstrololactone	,, ,,	No pink colour was obtained as for Westerfeld's lactone
Stilbœstrol, hexœstrol, *p*-hydroxypropiophenone	No green	
Dienœstrol	Deep blue	Technique of Series B used

Series B. Quantitative procedure for dienœstrol. 25–100 μgm. of dienœstrol dissolved in glacial acetic acid is mixed with 1·8 c.c. 85 per cent phosphoric acid. A sequence of yellow, orange, orange-pink and pink colours develops on standing at room temperature for one hour. Subsequent heating at 100° C. for one hour followed by addition of 3 c.c. of acetic acid and re-heating for a further hour results in the quantitative formation of a bluish-purple colour. An intense violet-blue fluorescence is also given. Hexœstrol, stilbœstrol, hydroxybenzoic acids and pyrocatechol do not give this reaction, but *iso*dienœstrol gives a similar colour. The presence of excessive amounts of *p*-hydroxybenzoic acid interferes with the quantitative determination of dienœstrol.

Series C. Non-phenolic steroids. 25–250 μgm. of androstenediol dissolved in 0·2 c.c. glacial acetic acid is mixed with 1·8 c.c. 85 per cent phosphoric acid, warmed at 55° C. for fifteen minutes, cooled and diluted to 5 c.c. with glacial acetic acid. After standing at room temperature in the dark for seventy-five minutes a violet colour and violet fluorescence (ultra-violet) develops.

This colour reaction appears to be specific for androstenediol and is not given by cholesterol, pregnandiol, cholic acid, 17 ethinyl androstenediol, progesterone, desoxycorticosterone acetate, pregnenolone, $\Delta^{5:6,\ 16:17}$-pregnanedienolone 3 : 20, *trans* testosterone and methyl testosterone. *trans trans* Methylandrostenediol 3 : 17 gives a bright green fluorescence with very little colour, whereas dehydroandrosterone gives an unstable deep pink colour.

Conditions influencing the ease and degree of dehydration of the compounds under test are evidently of considerable importance in the development of colour and fluorescence.

R. J. BOSCOTT

Anatomy Department,
Medical School, Hospitals Centre,
Birmingham 15.
Sept. 1.

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Fermentation of Pyruvate, β-Hydroxybutyrate and of C₄-dicarboxylic Acids by some Butyric Acid-forming Organisms

ACCORDING to several authors, pyruvate is an intermediate in the formation of C_4-compounds in the butanol-acetone fermentation. According to others, pyruvate is not such an intermediate and gives rise only to acetate when fermented by resting cells of butyl organisms. The different results obtained by the various authors can be explained by the utilization of different strains. Thus, we have observed that washed cells of the strain *GR*4 of *Clostridium saccharobutyricum* Schattenfroh and Grassberger, when acting on pyruvate, give rise to acetate and butyrate. The same results are obtained with suspensions of *Cl. acetobutylicum* (Weizmann) McCoy, Fred, Peterson and Hastings, strain *Fd*11, whereas strain *PC*48 and some other strains of the same organism give rise only to acetate when acting on pyruvate. These last strains may need a coupled reaction to ferment pyruvate in the normal C_4-compounds.

M/1,000 arsenite totally suppresses butyric acid formation from pyruvate with those strains able to give both acetate and butyrate from pyruvate[1]. The total volatile acid is about 30 per cent lower in the presence of arsenite than in the controls, but only acetic acid is formed. This suggests a possible transformation of acetate into butyrate during normal fermentation. Such a transformation has been found to occur in cultures in experiments using carbon-13 by Wood, Brown and Werkman[2]. Further experimental evidence for this fact has been adduced by us on the course of pyruvate fermentation by resting cells. At the beginning of the experiment, pure acetic acid was obtained, while the ratio butyric/acetic acid eventually reached 1/1 and even 2/1 (Duclaux distillation data).

Acetate alone, or in the presence of hydrogen (with and without phenosafranine), does not give rise to butyrate.

Peldàn[3] suggested that β-hydroxybutyrate could be an intermediate in the formation of butyric acid. We have found that this compound is readily fermented at *p*H 7 by washed suspensions of all the strains of *Cl. saccharobutyricum* and *Cl. acetobutylicum* tested, whether or not they were able to form butyrate from pyruvate. The volatile acid products of this fermentation were acetic and butyric acids in the ratio 1/1, independently of the time of incubation. Butyrate formation from β-hydroxybutyrate is unaffected by arsenite. Our results on β-hydroxybutyrate fermentation do not agree with the conclusions drawn by Johnson, Peterson and Fred[4] from their studies on growing cultures.

Our strains, in accordance with the findings of Simon and Weizmann[5], do not ferment succinate. On the contrary, fumarate, oxalacetate, and to a lesser extent, malate, are well fermented to butyric and acetic acid by *Cl. saccharobutyricum* (strain *GR*4).

We propose as a working hypothesis the following scheme for butyric acid formation:

pyruvate → acetate → unknown intermediates → β-hydroxybutyrate → acetate + butyrate.

According to this hypothesis, arsenite acts on a stage anterior to the formation of β-hydroxybutyrate.

A detailed account of the experiments will shortly be published elsewhere.

GEORGES N. COHEN
GERMAINE COHEN-BAZIRE

Laboratoire de Chimie bactérienne,
Institut Pasteur,
Garches (S. et O.).
May 20.

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[2] Wood, H. G., Brown, R. W., and Werkman, C. H., *Arch. Biochem.*, **6**, 243 (1945).

[3] Peldàn, H., *Biochem. Z.*, **309**, 108 (1941).

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British Abstracts

IN my section of the account published in *Nature* of August 21 of the Royal Society Scientific Information Conference, I stated that ***British Abstracts*** were of the 'indicative', that is, a briefer type; other abstracts were of the 'informative', that is, a longer type. That is how those various services describe the abstracts they publish. Fear has been expressed lest those unfamiliar with *British Abstracts* or with the use of these words, 'indicative' and 'informative', in this connexion may infer that *British Abstracts* differ radically from all the others, and may be even merely extended titles. This, of course, is not so.

The papers circulated to the Conference explained that an 'indicative' abstract aims at giving the reader sufficient information to decide whether he should read the original paper or not, and that while the 'informative' abstract is usually longer and contains more data, many of the abstracts published by the 'informative' services are of the 'indicative' type.

I am left with some doubt, however, regarding the aptness and usefulness of these words in this connexion.

DAVID CHADWICK

HEXOSAMINE COMPONENTS OF THE HUMAN BLOOD GROUP SUBSTANCES

By D. AMINOFF and W. T. J. MORGAN

Lister Institute of Preventive Medicine, London, S.W.1

FOR some time past we have been engaged on the isolation and characterization of the specific blood group substances which belong to the *ABO*[1] system. The identification of the component molecules of these complex mucoids has been delayed until satisfactory evidence for the homogeneity of the substances was obtained. On the basis of the results of measurements which have involved the physical, chemical and immunological properties of the human group *A*-substance, we consider that this material has now been obtained as a homogeneous complex. Full details of its preparation and properties will be given elsewhere[2].

The partial and complete hydrolysis products of the homogeneous *A*-substance have been investigated, and during the examination of the amino-acid components by means of two-dimensional paper partition chromatography[3], using collidine and phenol-ammonia as solvents, it was observed that two of the thirteen spots which developed on treatment of the paper with ninhydrin could not be identified with those expected from known amino-acids. It is well known, however, that the hexosamines, glucosamine and chondrosamine, of which glucosamine has already been identified as a component of the *A*-substance, react with ninhydrin under the conditions of the test to give a greyish-mauve area indistinguishable from the coloured areas which arise from the majority of amino-acids.

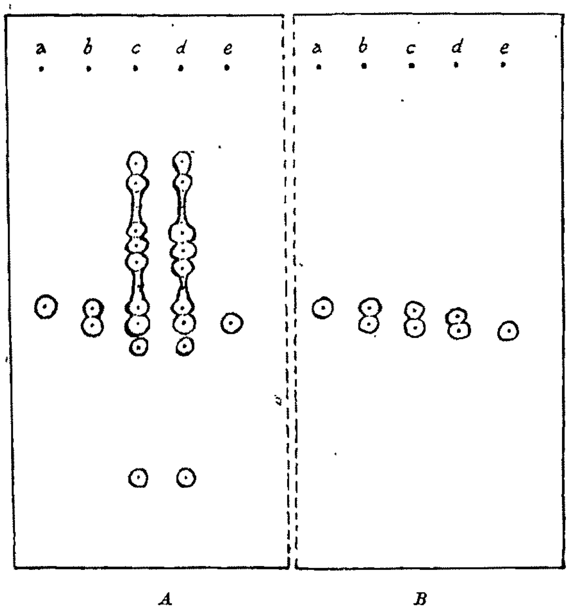
The colour reaction of the amino-sugars, glucosamine and chondrosamine, with a modified Ehrlich's reagent after treatment with an alkaline solution of acetylacetone under carefully controlled conditions has been used for the quantitative determination of these hexosamines[4], and has recently been extended to their detection in paper chromatography[5]. Using this reagent with the *A* hydrolysis products, two cherry-red spots were obtained corresponding in position to the two unknown ninhydrin spots.

A two-dimensional paper chromatogram using collidine and phenol-ammonia (0·6 per cent w./v. ammonia and coal gas) as solvent systems on the hydrolysis products (1 mgm.) of *A*-substance (16 hr. 6 *N* hydrochloric acid at 100°), to which 0·1 mgm. each of glucosamine and chondrosamine hydrochloride were added, resulted in no additional spots appearing when the paper was developed with ninhydrin. A similar chromatogram produced simultaneously with glucosamine (0·1 mgm.) and chondrosamine (0·1 mgm.), but developed with the hexosamine reagents in place of ninhydrin, revealed two areas corresponding in position to the two unidentified ninhydrin spots. It seemed probable, therefore, that the two unidentified ninhydrin spots were due to glucosamine *and* chondrosamine.

Two additional chromatograms using the acid hydrolysis products of the human *A*-substance were run with (*a*) collidine and *n*-butanol-ammonia (3 per cent w./v. ammonia) and (*b*) collidine and *n*-butanol-water as solvents. Both chromatograms showed two ninhydrin spots which, however, were not due to methionine or tyrosine, which have the same R_F value in these solvents, because two similarly placed cherry-red spots were obtained on another sheet run simultaneously and sprayed with the hexosamine reagents. The separation of the two hexosamines in butanol is poor; but with butanol-ammonia and with collidine a useful resolution is obtained.

These observations were correlated by making a run with collidine as solvent on a single sheet of Whatman No. 1 paper. Along the width of the paper, ten positions were marked out and the following substances (or mixtures) were put on the paper and run with the solvent for 72 hr.: (*a*) chondrosamine hydrochloride, (*b*) chondrosamine and glucosamine hydrochlorides, (*c*) acid hydrolysis products of *A*-substance with (*b*) added, (*d*) acid hydrolysis products of *A*-substance alone, and (*e*) glucosamine hydrochloride. The series was repeated on the remaining half of the paper. The paper was then dried and cut into two along the dotted line (see figure); one half was sprayed with the ninhydrin reagent and the other half with the hexosamine reagents. The coloured areas which developed are shown diagrammatically. There seemed strong evidence for believing that both amino-sugars were present as components of the *A*-complex.

N-acetylglucosamine and N-acetylchondrosamine give no colour with the ninhydrin reagent, move faster than the corresponding bases and yield a mauvish-pink colour with the hexosamine reagents. N-methyl-L-glucosamine, a component of streptomycin[6], has an R_F value in collidine only slightly greater than glucosamine, but its colour reaction with ninhydrin—a pale pink colour forming after heating at 80–90° for a few minutes—is in marked contrast to that shown by glucosamine and chondrosamine and by the 'unidentified' spots which arise from the hydrolysis products of the group *A*-substance. Again, under the test conditions with the hexosamine reagents, N-methyl-L-glucosamine develops a mauvish-pink colour, reminiscent of coloration which arises from the acetylhexosamines and very different from the cherry-red colour given by the hexosamines.



A. Chromatogram developed with ninhydrin reagent.

B. ,, ,, ,, acetylacetone followed by Ehrlich's reagent

It has been observed that treatment of the paper with collidine or phenol, but not butanol, seems to suppress its reaction with the ninhydrin and hexosamine reagents. Thus, although the chromatographic data do not completely rule out the possibility of the presence of N-methyl-L-glucosamine, this substance is certainly not responsible for either of the hexosamine spots obtained.

Partridge[5] examined by the chromatographic technique the sugar components of an inhomogeneous preparation of *A*-substance obtained from gastric mucin[7] and concluded that chondrosamine was not present.

To summarize the evidence for the occurrence of glucosamine and chondrosamine in the group *A*-substance, it may be stated that as a result of examining the complete acid hydrolysis products of the substance on paper chromatograms, two spots which occur close together are detected with three different reagents: (*a*) ninhydrin, (*b*) ammoniacal silver nitrate[5] and (*c*) the hexosamine reagents. All three reagents detect the hexosamines but under the test conditions exclude the presence of the N-acetyl derivatives and N-methyl-L-glucosamine. The two spots have R_F values identical with glucosamine and chondrosamine in (*a*) collidine, (*b*) phenol-ammonia, (*c*) *n*-butanol, and (*d*) *n*-butanol-ammonia (3 per cent w./v.). The addition of glucosamine and chondrosamine to the hydrolysis products of *A*-substance results in the development of no additional spots irrespective of the reagents used for development. Treatment with zeolite resulted in the removal of glucosamine and the unknown material[7] as determined by ammonia – silver nitrate reagent. Fractional precipitation of the *A* hydrolysis products with acetone and ether results in the separation of material which when tested on paper strips gives rise to two spots which are considered to be due to the presence of glucosamine and chondrosamine.

Preparations of the *A*- and *H*-substance[8] (the so-called '*O*' substance) obtained from pig gastric mucin, and partially purified *H*-substance isolated from human pseudo-mucinous cyst fluids, also show the presence of the two hexosamine spots.

An examination of the relevant literature shows that in many instances the amount of glucosamine isolated from the hydrolysis products of mucopolysaccharides and mucoids represents only a small part of the total hexosamine estimated to be present by the colorimetric method. For example, Meyer, Smyth and Palmer[9] isolated about 30 per cent of the total hexosamine present in a preparation of the neutral polysaccharide of pig's gastric mucosa, whereas from the acid mucopolysaccharide coexisting in this tissue a yield of more than 90 per cent of the hexosamine present was obtained. Several procedures have been devised for the isolation of glucosamine which give excellent yields of this amino-sugar[10], but in spite of the application of these methods to the hydrolysis products of some mucopolysaccharides poor yields of glucosamine have been obtained. In view of the difficulty of isolating chondrosamine, however, it is suggested that in certain instances the poor yields of isolated glucosamine might well be due to the presence of a second amino-sugar, and a re-examination of the nature and amount of the 'hexosamine' component in these materials is suggested.

The identity of the second hexosamine present in the blood group substances with chondrosamine is not conclusively established by the evidence presented in this communication, and the claim that it is a component must await the isolation of one or more crystalline derivatives identical with the corresponding derivatives of an authentic specimen of chondrosamine. We are now engaged on obtaining this evidence.

We are indebted to Prof. M. L. Wolfrom for a sample of N-methyl-L-glucosamine.

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VOLATILE CUPROUS AND SILVER SALTS OF FATTY ACIDS

By A. KELLER

Department for General Chemistry, University of Budapest

AND

DR. F. KÖRÖSY

Vavil Research Laboratory, Vacuumtechnical and Electric Co., Budapest

IN a communication in *Nature*[1], one of us (F. K.) reported on a volatile copper compound obtained by thermal decomposition of cupriformate. J. G. Maltby[2] directed attention to the work of A. Angel and A. V. Harcourt[3], according to whom cuprous acetate forms as a white sublimate when cupriacetate is heated.

We succeeded in isolating the volatile product of decomposition of cupriformate, and microanalytical determinations proved that it was cuprous formate. Our previous assumption that the 'volatile' compound was present in the form of vapour or gas in the gas streaming over the decomposing cupriformate was erroneous. Passage of the gas through layers of 5–30 mm. length of cotton wool, glass wool or asbestos revealed that we had been dealing with an extremely fine aerosol which could be 'developed' by chemical methods along the stopping layer, for example, with hydrogen sulphide as brown-black cuprous sulphide. The distribution of colour along the layer gave the impression of decreasing exponentially along its length. The aerosol also acted on saturated vapours, forming condensation centres.

By causing turbulent flow of the transporting gas, for example, by blowing it against a wall or into a reversed capillary, we obtained a white deposit of this aerosol which showed the following reactions: (1) water or water vapour decomposed it into a yellow solid (cuprous hydroxide) and formic acid; (2) acids decomposed it into a red insoluble powder of metallic copper and blue cupriformate; (3) it sublimes *in vacuo* between 100° and 105° C. but begins to decompose already at 105° C. (this may account for the fact that Kohlschütter[4] failed to detect it in his detailed work on cupriformate decomposition, because he worked at about 200° C.); (4) because it is decomposed by water and acids (1 and 2), it was difficult to collect sufficient pure material for analysis, since water and formic acid are among the primary decomposition products of the cupriformate. The gas had to be dried with calcium chloride and neutralized with layers of potassium carbonate which occluded most of the aerosol. However, it was possible with extreme precautions to prepare samples of 3–8 mgm. and to determine iodometrically their copper content and bromometrically their formate content, after having duly identified the latter by the calomel and silver reduction methods. Naturally, Cu and $HCOO^-$ were separated from each other before determination. The results agreed within 2–4 per cent with the theoretical values for cuprous formate (CuHCOO).

The only mention of this substance in the literature is to be found in A. Angel's paper[5], who obtained it from solution. We found that the formation of white cuprous compounds which sublime is a general property of cupric fatty acid salts: the acetate, propionate, valerate behaved in a similar manner; laurate and stearate, though melting and carbonizing, yielded mirrors also, indicating a similar decomposition of these salts as well. The cuprous compounds were all very prone to thermal decomposition into metallic copper. They also reacted with water and acids like the formate (reactions 1 and 2):

$$Cu.HCOO + H_2O \rightarrow CuOH + HCOOH \tag{1}$$

$$2Cu.HCOO \xrightarrow{H^{\cdot}} Cu(HCOO)_2 + Cu. \tag{2}$$

An old Liebig combustion tube, when heated gently while a stream of nitrogen passed through it, showed copper mirror formation at several points and a white deposit was formed at the end of the tube, where the temperature was about 100° C. The latter looked like cuprous formate and gave all its characteristic reactions. This fact seems to explain former observations on volatile copper in combustion tubes, which originally contained no fatty acids, though traces of other organic compounds were present, of which fatty acids—most probably formic acid—might arise through heating by the catalytic action of copper.

We also prepared the fatty acid salts of silver, taking care to avoid decomposition of the formate by immediate washing of the precipitate. The formate explodes with intense detonation on heating to 90–100° C.; it was necessary to mix it with indifferent powders to avoid detonation. All these salts could be made to sublime *in vacuo* using a micro-technique with extreme precaution. The analogy with the cuprous compounds seems to be perfect. Some tentative experiments with gold hydroxide in a stream of warm formic acid vapour looked as if there had been miniature explosions and mirror formation; however, we do not wish to insist upon the reality of these observations.

The analogy of silver and cuprous formate gave us the key to the quantitative study of thermal decomposition of the copper formates. First of all, we determined the gas reaction products of the decomposition of silver formate and found that it agrees with the following reaction:

$$2Ag.HCOO \rightarrow H_2 + 2CO_2 + 2Ag$$

within about 5 per cent, of which 1 per cent was methane, somewhat less carbon monoxide and the rest unidentified. Traces of water could also be observed. We assume that cuprous formate, which could not be prepared in a quantity sufficient to study this reaction, decomposes in the same manner.

On the other hand, we determined the decomposition products of 1 mol. of the thermally decomposed cupriformate, and found as average a relative error of about 5 per cent for carbon dioxide and formic acid and an error of 10–15 per cent for the rest:

0·97 mol. per cent carbon dioxide
0·84 mol. per cent formic acid
0·10 mol. per cent hydrogen
0·08 mol. per cent water (approximately)
0·05 mol. per cent carbon monoxide ,,

This accounts for 102 per cent hydrogen, 93 per cent carbon and 94 per cent oxygen. The results indicate clearly that the main line of decomposition (say, 80 per cent) must follow the reaction:

$$Cu(HCOO)_2 \rightarrow Cu + HCOOH + CO_2.$$

Only a side branch of the decomposition can go through cuprous formate if we assume that (1) its decomposition is analogous to that of silver formate, and (2) all hydrogen found is formed from this cuprous salt:

$$2CuHCOO \rightarrow 2Cu + H_2 + 2CO_2.$$

In this case the excess of carbon dioxide with respect to formic acid should be double the molecular percentage of hydrogen, while actually 1·3 mol. were found; but the experimental errors may account for the difference. Roughly, 15 per cent of the original cupriformate would have reacted in this event to yield cuprous formate, and it can be stated with reasonable certainty that the reaction taking place is:

$$2Cu(HCOO)_2 \rightarrow 2CuHCOO + HCOOH + CO_2.$$

There is, however, a possibility of the following reaction:

$$2Cu(HCOO)_2 \rightarrow 2CuHCOO + H_2O + CO + CO_2.$$

The presence of carbon monoxide and water could be taken as indication of the second reaction, but the fact that the carbon monoxide obtained was approximately half the hydrogen found may indicate that it is only one of several reactions occurring. We should not forget that Kohlschütter found a small quantity of hydrocarbons among the decomposition products; this may have been synthesized by catalytic action of the highly disperse copper from the primary products. We found only insignificant traces of formaldehyde among them.

On the hypothesis that the direct decomposition of cupriformate yields copper powder and that decomposition through intermediary cuprous formate is responsible for the formation of the copper mirror on the wall of the reaction vessel, we tried to separate these two forms of copper and found that there is certainly not more than 25 per cent copper in the form of the mirror. It may have been considerably less, in accordance with the above calculation.

The nature of the 'volatile copper compound', or more correctly 'compounds', is therefore definitely established, and the main lines of thermal decomposition of cupri-, cuprous and silver formate are determined with reasonable certainty.

A detailed account of the work will appear in *Magyar Technika.*

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ENGINEERING STUDENTS AND MATHEMATICS

On the morning of September 14, at a joint session of Sections A (Mathematics) and G (Engineering) of the British Association, a discussion took place upon the subject of "Applicable Mathematics".

Wing-Commander T. R. Cave-Browne-Cave (president of Section G) in his opening remarks emphasized that mathematics is a matter of importance, but often of difficulty, to engineering students.

Mr. D. N. de G. Allen (Mathematics, Imperial College of Science and Technology, London) said he spoke as one engaged in teaching mathematics mainly to undergraduate and postgraduate engineering students. He would consider not the oft-asked question: "What does the engineer require of mathematics ?", but rather "What does his mathematics require of the would-be engineer ?" Mathematics is an integral part of engineering science, evolved to satisfy the demands of engineering, and should be used by the engineer as one of the tools of his trade. The obstacles the engineer has to overcome are: first, the fact that his problem is stated in engineering terms, and must at the outset be translated into mathematical terms; secondly, the mathematical problem must be set up; thirdly, a mathematical solution must be found; fourthly, this solution must be translated back into an engineering solution. In stage one it is desirable that *all* the available data be explicitly stated. In stage two it is especially important to realize whether the mathematical problem is, or is not, complete in itself. In stage three the maximum possible use should be made of simple ideas, simple methods, and simple functions. In particular, numerical methods, which enable formerly intractable problems to be solved by simple arithmetic, using processes which are intelligible at every step, have great merit, at postgraduate as well as at undergraduate level. At the same time, however, the more advanced mathematical methods should not be entirely overlooked; the engineer should be aware of the existence of such methods, and should know when, and how, to consult the mathematical expert.

Dr. J. A. Pope (Engineering, University of Sheffield) pointed out that engineering, a branch of applied science the object of which is to create objects of immediate utility, calls upon many branches of science; and while the engineer could not be expected to have a detailed knowledge of all these branches, he must know enough to be able to appreciate the significance of the information supplied by the specialist. But engineering is also a delicate balance between tradition and the application of scientific knowledge, the 'factor of safety' representing the traditional element in design. Turning to mathematics, he suggested that any mathematical process which the engineer is prepared to adopt must be susceptible of a physical interpretation, and this, indeed, at every stage. Another necessity for the engineer is 'pictorial vision', and this can be both aided and exploited by copious use of graphical methods in teaching mathematics; abstract ideas can with advantage be handled by means of graphical representation, for example, vector diagrams, and the Argard diagram for complex quantities involving $i = \sqrt{(-1)}$. After brief reference to some essential elements, such as power and Fourier series, integration, partial differentiation, and differential equations, the advantages of numerical methods (step-by-step and 'relaxation') were mentioned, and the necessity of some more advanced mathematics for the abler men was pointed out. But there is a difference in intellectual make-up between the mathematician, master of abstract thought, and the engineer, servant of practical necessity. This has sometimes led to barbarous treatment of mathematical lecturers by otherwise well-behaved engineering students, and to a 'pearls before swine' attitude on the part of some of the former.

Mr. F. S. Snow (president, Institution of Structural Engineers)—whose contribution was read for him on account of illness—referred more particularly to the extent to which the average engineer needs to utilize mathematics in the solution of day-to-day problems. The more experienced an engineer, the less mathematics he personally uses in his day-to-day business. He is, however, able to use the mathematics he learned as a student when necessary, and knows where to turn for the more advanced methods. But the experienced engineer will not profess to be able to design, say, a reinforced concrete column by eye alone, and he will employ younger engineers, and perhaps even mathematicians, to perform the calculations inseparably connected with design. For these, familiarity with mathematics, at least as far as the calculus, is essential. From time to time, new theories based on new assumptions are produced, usually by the mathematicians, and at first the engineer must rely upon the resulting formula; reinforced concrete shell roofs are an example. On the other hand, the practical engineer is faced with uncertainty as to data, as to the properties of many of the materials he uses, and as to the excellence (or otherwise) of the workmanship. Mathematically elegant designs may be scrapped because they demand a higher standard of workmanship than is generally available. Thus, while all engineers should attain a standard in mathematics at least as high as that prescribed by the professional institutions, they require also to amass a vast amount of experience.

Dr. A. G. MacFarlane (Telecommunications Research Establishment, Malvern) devoted himself to a particular, rather than a general, aspect of the subject under discussion, namely, the calculus of variations and its usefulness as a method for the solution of physical and engineering problems. He referred to the development of the principle at the end of the eighteenth and beginning of the nineteenth centuries as outstanding, the most important feature being Hamilton's demonstration that the equations of dynamics might be derived from a stationary principle. As a result, variational principles now occupy a central position in theoretical physics, but are still not used as much as they might be. Most problems must be idealized before they become tractable, but the more powerful the mathematical technique, the less the amount of idealization necessary; it is therefore desirable to review all the possible methods when tackling any problem. Most physical problems are usually stated mathematically in terms of differential equations and boundary conditions. But differential equations are 'local', and use of integrals is advantageous, because they include the behaviour of the functions over the whole range of variables, and also because they incorporate the boundary conditions. Such methods are (1) integral equations, (2) variational principles. Using for illustration the diffraction of electromagnetic waves by a slit, the advantages of the variational methods were outlined. The variational equations may be solved, for example, by Ritz's method or by 'relaxation'. Another advantage is that the integral which is to be made stationary usually represents a quantity of great physical significance.

Prof. W. G. Bickley (Mathematics, Imperial College of Science and Technology, London) said that the opening speakers had considered the mathematical education of the ordinary engineer, and the mathematical needs of the extraordinary engineer, in what seemed to him about the right proportion, and had underlined the fact that the problem exists at two levels. At the lower level the problem is not so much *what* to teach, as *how* (and to some extent *when*) to teach it. Following up Mr. Allen's emphasis upon the necessity of translating from the language of engineering to the language of mathematics, he stressed the desirability of the lecturer in mathematics being able to speak the engineer's language. One of the greatest obstacles in the way of the enlightened mathematician is the still too prevalent attitude that mathematics should be avoided like a plague, instead of used to increase efficiency. It is inconsistent to advocate modern machine tools in the workshop, and fall back upon the equivalent of cold chisel and file for thinking. So absurd, indeed, that he wondered whether the mathematicians had always given the engineering students a fair deal, whether the barbarity referred to by Dr. Pope was partly their fault—if there was a 'pearls before swine' attitude, then barbarity was just retribution. Speaking of engineering students as amenable to sympathetic treatment, and of teaching them mathematics as a rewarding and enjoyable task, he urged his mathematical colleagues to take this task seriously. Familiarity with the mathematical chapters of the engineering text-books would give much food for thought, in more ways than one. Improvements were, of course, being made, and he instanced the work of a sub-committee set up by the Mathematical Association. But education is a slow process. Perhaps some of his students, becoming lecturers in engineering, might condition the minds of their students to more and better mathematics.

Turning to the high-level problem, Prof. Bickley said two things are necessary—to be able to give a 'top-dressing' of applicability to the graduate mathematician, and a top-dressing of mathematics to the abler graduate engineer. For this a central "Institute for Applicable Mathematics" is desirable. Attached to a university, but maintaining close contact with research institutions, with a staff collectively conversant with classical and modern mathematics, mathematical physics and technology, interested in seeing where and how mathematics has aided and can aid the scientific worker and technologist, such an institute would so equip its students that they might fit very quickly into any research institution or could become teachers in the technical colleges and universities. Part-time and refresher courses, for those already engaged in research or teaching, would also be provided. Indeed, the principle had been agreed, but lack of funds has prevented a start being made. Could industry, perhaps on a co-operative basis, come to the rescue? If so, the outlay would earn rich, if perhaps indirect, dividends.

Sir Richard Southwell remarked upon the friendliness of the discussion. He thought this a good thing, because in his opinion there *is* a fundamental difference of outlook between mathematician and engineer, in consequence of which they would have to agree to differ—and agreement to differ is possible only between friends. He gave some illustrations of the difference of outlook. As regards calculus of variations, he thought that many engineers were already familiar with examples of the idea, for example, minimum strain energy as a basis for analysis of structures. Many abstract ideas could be assimilated if they were approached through concrete examples, and he agreed with Dr. Pope's emphasis upon keeping the physical meanings in view. He also instanced Rayleigh's use of variational methods for deducing governing equations throughout his great "Theory of Sound".

Mr. R. A. Fairthorne agreed upon the necessity of properly stating the problem. To do this needs a realization of what is essential, and he had found lawyers and journalists, who habitually have to endeavour to see the essence of a problem they do not understand, better at this than mathematicians or engineers. Training in logic or philosophy greatly assists. Prof. H. S. Ruse commented upon the general keenness of engineering students. He suggested that what was perhaps more important to the engineering student than acquisition of technique was an appreciation of mathematical methods of thinking. Prof. S. J. Davies said that what he would wish for his students was that the mathematicians would teach them mathematics. He mentioned that a water turbine recently constructed according to the 200-year-old design of the mathematician Euler had an efficiency of more than 60 per cent.

Prof. Bickley thought that Sir Richard Southwell tended to exaggerate the difference between mathematicians and engineers; but that so far as it did exist, a friendly agreement to differ, along with a sincere attempt to understand one another's language, were desirable. He agreed with Mr. Fairthorne upon the importance of being able to discern the crux of any problem, and thought that the conciseness and precision of mathematical expression were a great help in this direction. He was glad that Prof. Ruse could agree about the keenness of engineering students. He could agree with Prof. Davies, and asserted that the one thing that the mathematics course should not appear to be was a sequence of *ad hoc* tricks for doing particular jobs. He did, however, think that the best chance of getting engineering students to appreciate mathematics for its own sake was to start with a recognition and an understanding of their interests and habits of thought.

CONTROL OF ENVIRONMENT IN HORTICULTURE

ON September 13, Section M (Agriculture) of the British Association held a discussion on "Control of Environment in Horticulture", over which Prof. H. D. Kay presided.

Dr. W. F. Bewley opened with a paper on "The Control of Heat and Light in Glasshouses". He pointed out that although plants in glasshouses are warmer and more sheltered than those in the open, the light intensity is reduced, moisture tends to accumulate, and crop rotation is scarcely possible. So the owner of glasshouses has problems to face which have no parallel in field cultivation.

The action of light must be considered in two different ways, namely, its photosynthetic effect on the production of carbohydrates with the consequent increase in growth, and its photoperiodic effect in deciding the actual time of flowering. Dealing with the former and referring to workers in the United States, Holland and Britain, he pointed out that by irradiating seedlings and young plants for three or four hours at the end of the day, it is possible to stimulate growth considerably, and in the case of cucumbers to achieve a worthwhile increase in crop. The main facts emerging from the experiments are that a high light intensity, 300–400 foot candles, is necessary, that the effect is mainly upon young plants and that the cost of the apparatus is high. The work has not yet reached a stage at which it could be recommended to commercial growers.

In photoperiodism, the case is much different, for by adjusting the length of day either by darkening or irradiating the plants, it is possible to retard or advance the flowering of many plants; and in the case of chrysanthemums to produce flowers for market at any time of the year. The apparatus is cheap, the duration of illumination short, and the process effective. He suggested that the assistance of physicists and engineers is necessary to solve the problem of light supply to increase growth and crop production, and that large-scale illumination from high-power lamps above the ranges of glasshouses might provide the solution. Until this is achieved, growers should site their nurseries in districts where winter light is at a maximum, glasshouse builders should design better lighted houses, and east-to-west houses should be built for propagating young plants and for growing pot plants during the winter.

Turning to the question of heat, Dr. Bewley said that considerable progress has already been made in thermostatic control. It is now possible to maintain a constant night temperature by applying thermostatic control to all systems of heating, including high- and low-pressure steam, steam-cum-water, oil-fired boilers, gravity feed and under-feed stokers using solid fuel. Despite these improvements, however, he said little has been done to cool the glasshouses during the summer, and he hoped the engineers would help.

On the subject of soil warming, he discussed the relative values of electrically heated wires and hot water circulated through small pipes. Soil-warming experiments have shown that raising the soil temperature provides bigger and cleaner roots, better plants, heavier crops and earlier maturity.

In conclusion, Dr. Bewley concluded that temperature control of glasshouses has already made good progress, but that control of light is still a problem for the future.

Mr. Raymond Bush, who followed with a paper on "Frost and the Fruitgrower", said that prior to 1935 no real attention had been given in Britain to May frosts. Indeed, the East Malling conference held that year showed very clearly that no one knew very much about them. From his extensive investigations, Mr. Bush gave many examples of frost injury which showed very clearly that cold air follows to some extent the behaviour of water in flowing over the land; it follows the contours, settling in valleys and hollows generally, or draining through them without causing damage. In view of the way in which great variations in crop production can be attributed to frost, he urged the necessity for selecting the correct site when planning new plantations, and expressed the view that areas of land suitable for future development should be earmarked for this purpose. So many orchards, however, are so badly sited that it is now a question of fighting the frosts and not preventing them. In this respect Mr. Bush discussed the value of shelter belts, but pointed out that they should contain gaps through which the cold air could drain away to levels below the orchards.

The talk was admirably illustrated with lantern slides. By this means, Mr. Bush gave a clear picture of the present attempts to fight frosts both in America and in Great Britain. He discussed the use of heater pots, the movement of air by mechanical means, including the helicopter, and the use of smoke generators and infra-red lamps. In conclusion, he was careful to point out that the wise choice of a site is still of fundamental importance.

The last paper, by Mr. F. A. Secrett, was on "Horticultural Crops in their Relationship to Water". Mr. Secrett said that the present world food shortage demands that the best use must be made of all available land, and that if the weight per acre could be increased, more land would be freed for other crops. He argued that as the growth of plants varies directly in accordance with the water supply, we experience gluts in wet weather and shortages in dry weather. Further, dry spells in the summer cause delay in sowing or planting the second crop. Armed with an efficient irrigation plant, growers are independent of rain. They can produce better crops of higher quality vegetables and continue their cropping programme unhindered by dry weather. Indeed, he claimed that some crops can be doubled in weight where watered overhead, especially if a little soluble nitrogen is added to the water.

Mr. Secrett discussed in detail the results of experiments on his farm carried out in co-operation with Rothamsted Experimental Station. For example, the application of 4 in. of water increased the yield of carrots by 20 per cent. Sugar beet producing 20 tons of roots in the control plot gave 29 tons in plots receiving 10 in. of water by overhead irrigation, and in addition to this the sugar content was increased considerably. Speaking on the question of quality, Mr. Secrett claimed that when vegetables are irrigated correctly they improve in flavour, and gave examples of this in the case of radish, lettuce and cauliflower. Overhead irrigation is a very valuable process in the hands of the grower.

The advantages of overhead irrigation are many. The grower is independent of rain, and can continue to carry out his crop programme and cultivations in the driest weather. Quality is improved, weight of crop per acre is increased, a high plant population is possible, and pests due to drought are controlled. Soluble fertilizers can be added to the water and minor elements also supplied in this way. Production is speeded up and a greater variety of vegetables can be grown.

The discussion was opened by Lord Bledisloe, who was followed by Sir John Russell and others. In replying to questions Dr. Bewley said that, whereas glasshouse growers as a whole are not attracted by cloches, new entrants into horticulture are learning how to use them and many seem satisfied with the results. He thought that no objection could be raised to steel houses on the basis of more severe temperature fluctuations. He had examined most glass-substitute materials, and while some are satisfactory for a year or two, those that are cheap enough for commercial purposes do not stand up to weather conditions very long. He had long been interested in waste heat from power stations and factories. Usually the waste hot water is not hot enough for circulating in the glasshouse pipes, and there is the disadvantage of injurious fumes and grit owing to the close proximity of the industrial plant.

Mr. Bush, in reply to questions, emphasized that shelter belts should always contain gaps through which the cold air can drain away. The lime makes a good shelter belt, but must not be too dense.

Mr. Secrett said that the addition of nitrate of potash in the irrigation water had always given better results than nitrate of soda, but he could not say why. It was perhaps surprising that the very small amounts of fertilizers used in the water had such big effects, but it was probably due to the repeated applications. There is no limit to the area that can be irrigated provided the spray lines are available. His units are four acres, and at Milford he irrigated twenty acres from one centre.

INTER-UNIVERSITY RELATIONS AND EXCHANGES

THE question of inter-university relations, which was discussed on July 21 at the Congress of Universities of the Commonwealth, is partly an administrative and partly an academic question. On one hand, it is necessary to make such business arrangements between the universities as will enable a young student or teacher to move from one university to another without academic loss of standing or financial embarrassment. On the other, it is necessary to make such an exchange sufficiently attractive from an academic point of view for the man or woman contemplating a temporary migration to make sure that it will be academically advantageous. No young man with academic ambitions —which will probably be centred in his own country— will welcome the idea of an exchange which will leave him for a year in a university which is not equipped whether in its libraries or laboratories to enable him to develop his own research. Conversely, no university will welcome a teacher who regards himself as nobly and self-sacrificingly spreading the joys of learning to universities less lucky than his own.

This latter problem can only be met by the universities knowing each other better. Though many of the speakers at the Congress admitted that their universities were ill-equipped for certain types of work, almost all were able to claim that in one subject or another they were doing work, or had work waiting to be done, which would be most attractive to a young teacher anxious to become master of some topic. The vast quantity of work awaiting the historian of Australia is an example. The first essential is that the universities should know each other far more intimately than they do at present. The Congress agreed to recommend that the universities of each country should be encouraged to form an agency which should act as an instrument of communication with universities elsewhere. Further, since the whole Congress meets only every five years, it was suggested that, in the years between such meetings, vice-chancellors and senior members of staff should visit each other as frequently and as regularly as possible.

The Congress passed several resolutions designed to make the traffic between universities easier and less hazardous. The first resolution dealt with the announcement and advertising of vacancies. It is in this stage that the central office of the Universities Bureau can be of great assistance. It can keep in touch with the appointments committees of the several universities and provide information about the type of post to be filled. It can arrange for candidates to be interviewed by a panel composed both of experts in any subject and of men acquainted with the university which is advertising a vacancy. It can arrange for the successful candidate to be given expert advice about what he may expect to find at the university to which he is going. But it cannot fulfil these functions unless it is very fully informed of the needs of the advertising universities. Many posts are filled by a local man although the formality of advertising may be maintained. It is obviously undesirable in these cases to put candidates to the expense and inconvenience of applying for a vacancy which is more nominal than actual. But if the Bureau receives the help it needs, it can be of immense use to any universities arranging exchanges.

The second resolution dealt with the question of superannuation benefits. Though the importance of ensuring that a man does not suffer financial loss if he goes temporarily to another university needs no stressing, the method of achieving this end is extremely complicated. A committee was set up to inquire into the possibilities.

The question of travelling expenses is closely related. The cost of moving from one part of the Commonwealth to another is in itself sufficient to make the idea impossible for most aspirants. It was agreed to approach bodies or foundations which may have resources available for this purpose; and the Congress was given to understand that proposals would be sympathetically received by some at least of these foundations. It is quite certain that no exchanges can be successfully arranged unless the finances are arranged in such a way as to make the project if not attractive at least reasonable, from the point of view of the scholar or student who is contemplating migration.

The Congress had before it a report written by Mr. Douglas Veale, registrar of the University of Oxford. Mr. Veale has recently been in Australia and wrote an account of his visit and put forward several recommendations as a result of what he had learned. As his memorandum took the form of a report to his own University, it was not discussed by the Congress; but it included the greater part of what the delegates to the Congress were seeking.

and, moreover, it put it in a form which implied that it would not be impossible to implement the proposals almost at once.

Mr. Veale's first recommendation was based on the fact that universities in Britain are overcrowded and under-staffed. A great part of the extra burden which is now being borne in British universities could be shared with young postgraduates from abroad—preferably young men immediately after their appointment to lectureships at their own universities. There would be no difficulty in asking them to take a few hours teaching, by which means they could supplement their incomes without making it impossible to do research work on their own. Mr. Veale found that the idea of combining teaching and research in this way would be welcomed by the Australian universities; and there is every reason to think that it would be to the advantage both of the teacher and of the taught.

Mr. Veale's other recommendations were closely in line with the resolutions which the Congress had passed. The discussion and the resolutions showed two things very clearly: first, a realization on the part of universities in all parts of the Commonwealth that it would be greatly to the advantage of all concerned if they could know each other better, and make more frequent exchanges of men and ideas; secondly, a determination to overcome the difficulties which are at present obstructing the way. A great deal depends on the reports which will be issued by the committees set up by the Congress at Oxford.

HEALTH OF THE PEOPLE OF BRITAIN

THE report of the Ministry of Health for the year ended March 31, 1947 (Cmd. 7441, pp. 1–204. London: H.M. Stationery Office, 1948. 3*s.* 6*d.* net), records, in general, another favourable bill of health. In spite of the continuance of rationing and other controls, and of the various additional ingredients of that too-familiar conception 'austerity', the vital statistics and other features of this report suggest that austerity is not really doing the population of Britain very much harm. In the period covered by the report the birth-rate rose to 19·1 per thousand of the population, a figure which is the highest recorded since 1923; and the infant mortality-rate fell to 43, which is a new low record. Maternal mortality also fell to a record low level of 1·43 per thousand total births, and death-rates at ages of less than fifteen years from measles, scarlet fever, rheumatic fever and heart disease were all the lowest ever reported. The death-rate was 12·0, which is the lowest since the previous best (11·6) in 1938.

One of the outstanding features of the year was the success of the diphtheria immunization policy. Deaths from this disease numbered 472, instead of the 2,361 reported in 1938, and there was a fall of 36 per cent in the notifications of diphtheria as compared with the year 1945. The greatest proportional decline was in the age-group 5–10 years (42 per cent), and the next greatest in the age-group 10–15 years (39 per cent). These figures speak for themselves; but the warning is issued by Sir Wilson Jameson that continual control of the antigens used for the immunization and maintenance of a high proportion of immune children are essential if this excellent result is to be maintained.

Encouraging also is the fact that in 1946 new low records were reported for deaths in Britain from respiratory and other forms of tuberculosis. In 1946 the number of deaths from this cause was 22,847, whereas ninety years ago it was 66,000 in England and Wales among a population half its present size. The report wisely avoids complacency about this advance in the control of a disease which still causes nearly one third of all deaths at ages between fifteen and thirty-nine. More beds for tuberculous cases are urgently required to accommodate the long waiting lists, and just as urgent is the need for more staff. If, says the report, the staff had been available, half the patients awaiting treatment could have been given beds during the last two years.

Notifications of whooping cough were higher than in 1945, a fact which will not surprise the parents of young children; but deaths from this distressing disease were lower. A reliable prophylactic vaccine has yet to be found, but experimental work on this problem is being energetically continued.

A serious feature of the report is the great increase of syphilis. New male cases at treatment centres rose to 10,705, a figure which is nearly double that of the previous year. Female cases, on the other hand, were 6,970 compared with 5,527 in 1945. An increase of 1,654 in the deaths from cancer is also recorded; but the report emphasizes that modern methods of treatment of this disease can do much to relieve the pain and suffering that it causes.

Among the many interesting facts recorded in the report is the slight decline since the middle of 1945 of about three-quarters of a pound in the average weights of adults aged twenty-five to fifty-four; but the improvements in the heights and weights of school children recorded during the later years of the War have been, on the whole, maintained. Nutritional surveys have shown that only 33 out of 7,216 persons in various parts of Britain could be classified as badly nourished.

During the first six months of 1946, smallpox was a continual menace because of the heavy return traffic from India by sea and air; but the energetic action of the health authorities confined the outbreaks that occurred within narrow limits. Readers of this part of the report will realize how much steady and unrecorded work is continually being done to safeguard the health of the people; and travellers by sea and air who read it in conjunction with the section dealing with the control of airborne and seaborne disease will understand that any regulations to which they have to submit when they enter Britain are not lightly imposed. In these days of rapid travel over great distances, it is clearly the duty of every traveller to see that he does not wittingly carry into the country which he visits diseases which may be deadly to the people living there.

It is not possible in a short review to record all the other interesting features of this comprehensive report. Apart from the facts it gives about the incidence of diseases other than those mentioned above, it includes discussions of the work of the emergency public health laboratory service, now a permanent feature of the medical organisation of the country, and of the excellent work being done on all aspects of maternal care, nutrition, the improvement of hospitals and their conflict with the building restrictions, water supplies, health publicity and other aspects of that proteus which we call public health. If there be anyone who doubts that the best effort and brains are being employed in this beneficent work, he should read this report and learn the truth. It will tell him, not about politics, but solely about the control and relief of suffering and the maintenance of the health of everybody. For that reason all those whose work is recorded or implied in its pages must feel gratified that their efforts have produced, in spite of the difficulties of these times, so much that is positive good and so much, also, that points to even greater achievements in the future. G. LAPAGE

BRITISH COUNCIL

ANNUAL REPORT

THE report of the British Council for the year ended March 31, 1948, refers to the withdrawal of its activities from Iceland, Switzerland, French North Africa, Bolivia, Ecuador and Paraguay and the closing of institutes and provincial offices in Belgium, the Netherlands, the Argentine, Colombia, Chile and Peru. To meet the reduction in funds for 1948–49 from £3,500,000 in 1947–48 to £3,150,000, further reductions in services such as books, drama and films are also being made. During the year, however, the educational work of the Council has steadily developed. It has continued to secure or to recommend British candidates for posts in foreign universities, and forty-two posts, mostly professorships and lectureships, are now subsidized and filled by the Council, and of these ten were filled in 1947–48. The Council has also assisted in the recruitment of suitably qualified staff from Britain for British and foreign schools in many countries overseas, and during the year launched a new scheme of bursary awards designed to bring to the United Kingdom persons who would not normally qualify to obtain scholarships but who, being actively engaged in industry or professional work, would benefit from a short stay in Great Britain and from mixing with those of like occupations.

The large volume of scientific bibliographical inquiries and requests for scientific information has made it necessary to amalgamate the science libraries and scientific information services. Assistance was given to the convening bodies of scientific conferences held in the United Kingdom, and a conspectus of current scientific research in Britain has been compiled and is maintained with the co-operation of numerous bodies and by visits of Council staff to university research departments. The publication *Monthly Science News* has been replaced by the larger journal *British Science News*, and assistance has been given in placing agricultural scholars of the Council and in arranging tours for some fifty agricultural visitors. The collection of seed samples from a large number of countries was organised at the request of various research stations, and advice and assistance given to 103 private students from ten countries and to 32 engineers and technicians from thirteen countries on visits to Great Britain. The medical library and information service has expanded considerably, most of the 284 books added being received for review in the *British Medical Bulletin*, while 310 copies of the monthly list of new British medical publications are circulated to libraries and institutions abroad.

Programmes of work were arranged for more than forty overseas medical graduates holding British Council scholarships, and the Council is also arranging programmes or accommodation for most of the 'fellows' appointed by the World Health Organisation who elected or were advised to study in Britain. The Council's organisation for receiving visitors was increasingly used by Government departments, overseas Governments, universities and professional societies. Besides the 599 who came as the Council's guests, forty per cent of whom were concerned with science, medicine, agriculture and engineering, 306 who came without financial assistance from the Council had programmes arranged for them. The Council also financed a limited number of delegates to scientific conferences and cultural events, and was also invited by several universities to assist recruitment for their summer schools. The Council took the initiative in convening a committee representing British universities to discuss the possibility of organising a series of summer schools in 1948, designed particularly for American students. The scheme involves a total of 700 students, for nearly 200 of whom from overseas the Council has accepted responsibility.

Reports on activities overseas are considerably curtailed in comparison with previous reports and contain little reference to scientific activities except in Finland, Italy, Poland and Brazil. The slightness of the accounts of the scientific activities of the Council constitutes one of the chief criticisms of the report, although the figures quoted for exchange of students and the like do not suggest that science is not well represented in the Council's activities, or support the impression that might be derived from other passages of the report that the Council is becoming increasingly an instrument of political warfare.

It is perhaps natural that, in view of the searching examination to which the activities of the Council were subjected by the Select Committee on Estimates in a report published last April, some space should be given to comment on the Select Committee's report. While satisfied that the evidence indicated that the Council is regarded as outside politics and that its work is not associated with propaganda or the political feeling of the day, the Select Committee directed attention to the need for introducing an improved permanent service, and questioned the necessity for so heavy a staff at headquarters. Without going closely into the important question of recruitment, the report indicates that the British Council itself leans towards the view of the Select Committee that Civil Service standards should be applicable in recruiting the bulk of its staff. No agreement has yet been reached, however, on the question of the grades and conditions of service which will ensure the maintenance of efficiency everywhere and adequate representation overseas, nor does the fundamental question appear to have been considered whether the service of the Council should constitute a closed service or whether its staff should comprise mainly those seconded for fairly short periods and then returning to academic life or their normal occupation. The Council hopes for some reduction in staff as a result of careful overhaul of establishments at headquarters, but fears that the financial savings will be absorbed by overdue improvements in staff conditions. Staff questions may not figure so prominently in future reports, but whether they do or not, the report might reasonably be expected to provide fuller public explanation as to how and by whom the plans for our cultural strategy are prepared.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, October 9

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. Haswell Alder: Inaugural Address as President.

Tuesday, October 12

Scientific Film Association (at the Royal Institution, Albemarle Street, London, W.1), at 10 a.m.—Conference on "The Film in Scientific Research" (to be opened by Sir Robert Watson-Watt, F.R.S.).

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. Bernard Fagg: "The Beginnings of Art in Northern Nigeria".

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. S. Whitehead: Inaugural Address as Chairman.

Illuminating Engineering Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. J. M. Waldram: Presidential Address.

Manchester Geographical Society (in the Geographical Hall, St. Mary's Parsonage. Manchester), at 6.30 p.m.—Mr. J. M. Wordie: "Explorations in Graham Land and in the South Shetlands".

Textile Institute, Yorkshire Section (at the Midland Hotel, Bradford), at 7 p.m.—Mr. J. Foster Beaver: "The Romance of Wool".

Society of Instrument Technology, North-West Section (joint meeting with the North-Western Branch of the Institution of Electronics, in the College of Technology, Manchester), at 7.30 p.m.—Mr. D. Edmundsen: "Electronic Development in Instrumentation".

British Psychological Society, Social Psychology Section (in the Physiology Theatre, University College, Gower Street, London. W.C.1), at 8 p.m.—Dr. Ruth Griffiths: "Measuring the Abilities of Children in the First Two Years of Life".

Wednesday, October 13

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "The Control of Milk Quality" (to be opened by Mr. E. B. Anderson and Mr. L. J. Meanwell). (Members of the Food Group of the Society of Chemical Industry are invited.)

Physical Society (joint meeting of the Colour and Optical Groups, at Northampton Polytechnic, St. John Street, London, E.C.1), at 3 p.m.—Scientific Papers.

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Pentti Eskola: "The Problem of Mantled Gneiss Domes" (Fourth William Smith Lecture).

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. Smith: Inaugural Address as Chairman.

Society of Chemical Industry, Food Group (joint meeting of the Microbiological and Nutrition Panels, at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Dr. E. F. Gale: "The Role of Vitamins (and Metals) as Co-enzymes in Bacterial Metabolism".

Royal Institute of Chemistry (at I.C.I. (Paints), Ltd., Wexham Road, Slough), at 6.30 p.m.—Mr. G. R. Cornish: "Methods of Determining Molecular-Weights of Polymers"; Mr. C. H. Young: "The Performance of Paint Films".

Tuesday, October 12—Wednesday, October 13

Society of Chemical Industry (at Geneagles Hotel, Gleneagles).—Convention on "High Vacua".

Thursday, October 14

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Joseph Pearson: "The Marsupial Placenta".

Physical Society, Acoustics Group (in the Small Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. W. West: "The Accuracy of Measurements by Rayleigh Disc".

Illuminating Engineering Society, Manchester Centre (joint meeting with the Northern Local Committee of the British Optical Association, in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. W. J. Wellwood Ferguson: "Colour".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. K. B. Ross and Mr. D. N. McKinlay: "Integration of Operations in a Large Refinery".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. O. Ackerley: Inaugural Address as Chairman.

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Friday, October 15

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. A. W. Fox: "Transverse Navigation, an Alternative to the Grid System".

Royal Institute of Chemistry (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. H. B. Nisbet: "Anæsthetics".

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. Mungo Campbell: Presidential Address.

Society of Dyers and Colourists, Manchester Section (at the Gas Department Showrooms, Manchester), at 6.30 p.m.—Prof. W. T. Astbury, F.R.S.: "Adventures with the Electron Microscope".

Plastics Institute (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—"A Review of Thermoplastic Materials" (Chairman's Address).

Society of Glass Technology, North-West Section (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Dr. B. P. Dudding: "Statistical Methods and Industrial Efficiency".

Saturday, October 16

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mrs. Bertild Bekker: "Peoples in the Mountains of Central Celebes".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lectureship in Mechanical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (October 16).

Senior Assistant in Structural Engineering, a Responsible Lecturer in Organic Chemistry, Lecturers (2) in Chemistry, and a Lecturer in Mechanical Engineering, in the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (October 16).

Lecturer in Biological Subjects (Botany and Zoology)—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (October 16).

Research Assistant for experimental work in collaboration with clinical research teams, in particular in the Department of Otology—The Secretary, Middlesex Hospital Medical School, London, W.1 (October 16).

Lecturer in Mechanical Engineering Drawing to H. N. C. standard—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (October 16).

Lecturer in the Department of Physics and Mathematics of the City Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (October 18).

Senior Assistant in Organic Chemistry—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (October 20).

Plant Pathologist to undertake research on virus diseases of fruit plants, a Physical Chemist in the Plant Protective Chemistry Section to work on problems involved in the control of pests and diseases of fruit, a Research Entomologist to be attached to the Plant Protective Chemistry Section for laboratory and field studies of insecticides and their mode of action, a Junior Organic Chemist in the Biochemistry Section for work on the organic constituents of fruit-bearing plants, an Honours Graduate in natural science with special interests in plant physiology and botany for work on frost damage to fruit plants, and an Assistant for maintenance and construction of experimental apparatus, including thermo-electric instruments, for work on frost damage to fruit plants—The Secretary, East Malling Research Station, Maidstone, Kent (October 23).

Lecturer in Philosophy—The Very Reverend the Dean, Christ Church, Oxford (October 25).

Smithson Research Fellowship—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (October 30).

Lecturer in Physical Chemistry in University College, Ibadan Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (October 31).

Assistantship in the Department of Zoology—The Secretary The University, Old College, Edinburgh 8 (November 1).

Chief Mechanical Engineer (under the Chief Mechanical and Electrical Engineer) in the Production Department at Headquarters in London—The National Coal Board, Establishments (General Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/90 (November 15).

Professor of Botany at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (December 15).

Reader or Senior Lecturer in Biochemistry in the Department of Physiology, University College of the West Indies—The Secretary Special Committee of the Senate on Higher Education in the Colonies University of London, Senate House, London, W.C.1 (January 15)

Tucker-Price Scientific Research Fellowship for research in Mathematics, Science, or an allied subject—The Secretary, Girton College, Cambridge (January 15).

Lecturer with special qualifications in Analytical Chemistry and some inorganic interests, and a Lecturer with special qualifications in Organic Chemistry—The Secretary, The University, Aberdeen.

Laboratory Technician in the Department of Pathology—The Pathologist, Royal Devon and Exeter Hospital, Exeter.

Laboratory Technicians in the Biochemical Research Department—The Secretary, Institute of Psychiatry, Maudsley Hospital Denmark Hill, London, S.E.5.

Graduate (or equivalent) for Analytical Laboratory—The Assistant Secretary, British Coal Utilization Research Association, Randall Road, Leatherhead.

Senior Assistant in Civil Engineering, and a Lecturer in Mechanical Engineering—The Clerk to the Governing Body Battersea Polytechnic, Battersea, London, S.W.11.

Economic Statistician or Economist for investigations in economic and social relations between agriculture and industry, and a Research Assistant in Rural Social Organisation—The Secretary, University of Oxford Agricultural Economics Research Institute, Parks Road Oxford.

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CULTURAL AND SPIRITUAL PROGRESS OF MANKIND

MUCH of the Lambeth Conference report* deals with matters which are not the immediate concern of men of science as such; but two of the committee reports and certain passages in the Encyclical Letter are of interest in view of the increasing concern of the scientific world with the ethical aspects of atomic warfare, and of the attempts being made to formulate a professional code on the lines of the Hippocratic Oath. Moreover, a number of men of science have taken a prominent part in the movement to formulate a declaration of human rights, and on this also the report has something of interest to say. Thus even if their interest is indirect and by virtue of their citizenship rather than their professional activities, scientific workers cannot be altogether indifferent to any document that in any degree helps to clarify thought on the moral and spiritual values that form the real foundation for any attempt at union of the Western democracies. The frankness, clarity and logic of the whole report will indeed commend it to many outside the Anglican Communion, even if they do not always accept its premises or draw the same conclusions, at least without some reservations. The final invitation to all men and women to join in the war against the evils which wreck man's life and against the false creeds which debase it will be welcomed by many men of science.

The Encyclical Letter is noteworthy for a lucid restatement of the Christian doctrine of man as opposed both to Communism and nation worship. The claim for freedom is put in terms which many men of science will support, as they will welcome the insistence that rights imply duties which must be faithfully discharged. The Letter welcomes the great expansion of man's understanding of himself and of the world; but points out that knowledge may be used by man for self-destruction, and his greatest inventions turned to his ruin unless he learns to discipline his own nature and his powers. In forthright terms the claim that man should give himself entirely in obedience and service to the nation or group of which he is a member is rejected. Society exists to serve the needs of its members, not to enslave and possess them wholly, and the Letter maintains uncompromisingly that Christians must reject the Marxian Communism which exalts atheism and puts supreme confidence in material progress, and must condemn the cruelties, injustice and false propaganda inherent in it.

Neither the Letter nor the report as a whole fails to recognize that Communism to many people appears as a protest against social injustice, and it is urged in the report that it is the special duty of the Christian Church to oppose the Marxian challenge by sound teaching and the example of a better way. Firm support is also given to the work of the Commission of the United Nations on Human Rights. The Letter also calls on all nations collectively to control the manufacture and use of atomic power, and to pledge themselves never to use it for the purposes of war; and it calls upon the nations even at the price of limiting their own sovereignty to work together to remove the causes of war and to promote human culture and welfare.

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* Lambeth Conference, 1948: The Encyclical Letter from the Bishops, together with Resolutions and Reports. Pp. v+53+iv+120. (London: Society for the Propagation of Christian Knowledge, 1948.) 5s.

In one of its resolutions on the Church and war, the Lambeth Conference affirms that it is the duty of governments to work for the general reduction and control of armaments of every kind and for their final elimination, except those which may be necessary for international police protection. Nevertheless, it recognizes that in the meantime there are occasions when both nations and individuals may be obliged to resort to war as the lesser of two evils, though the present report adds little to what was said on this subject earlier this year in "The Church and the Atom", which was prepared by a commission appointed by the Archbishops of Canterbury and York. The report of the Committee on the Church and the Modern World shows that the thought of the Conference ran on similar lines to that of the Commission; although the report presents not so much a challenge to thought, as did that of the Commission, as a call to action to combat the present disastrous trend towards another world war. It rightly points to the danger in the growing fatalism on this subject, and reminds us we can have either war or civilization—not both.

The value of the United Nations Organisation is recognized; but it is pointed out that any such organisation must be permeated with moral and spiritual power. Again the report calls for endeavour to remove the causes of war by striving for greater economic well-being throughout the world, greater emphasis on social welfare, better observance of human rights in every sphere, and more constant use of international negotiation and conversation. Equally, the inherent danger of unbridled arrogant nationalism is faced. In the sections on the Church and the modern State, the challenge of dictatorship is repudiated as inconsistent with the Christian way of life and as offering an absolute conflict of values whether the basis of the dictatorship is a secular or a religious view of life; but it is not claimed that a parliamentary democracy is the only alternative to dictatorship in the modern world. On the contrary, a contribution is offered towards thinking out afresh the terms of co-operation, and towards a fresh experiment in co-operation, which merits the attention of all concerned with the problem of active democracy and the preservation of individuality and initiative under the present conditions of industry, commerce and society.

In a further section, there is a dignified and searching analysis of Communism which recognizes that Communism cannot be overcome by argument alone. It has to be outlived, not merely outfought. The positive suggestions made here should command approval and support far outside the Anglican Communion. To proclaim human rights without equivocation and respect them in practice; to do full justice to the truth in Communism; to recognize that the acceptance of an economic theory of Communism as distinct from Marxian atheism does not involve exclusion from the fellowship of the Christian Church; and to appreciate fully the immense contribution which science and technology have made to human welfare, and the dedicated lives of countless men of science and technicians—these are means which commend themselves to men and women of goodwill, and are already the basis of constructive contributions to human welfare and new experiments in communal living.

In the sphere of education, although there is little in the report that is new, there is much that will be welcomed. The most pressing need here, it is urged, is a *rapprochement* between religion and science, and the harnessing of scientific means to Christian ends. The Conference affirmed its belief that a fresh understanding of the nature and function of universities is greatly needed, and in that reassessment the place of theology in its full meaning must be duly considered.

Clearly it lay outside the scope of the Lambeth Conference to offer suggestions for dealing with such dangers as excessive specialization and the consequent lack of integration; but the report offers a real contribution towards supplying that clear sense of purpose the absence of which it regrets. The central problem of the relation of knowledge and power is fairly and squarely faced.

Through the new discoveries and inventions of our own time, man has gained power for the better ordering of the world. Those possessions now necessitate new forms of social organisation and the transcendence of outworn experiments in our ways of living and social institutions as the very condition of our survival. The over-riding task when all human values are threatened and man is being reduced to insignificance by forces beyond the individual's control is the vindication of man against all that cheapens or degrades him, and the rebuilding of a culture in which personal life holds the acknowledged primacy.

Whether or not they follow the argument of the report in its further searching and often stimulating analysis of man and his nature, scientific workers could scarcely wish for a fairer statement of the main issue. The Conference welcomed the great advance in scientific discovery characteristic of our age and repudiated the suggestion that any check should be placed upon it. Men of science, on their part, have also recognized that the consequent growth of man's knowledge increases his moral responsibility for the use and misuse of it. They will note with appreciation, also, the welcoming without reserve of the findings of scientific investigation into man's psycho-physical constitution, and the respect for the vocation of the man of science as a service to the God of truth. They, too, admit the desperate need for bringing technical discovery into true line with ethical direction, and that political freedom is everywhere in imminent danger because men shirk the price that must be paid for it and are prone to evade that responsibility, whether intellectual, civic or moral, by which alone it can be main tained. They, too, recognize that the hope that free institutions can be safeguarded on a secular basis must prove self-defeating, and some at least repudiate a determinist theory of history. If some cannot accept in their entirety the premises and conclusions of Christian thought even as displayed in the Lambeth Report, they may, none the less, be grateful for the evidence it affords of powerful support for many of the policies which they would wish to see pursued. The resolutions of the Conference may well lead to action and to the mobilization of moral and spiritual power behind the measures necessary no less for the furtherance of science than for the preservation of society and its highest cultural and spiritual values.

THE EINSTEIN ENIGMA

Einstein

His Life and Times. By Philipp Frank. Pp. 367. (London: Jonathan Cape, Ltd., 1948.) 16*s*. net.

THOSE who, like the present reviewer, are personally unacquainted with Einstein, will read this book with a shock of surprise. While Dr. Frank's sympathies are all with Einstein, the portrait presented to us is not altogether a pleasant one. We see a man developing early into the traditional type of nineteenth-century 'professor'. He regards himself as free to develop any eccentricity of behaviour, whether those about him like it or not, and to talk shop in season or out of season, a characteristic illustrated (p. 144) by the description of a courtesy visit to a non-mathematical colleague in Berlin, in which, after subjecting his hosts to a forty-minutes discourse on relativity, Einstein left abruptly. This lack of appreciation of the fact that ideas and interests which did not happen to interest him might still be as valuable as those that did may well explain Einstein's difficulties in the Berlin Academy, or his failings as a teacher. Always, apparently, ready to lecture on his researches of the moment or to deliver popular discourses, Einstein was not prepared to teach his students systematically what they had need to learn. An attitude of this kind is not incompatible with a deep concern for abstract causes such as pacificism or Zionism, and his lack of human contacts had one good result: it turned Einstein in the early 1920's from becoming a political leader of the Zionist movement. But there is another side to the picture: an impulsive kindliness made him only too ready to help refugee scholars after 1933, or to aid by correspondence a student in Prague (p. 331), or to instruct in arithmetic, at her own suggestion, a little girl of ten who lived near him in Princeton (p. 356).

Dr. Frank does not, of course, aim at an exposition of relativity theory; but he does describe Einstein's philosophical views in some detail (pp. 259 and 336). Einstein adopts a logical positivist view on the basic theoretical laws of Nature, which are for him free creations of the imagination confirmed by observation. Logically, this should lead to the acceptance of Newtonian mechanics as an equally good alternative to relativistic mechanics when we reflect on the enormous body of observational confirmation the [illegible] receive in engineering and astronomy, for example. At the same time, Einstein holds a realist view on electromagnetic and gravitational fields, light, atoms, electrons, etc. They are 'physical realities' and not concepts freely created for the purpose of interpreting observations. Nor is it easy to see how a belief in the rationality—almost the mathematical character—of Nature (p. 340) can be reconciled with his view of the character of scientific law. If Nature is rational, surely its laws are there to be discovered, and not created, by the man of science?

Dr. Frank's account of the times in which Einstein lived is written from the point of view of a Central European who sees Germany and her immediate geographical neighbours as the world-focus of scientific activities. Many quotations illustrate the strange vagaries of the totalitarian mind: in Nazi Germany relativity theory is the expression of Jewish physics, in Russia the theory is at first contrary to and later in accordance with dialectical materialism. Dr. Frank's selection among Einstein's contemporaries of those worthy of mention is very odd indeed. The venomous ideological crank, Philipp Lenard, is often referred to and freely quoted; but men who most nearly reached Einstein's intellectual stature and who developed and made known the theory of relativity receive scant attention. Hermann Weyl and de Sitter are not mentioned at all, and the three references to Eddington scarcely do justice to his contributions to the theory. Indeed, Einstein is credited (p. 326) with proving after 1933 that the geodesic principle is deducible from the field equations, though a proof of this theorem is to be found in the "Mathematical Theory of Relativity" written in 1923. Again, from pp. 346–351, we obtain the impression that the atom bomb was due to the scientific and political efforts of Einstein, O. Hahn, L. Meitner, E. Wigner, E. Fermi and L. Szilard. Even if Chadwick and Cockcroft are not worthy of mention, surely some native-born American physicists had a hand in the matter!

G. C. McVittie

THE CAVITY MAGNETRON

Microwave Magnetrons

Edited by George B. Collins. (Massachusetts Institute of Technology; Radiation Laboratory Series, Vol. 6.) Pp. xviii + 806. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 54*s*.

THE origin and excellence of the Radiation Laboratory Series of monographs is now well known, and can need little in the way of introduction to the physicists and engineers on both sides of the Atlantic who took part in the great war-time venture of radar. Without the cavity magnetron it is more than doubtful whether micro-wave radar could have become the decisive weapon it turned out to be. In this sense, therefore, the volume under review is perhaps the most important of the series, providing the central theme without which many of the other volumes could not have been written.

The cavity magnetron as a micro-wave generator of pulsed power of the order of a few kilowatts was taken to the United States by Sir Henry Tizard and Prof. J. D. Cockcroft in May, 1940, in a form entirely suited to manufacture; and this after only a few short months of work by those concerned. This early work, the later use of higher peak voltages and magnetic fields, the introduction of strapping in 1941, and the later achievements of peak powers of 2 or 3 × 10^6 watts at a frequency of 3 × 10^9 mc./sec., are efforts of which British physicists and engineers in universities and in industry may be justly proud. Much also of the development of an adequate theory of the magnetron was carried out in Britain by Hartree and Stoner and their collaborators. The method of the self-consistent field so strikingly successful in atomic physics proved equally valuable in the theoretical study of the magnetron. The Physics Department of the University of Birmingham, under the direction of Prof. M. L. Oliphant, was the centre from which sprang much of the experimental scientific effort on magnetrons in Britain or any other country. Oliphant, and no doubt others, recognized at an early stage the significance of obtaining high powers at centimetre wave-lengths. The klystron at that time was limited by a comparatively low beam current, but had the advantage of cavity resonators. The basic problem at the end of 1939 was to decide on a device which would take advantage of an enclosed resonator system and be much less limited in current. The cavity magnetron was the answer. In looking back on this venture, I think it is fair to comment that no other war-time effort has shown so well the original approach of British men of science to new problems; for not one of the team there collected could claim to have any prior experience in the field of microwave generators.

The approach of the Radiation Laboratory to the problems of the magnetron, as to other aspects of radar, was, as a result of the pioneer work carried out in Britain, bound to be rather different. The great American effort on the magnetron was one largely, perhaps, directed to understanding, consolidation, and manufacture rather than new discovery; at least that is the way things turned out. There are, of course, exceptions to this, such as the 'rising-sun' magnetron, a development arising entirely from the Columbia Laboratories. The volume under review pays only a brief tribute in its early pages to the British effort on the magnetron, and gives little idea of how the work developed. The book is a detailed analysis of the properties and behaviour of the cavity magnetron; it is not the story of the magnetron, nor is it intended to be. But it is a pity that time could not have been found for a more adequate survey of the development of ideas, experimental results, and theories from the numerous N.D.R.C. and C.V.D. Reports available to the authors. "Microwave Magnetrons", in short, gives a tremendous impression of knowledge of the subject, but gives little idea of how that knowledge grew from stage to stage.

Like other volumes of the series, "Microwave Magnetrons" is not easy meat for the uninitiated. The book contains a good introduction by its editor G. B. Collins, and is thereafter divided into five parts: resonant systems; analysis of operation; design; tuning and stabilization; practice. Parts I, II, III each contain four chapters and Parts IV and V three chapters each. The purpose of Part I is a discussion of the fundamental electromagnetic properties of the resonant system and the output circuit. Three types of resonant circuit are dealt with: the unstrapped system, the rising-sun system, and the strapped system. In Part II the operation of the magnetron is analysed first by a study of the interaction of the electrons and the electromagnetic field; this is followed by chapters on the space charge as a circuit element, transient behaviour involving a discussion of the starting of oscillation; and a discussion of noise.

Part III opens with a valuable discussion of the principles of design, and lays emphasis not only on the fundamental parameters but also on those of importance to the user. A discussion on resonant systems, cathodes, and a short chapter on permanent magnets make up the remainder of Part III. Part IV is concerned with tuning and stabilization. Part V is devoted to American manufacturing methods, and as such is admirable. Chapter 19 describes typical magnetrons, all American. Those interested in the contributions of British science and engineering to the study and manufacture of the cavity magnetron will regret that more space could not have been found for a discussion of their efforts in this key volume, which remains, nevertheless, a most imposing monograph on 'the heart of radar'.

J. T. RANDALL

PSYCHOLOGY AND MYSTICISM

Hindu Psychology

Its Meaning for the West. By Swami Akhilananda. Pp. xviii + 241. (London: George Routledge and Sons, Ltd., 1947.) 12*s*. 6*d*. net.

THE title of Swami Akhilananda's book is misleading to the Western reader. It is not quite clear what he means by Hindu psychology. A clue is given in Prof. Brightman's introduction in which he says "The purpose of this book is not to lead him *to substitute Indian Psychology for Christianity or Judaism*". Hindu psychology is, then, something which could take the place of a religion.

Although the Swami does not define Hindu psychology, he states that its method is "training the total mind of the individual, including thought, emotion and will". This is an entirely different conception of method from that of the European and American schools of psychology. It is well to bear in mind when reading this book the enormous chasm separating the Hinduism of the cultured classes from that of the masses in India; and it must also be realized that Hinduism is not only a religion but also a social system, the basis of which is caste.

The essence of higher Hinduism is a belief in the unity of being. "Knowledge of eternal truth belongs to those and only those who see but One in the manifold changes of the Universe". This religious philosophy is evident in Swami Akhilananda's work.

The book begins with a very brief outline of Western schools of psychology which are not, in the author's opinion, concerned with the "total mind", an abstraction not defined. The psycho-analytic concept of two layers of mind is also considered inadequate. The Hindu psychologists recognize four states of consciousness: the sleeping and dreaming states, which are included in the subconscious of Western terminology, the conscious, and the superconscious. It is in its concern with the superconscious states (not to be confused with telepathy and clairvoyance) that Hindu psychology is unique.

The chapters dealing with meditation and its effects, insight, extra-sensory experiences, and the superconscious state, are the most interesting, but bewildering to the reader unaccustomed to Eastern mysticism.

The sincerity of Swami Akhilananda is obvious and Western pride in its scientific attitude is shaken by this statement: "It is true that the Occidenta countries, with the help of scientific achievements, have done a great deal for the betterment of the everyday life of man. Yet in the West, because of the restlessness, unhappiness, and dissatisfaction of the mind, there are constant conflicts and frustrations resulting in extreme forms of mental disorders, nerve troubles, and functional ailments. This shows that the modern ways of life, based on scientific discoveries and their uses, have not solved the psychological problems of the West. On the other hand, the problems are becoming more and more frightening. So the West must find a way out of this dangerous situation". D. M. WHEATLEY

QUASI-ABELIAN FUNCTIONS

Funzioni quasi-abeliane

By Prof. Francesco Severi. (Pontificiæ Academiæ Scientiarum Scripta Varia 4.) Pp. 327. (Rome: Pontifical Academy of Sciences, 1947.) n.p.

THE present treatise, constituting almost entirely an original work, was written during 1944–45 and communicated as a memoir to the Pontifical Academy of Sciences, by which it has been published as one of a series of monographs. Its purpose is to fill an obvious gap both in the theory of algebraic functions and their integrals and in the relevant geometrical literature, subjects to which Prof. Severi has made masterly contributions during the last forty-five years. The concept of quasi-Abelian function, in its simplest form, has its origin in a theorem of Weierstrass, which asserts that the only uniform functions of a complex variable possessing an algebraic addition theorem are the elliptic functions and their degenerate forms, namely, the exponential and rational functions. The functions of the last two types are the quasi-Abelian functions relative to the elliptic function.

In his treatise Severi is primarily concerned with the solutions of the generalized problem, that is, the uniform functions of any number of complex variables which possess an algebraic addition theorem; for solutions of the most general kind—the so-called Abelian functions—there already exists a very great literature extending over more than a century, but hitherto there has been no systematic treatment of the degenerate forms. As Severi shows, these are likewise periodic functions in general, though with fewer periods than the associated Abelian functions, and in many respects are strictly analogous to the Abelian functions themselves.

Severi's investigation is, naturally enough, in the tradition of the Italian school of algebraic geometry, which, taking its cue from the Germans Brill and Noether, has translated the discoveries of Abel, Jacobi and Riemann concerning multiply-periodic functions into the language of the geometry of curves. For this purpose it employs a strikingly simple technique, depending on the consideration of sets of points on an algebraic curve, from which results not only a remarkable gain in elegance and power, but also a method capable of extension to similar problems of a more complex nature. To this method Severi has now added a concept which has already played an essential part in other researches of his: thus while, according to the classical theory, an algebraic plane curve of degree n, possessing d double points, has a genus p given by the formula $p = \frac{1}{2}(n-1)(n-2) - d$, Severi's innovation consists in regarding a certain number of these nodes as virtually non-existent, so that the curve has a *virtual genus* greater than p.

The first section of the treatise—about one-third of the whole—is in the nature of a prelude, devoted to the theory of series of points on a curve. The next two sections deal with the quasi-Abelian functions in all their generality, their periods, the associated integrals and allied geometrical results concerning the so-called Picard variety attached to a curve of genus p. Severi begins by posing three alternative definitions of the functions, and eventually shows that all three are equivalent to the one already stated above; here, it must be noted, certain parts of the theory hinge on a hypothesis of a geometrical character which has so far not been established. The last section, which is comparatively brief, completes an interesting chapter in the theory of surfaces. It is just forty years since Enriques and Severi wrote their prize memoir (*Acta Mathematica*, 1909–10) on hyperelliptic surfaces, that is, surfaces the coordinates of the points of which are expressible as uniform quadruply-periodic functions of two independent variables; an example is Kummer's quartic surface, which itself includes Fresnel's wave surface as a special case. The memoir has now been supplemented by a study of the quasi-hyperelliptic surfaces, which comprise Plücker's quartic surface, a familiar locus in line geometry; Severi shows how this is obtainable as a limiting form of Kummer's surface.

The book, which concludes with a detailed bibliography, is a notable addition to the distinguished author's publications, and will doubtless occupy a permanent place in the literature. L. ROTH

BLOOD PRESSURE

Blood Pressure and its Disorders, including Angina Pectoris

By Dr. John Plesch. Second edition, revised and enlarged. Pp. xiv + 307 + 15 plates. (London: Baillière, Tindall and Cox, 1947.) 21s. net.

THE first edition of this book by Prof. Plesch will be well known to most workers interested in this subject, and a second edition of it will be welcomed. Most of the chapters have been enlarged and some new ones have been added; references to the literature and case-histories increase the value of the book, and suggestions made by readers of the first edition have been incorporated. The author says that he has dealt only with aspects of the subject of which he has had practical experience through research and observation, and that he does not intend to present the reader with a text-book. This note of personal experience is evident on every page. It is a book for the progressive and open-minded worker who shares its author's evident desire to understand thoroughly the origins of the diseases discussed and to relieve the suffering that they cause by treatment based upon this understanding.

A short review cannot give an idea of the wide field covered by the text. Planned in three main sections, one on arterial blood pressure, one on venous pressure and one on the much-discussed conception of angina pectoris, the book deals with the physiological basis of disorders of the blood-pressure, their diagnosis and the clinical application of the facts discussed. No doubt many readers will be especially interested in the section entitled "Angina Pectoris", partly because the author does not restrict the conception of angina to spasms of the coronary arteries of the heart, but discusses it as "generally applicable to spontaneous cramps of any artery of the body".

We hear much nowadays about arteriosclerosis and high and low blood-pressures; but Prof. Plesch thinks that the danger of arteriosclerosis, at any rate, is over-estimated. Post-mortem examinations, made in different countries, of healthy young soldiers who fell in the First World War, show that 44·5 per cent of soldiers between the ages of twenty-one and thirty years of age and 62 per cent of those between thirty-one and forty years bore evidence of arteriosclerosis. These figures are surprising; but the mortality from this disease is only 6 per cent of the total mortality, and Prof. Plesch concludes that arteriosclerosis is not necessarily progressive and that it can be cured. During his valuable discussion of the general and symptomatic treatment of angina pectoris, he makes interesting observations on diet, the consumption of alcohol and smoking. Smokers will be especially interested in his analysis of various tobaccos and their effects.

An appendix discusses the use of the tonoscillograph and the interpretation of tonoscillograms, the author's techniques of auscultation and borderline percussion, the use of the blood-gas analyser with an absorption cell, and his experimental work on the immunization and sensitization of patients by injections of their own urine.

The book is well produced, and the photographic and other illustrations add much to its value.

THE BEHAVIOUR OF SEEDS

Twenty Years of Seed Research at Boyce Thompson Institute for Plant Research

By Lela V. Barton and William Crocker. Pp. 148 + 22 plates. (London: Faber and Faber, Ltd., 1948.) 21*s.* net.

FOR more than twenty years workers at the Boyce Thompson Institute at Yonkers, New York, have been publishing papers on the factors influencing the germination and continued viability of seeds. Their investigations have been not only of academic interest, but also of practical significance to people who produce, market, and sow seeds; and presumably it has been with this in mind that two of the senior workers concerned have now written a very brief summary of the Institute's work in this field. Farmers, gardeners and seedsmen will find this book giving, with a minimum of scientific terminology, confirmation, explanation and extension of much that they have discovered and guessed, and also some suggestive new facts.

Part 1 of the book reviews various types of delayed germination, due to the need for after-ripening, by drying, or by 'stratification' at low temperatures while moist, or to resistant seed coats, or to internal 'physiological' dormancy of root or shoot rudiments. The examples given underline the survival value of many of these peculiarities, and emphasize that sufficient knowledge of a plant's life-history and wild environment will provide a good basis upon which to forecast the conditions required for the most speedy and complete germination of its seeds. Apart from this, general principles are not easy to formulate. Although the seeds of related plants naturally tend to show similar behaviour, considerable variation can be found within the genus or even between varieties of the same species. In this wet harvest season of 1948 the British farmer is, once again, having thrust upon his notice the unfortunate readiness to 'sprout out' of the otherwise admirable wheat Holdfast, and the more stubborn initial dormancy of, for example, some varieties of Scandinavian origin. The same phenomenon is seen from another angle in the seed-testing laboratory, where freshly harvested wheats of the latter type are artificially dried at 40° C. as a matter of routine, or they tend to grow slowly and erratically in the test dishes.

A chapter, with the only plate in colour, is devoted to ways in which the capacity of seeds to germinate can be ascertained quickly without waiting for normal growth. The summary dismissal of chemical tests in favour of an excised embryo technique is unjustified. Unless the seed is large, the latter method requires a considerable amount of time and manipulative skill, and only yields results after some days; whereas sectioning of the soaked seed followed by treatment with a dilute aqueous solution of triphenyl tetrazolium chloride or bromide, a technique developed in Germany during the recent War, can give information in less than two hours, and has proved so practicable and reliable, at any rate with seed grain, that it is now regularly utilized by at least one commercial house.

Part 2 is concerned with the life-span of seeds and the effect on it of storage conditions, and here the authors are able to make the general recommendation that "rather low moisture content and/or low temperatures are effective for successful storage of vegetable seeds" and, in fact, of the majority of seeds. Here, again, generalization is unsafe. Barton and Crocker, for example, confirm the familiar observation that *Delphinium* seeds are short-lived unless specially stored. But 1938 seeds of *Delphinium denudatum* stored without special precautions and sown by the writer in 1939 and every year since, have shown the expected fall in percentage germination to very low in 1940, nil in 1941 and every subsequent year until, in 1948, the ten-year-old seed produced two sturdy plants! Storage of farm and garden seeds for a year or more is common commercial practice, but the normal 'carry-over' life of many seeds is insufficient to smooth out recurrent gluts and shortages, and it can be predicted that more experiment will almost certainly lead to the use of dried and thermostatically cooled air to increase the period of effective large-scale storage.

A number of photographs demonstrate impressively some of the points considered, and the frequent tables in the text are concise, easily interpreted summaries of the experimental results; although the serious student will note that many of them quote percentages only without actual numbers and are, therefore, not susceptible to statistical criticism. The references at the ends of the chapters appear to include only the papers by Boyce Thompson staff upon which the book is based, and might with advantage have been extended to include the more important relevant publications of other workers. A more serious limitation of this small book's usefulness may be imposed by the price, which even by to-day's standards is high. Perhaps its greatest merit is that it stimulates as well as illuminates, suggests not only how much but also how little is known, and this in one of the fields where a real contribution to knowledge can still be made by the enthusiastic individual with a minimum of time and equipment.

S. CLAY

Scientists Starred 1903-1943 in "American Men of Science"

A Study of Collegiate and Doctoral Training, Birthplace, Distribution, Backgrounds and Developmental Influences. By Prof. Stephen Sargent Visher. Pp. xxiii+556. (Baltimore, Md.: Johns Hopkins Press; London: Oxford University Press, 1947.) 25*s.* net.

FOR forty-five years scientific workers of the United States have been starred for pre-eminence by their colleagues in the reference work "American Men of Science", first by a few outstanding leaders in twelve scientific subjects, and then by those who had already been starred. This volume gives an analysis of the life-histories of those who have been starred in terms of their scholastic and academic background, and such other factors as their birthplace, month of birth, reasons for taking up a scientific career and parentage.

So far as the relative share of various American academies is concerned, this study is of no particular interest outside the United States; but a number of facts of more general interest emerge from the study. Thus we learn that more than three-fourths of the starred scientists have been employed by universities in recent years; also most starred scientists, for reasons that may well be in dispute, belong to the so-called upper classes, the highest percentage (one in seven) being fathered by Unitarian clergymen, the lowest (one in 196) by engineers. Cities are more likely to produce notable scientists than rural areas.

The statistical results given as to academic careers, however, must be considered as limited in their value when one finds among the starred physicists without a degree such a name as that of Einstein; he presumably appears in this category as having no American degree. The best chance of becoming a starred scientist seems to lie with those born in March, with January, May and October some way behind. A study of the lists in the various subjects shows no obvious omissions; but on the whole a tendency to go slightly below the level which would probably be aimed at in a similar classification in Britain. The book provides a mine of information about American men of science as a whole, which may well interest the curious as well as the serious student.

Children as Naturalists

By Margaret M. Hutchinson. Pp. 184 + 9 plates. (London: George Allen and Unwin, Ltd., 1947.) 7*s.* 6*d.* net.

MARGARET HUTCHINSON is the grand-daughter of the late Sir Jonathan Hutchinson, who founded the Educational Museum at Haslemere. In 1931 she opened her own junior school at her parents' home, Yafflesmead, near Haslemere. The school flourishes amid acres of semi-wild garden, meadow and woodland, and in this setting an enthusiast has shown how children's interest in Nature may be fostered through exploration, discovery and intimate contact with living creatures.

"Children as Naturalists" is a record of Miss Hutchinson's work and a testimony to her enthusiasm. Three general chapters on "Exploring with the Kindergarten", "Adventures with the Sixes and Sevens" and the "Study of Environment with Juniors" are followed by seven others called "The Quest for . . .", mammals, birds, pond creatures, flowers, etc. There are some useful photographs and diagrams to illustrate the text and many practical hints about the making of apparatus, as well as some of the scientific information needed by the teacher but not easily found in elementary text-books.

All this will be useful to the junior school teacher; but Miss Hutchinson's obvious advantages—small classes, large and varied grounds and the fact that she herself is a scientifically trained and passionately enthusiastic naturalist—should make her sympathetic with all teachers of Nature study in junior schools who do not reach the high standards revealed in this little book.

T. H. HAWKINS

New Biology, 3

Edited by M. L. Johnson and Michael Abercrombie. Pp. 176 + 24 plates. (Harmondsworth: Penguin Books, Ltd., 1947.) 1*s.*

THE third volume of "New Biology" maintains the standard of its predecessors. Addressed primarily to those who have a taste for scientific reading, this miscellany of essays aims at giving an up-to-date account of some aspect of biology which has excited contemporary interest. Contributions like "The Electron Microscope" and "Biological Research" by V. E. Cosslett are likely to be tough going for readers who know little about biology; but Alec Parker's article on "Beasts of Burden" will be as fascinating to the schoolboy as the *savant*. Articles on "How a Grasshopper becomes a Locust", "Forage Plants", "The Menace of the Roundworm", "Animal Life in Caves" and "Biology of Ship Fouling" indicate that the joint editors are well aware of those subjects which make popular reading.

The Genetics of Garden Plants

By M. B. Crane and W. J. B. Lawrence. Third edition. Pp. xvii + 299. (London: Macmillan and Co., Ltd., 1947.) 16*s.* net.

"CRANE and Lawrence" is now a standard text for both students of biology and for practical gardeners. Indeed, it is one of the few books which fulfil a want both for the academic specialist and for the practical man. The third edition is different in some respects from the earlier editions; parts of some chapters have been rewritten, and the subjects of xenia and polyploidy receive greater attention in special chapters. One criticism of the earlier editions was that the elementary introduction to genetics was too condensed for the non-specialist. By some clever and subtle writing the authors appear to have largely overcome this criticism in the third edition. Through fully annotated descriptions of research results, the book is an invaluable guide to the recent literature on horticultural plant genetics.

F. W. SANSOME

Territory in Bird Life

By Eliot Howard. New edition. Pp. 224 + 11 plates. (London and Glasgow: Wm. Collins, Sons, and Co., Ltd., 1948.) 10*s.* 6*d.* net.

A FRESH edition of Eliot Howard's classic book on "Territory in Bird Life" is indeed welcome, for it has long been difficult to obtain a copy of a work that every ornithologist should read. Published in 1920, it put forward the theory, supported by the author's many and painstaking observations, that the chief pivot of bird-life was territorial, nearly all birds needing to secure and hold a territory as a basis of their sexual activity and breeding cycle. This seemingly simple theory was found to have far-reaching implications, and to throw light on many aspects of bird behaviour; indeed, its importance has become more and more apparent with the passing of the years. It is good to have this new edition of so important a book.

FRANCES PITT

STUDIES OF THE STRUCTURE OF SYNTHETIC POLYPEPTIDES

By Prof. W. T. ASTBURY, F.R.S.
Department of Biomolecular Structure, University of Leeds

Dr. CHARLES E. DALGLIESH
University Chemical Laboratory, Cambridge

AND

S. E. DARMON and Dr. G. B. B. M. SUTHERLAND
Department of Colloid Science, University of Cambridge

THE recent synthesis of polypeptides from given amino-acids by Woodward and Schramm[1], following the neglected Leuchs polymerization[2], has reopened a promising line of attack on the problem of protein structure. Comparison of the properties of such synthetic polypeptides of known composition with those of proteins built of the same amino-acids should prove of great value, and in particular should help considerably in the interpretation of X-ray and infra-red data, which are still so imperfectly understood owing to the complexity of even the simplest protein. The general object of the work of which the preliminary findings are summarized below is therefore to synthesize as many as possible, first of homogeneous polypeptides (that is, those containing a single amino-acid species) and secondly of copolymers of two or more amino-acids, and then, by X-ray, infra-red and accessory techniques, to study their properties in relation to those of proteins of analogous composition.

Chemical

The polymerization of the anhydrocarboxyamino-acids was in the early cases performed in ethyl acetate in the presence of a tertiary base. Though this method has the disadvantage of giving unoriented products as white amorphous powders (the molecular weights being probably of the order of 2,000–5,000), it has the advantage that yields of the order of 50–70 per cent of polypeptide can be obtained from amino-acids available in quantities of only ½–1 gm.

With increasing availability of amino-acids, polymerizations have been carried out by the Woodward procedure, which permits in suitable cases the preparation of oriented products. The following amino-acids have been polymerized so far: glycine, sarcosine, *DL*-alanine, *L*-alanine, *L*-valine, *DL*-leucine, *D*-leucine, *L*-leucine, *DL*-*iso*leucine, *D*-*iso*leucine, *L*-*iso*leucine, *DL*-*nor*leucine, *DL*-α-phenylglycine, *DL*-phenylalanine, *L*-phenylalanine and *L*-tyrosine. Difficulty has been experienced with proline by this procedure, and this and other amino-acids are under investigation.

Marked differences have been observed between polymers from *DL*- and from optically active amino-acids, a particularly striking case being alanine, where poly-*DL*-alanine is readily soluble in water whereas poly-*L*-alanine is insoluble. In some cases the products separate with what appears to be half a molecule of structural water per amino-acid residue, which is much less readily removed from the polypeptides derived from optically active amino-acids than from those derived from *DL*-mixtures. The various mixed polypeptides have been synthesized by both the above procedures.

X-Rays

It is convenient to consider the kinds of X-r
diagrams obtained so far under the following head
(*a*) *Polyglycine.* So long ago as 1934, Meyer a
Go[3] reported on an X-ray examination of glyci
polypeptides obtained by the Leuchs reaction. The
photographs were not analysed in detail, but th
drew the conclusion that the atoms in the produ
formed when the N-carboxylic anhydride is expos
to moist air lie for the most part in planes of spaci
4·15 A. They mention, however, but do not repr
duce, another kind of diagram characterized by r
flexions at 4·4 A. and 3·45 A., that is obtained wh
the reaction is carried out in the presence of pyridin
Our diagram (Fig. 1*a*) is apparently like this latte
though we have also found indications of the form
in X-ray photographs of wool fibres, supplied
Prof. J. B. Speakman, on which a thin layer of pol
glycine had been deposited by the Leuchs reacti
carried out in ethyl acetate and water[4].

Fig. 1*a* is really a β-diagram made unfamiliar
having the backbone reflexion inside the side-cha
reflexion. It is consistent with a rectangular or ne
rectangular cell defined by $a = 4{\cdot}36$ A. (
$2 \times 4{\cdot}36$ A.), $b = \sim 7$ A., and $c = 3{\cdot}44$ A. Th
structure appears to be analogous to that worke
out by Bunn and Garner[5] for the so-called 6.6 an
6.10 nylons, and it is built presumably of sheets
chains parallel to (001). The chains in each shee
are linked by CO . . . NH linkages and their distanc
apart is 4·36 A. (cf. 4·4 A. in nylon and 4·65 A
in β-keratin).

(*b*) *Powder diagrams of the normal* β-*keratin typ*
One of the best-defined of these was obtained fro
a powder of poly-*DL*-*iso*leucine (Fig. 1*b*); but di
grams of a similar type were given also by th
polymers of *D*- and *L*-*iso*leucine, *DL*-alanine, *D*
α-phenylglycine, *DL*-phenylalanine and *DL*-*no*
leucine, and by the copolymers (glycine + *D*
alanine), (glycine + *DL*-phenylalanine), and (*D*
*iso*leucine + *DL*-phenylalanine). As with disoriente
β-keratin, β-myosin, etc., and denatured proteins, t
principal rings are 001 (side-chain), 200 (backbon
and 210. The side-chain spacing increases wit
length of side-chain, as would be expected; but it
seen also that the backbone spacing shows significa
variations: for example, glycine 4·36 A., *DL*-alani
4·59 A., *DL*-*nor*leucine 4·60 A., *DL*-*iso*leucine an
DL-phenylalanine 4·65 A., *D*- and *L*-*iso*leucine an
DL-α-phenylglycine 4·72 A. As reported in th
following section, corresponding variations are n
found in the infra-red spectra, which indicate th
the CO . . . NH hydrogen bond is similar in all th
polymers.

These combined observations are of the highe
importance, showing as they do that in spite
irregularities in chain direction caused by long
ungainly side-chains, with consequent variations
the backbone spacing between chains *as a whol*
the CO- and NH-groups of adjacent chains approa
each other always to nearly the same distance.
the same connexion it should be mentioned that the
are indications from other spacings that the effecti
length per residue in polyglycine and poly-*D*
alanine may be a little greater than the maximu
(3½ A. in silk fibroin) observed in the fibrous protein
and this recalls Corey's estimate[6] from X-ray cryst
data on glycine, alanine and diketopiperazine th
the effective length per residue in a *completely* ex
tended polypeptide chain should be 3·67 A.

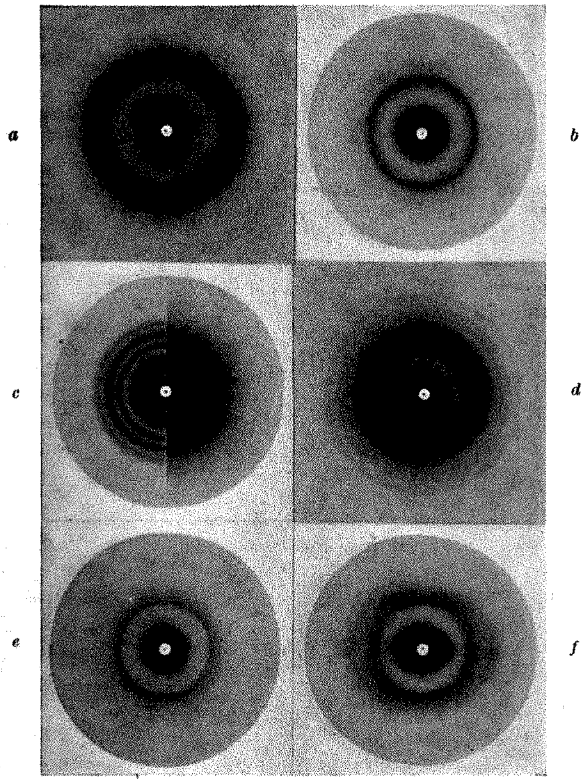

Fig. 1. (*a*) Polyglycine; (*b*), poly-*DL*-*iso*leucine; (*c*) comparison of poly-*DL*-alanine (right) with poly-*L*-alanine (left); (*d*) poly-*L*-phenylalanine; (*e*) poly-*D*-leucine + *DL*-phenylalanine, X-ray beam perpendicular to film; (*f*) poly-*D*-leucine + *DL*-phenylalanine, X-ray beam parallel to film

The powder diagram of the copolymer (*DL*-*iso*leucine + *DL*-phenylalanine) shows a strong side-chain reflexion of similar spacing to those of the polymers of the separate constituents; it is noteworthy, however, that no definite side-chain reflexion, but only a haziness, is seen in the diagrams given by (glycine + *DL*-alanine) and (glycine + *DL*-phenylalanine).

(*c*) *Abnormal powder diagrams.* Some of the powder diagrams discussed under (*b*) show unfamiliar features not yet fully accounted for; but on the whole it seems correct at the moment to regard them all as belonging to the type of β-keratin, that is, as structures built up by superposing flat or almost flat polypeptide grids so that the general directions of the side-chain and backbone linkages stand perpendicular, or almost perpendicular, to each other. All these normal β-diagrams, except those from poly-*D*- and poly-*L*-*iso*leucine, were obtained from *DL*-polymers and copolymers. A number of products, however, from *D*- or *L*-acids alone have been found to give diagrams showing a systematic peculiarity: there is notably a reflexion at about 5·2 A., and to explain the accompanying reflexions it would appear that it is this spacing, and not the normal backbone spacing, that has now to be taken perpendicular to the side-chain spacing. The counterpart of the normal backbone reflexion is present, too, but its spacing is now 'diagonal' (see Fig. 2); so that what was 200 in the *DL*-diagram becomes 201 in the *D*- or *L*-diagram, while the normal 210 becomes 211 (see Fig. 1*c* for a comparison of the diagrams of poly-*DL*- and poly-*L*-alanine, and note that the strong reflexion at 5·28 A. in the latter is completely absent from the former).

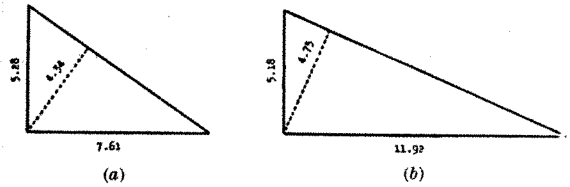

Fig. 2. (*a*) Poly-*L*-alanine: (*b*) poly-*L*-phenylalanine

This kind of modification has so far been observed with the polymers of *L*-alanine, *L*-valine, *L*-phenylalanine, and probably *L*-tyrosine; and poly-*DL*-leucine shows it with an additional complication that we have not yet elucidated. The diagram given by poly-*L*-phenylalanine (Fig. 1*d*), consisting of at least fifteen clear reflexions, is particularly striking: most or all of the reflexions can be explained on the basis of a rectangular cell of dimensions: $a = 2 \times 5{\cdot}18$ A., $b = 2 \times 3{\cdot}33$ A. (presumed amino-acid spacing), and $c = 11{\cdot}92$ A. (side-chain spacing).

The interpretation of these homogeneous polymers of *D*- or *L*-acids alone thus seems to require a new kind of side linkage in place of the backbone linkage met with hitherto. The new spacing is greater than the usual backbone spacing, and a possible explanation would be that it incorporates perhaps a water molecule between CO- and NH-groups of adjacent main chains, which are apparently still in the extended configuration.

(*d*) *Films.* For the present we are able to report only limited progress in making films or other oriented preparations of synthetic polypeptides. Traces of orientation could be detected in a pseudo-film of poly-*D*-leucine, and quite a rich, partially oriented diagram was obtained from a very brittle film of poly-*L*-tyrosine. This latter diagram has not yet been worked out satisfactorily.

The outstanding single set of results with films comes from preparations of the copolymer (*D*-leucine + *DL*-phenylalanine). It was first reported by Brown, Coleman and Farthing[7] that films of this copolymer, prepared by the method of Woodward and Schramm, gave, when photographed with the X-ray beam parallel to the surface, a quasi-fibre diagram resembling the well-known α-diagram given by the unstretched forms of the keratin-myosin-epidermis-fibrinogen group of fibrous proteins[8]. We have confirmed this finding (with films deposited on glass) and have made some further advances. Two of our photographs are illustrated in Figs. 1*e* and 1*f*, the former taken with the beam perpendicular to the film and the latter parallel. The film used for Fig. 1*f* was obtained from the inside of a glass tube in which a benzene solution of the copolymer (ratio 1 : 1) had been evaporated at about 70° C.: the orientation is the best so far produced in a film.

The following points may be noted. (1) The spacing of the prominent meridional arc, which so strongly recalls that of the α-diagram, is $5{\cdot}2_3$ A., and not $5{\cdot}1_4$ A. as found in α-keratin. (2) The intense central oval in Fig. 1*f* is foreign to the α-diagram: on the meridian its spacing is 11·9 A. (practically identical with the presumed side-chain spacings found in the powder diagrams of poly-*L*-phenylalanine and poly-*DL*-leucine), and on the equator $10{\cdot}3_7$ A. There is also a weak meridional reflexion at 7·4 A. (3) The central oval in Fig. 1*f* becomes a circle of spacing 11·9 A. in Fig. 1*e*: the $10{\cdot}3_7$ A. spacing is therefore preferentially oriented perpendicular to the film.

Pending the outcome of experiments, which are in progress, to prepare genuine fibres, it would be premature just now to attempt any detailed interpretation of this most interesting diagram. None of the usual methods of transforming α- into β-proteins has yet proved effective in changing it into one of the orthodox β-type, and in view of the diffraction peculiarities mentioned it is very questionable indeed whether it is a case of a true α-structure: rather does it recall the polymers of *D*- and *L*-acids described under (*c*), which appear to be in the extended configuration, but with a new kind of side-linkage of spacing of about 5·2 A. Incidentally, the 1 : 1 ratio of the constituents of the copolymer is not specific, since we have obtained a powder diagram of a similar type with the ratio 5 : 3.

(*e*) The investigation is being continued along the lines of further combinations of amino-acids and preparations oriented if possible as fibres. Exact knowledge is also being sought on the extent to which some of these synthetic polypeptides may combine with water, and the bearing this may have on the occurrence or not of the supposed new side-linkage of spacing about 5·2 A. If it should turn out that such a type of spacing includes also that found in the film diagram given by the copolymer (*D*-leucine + *DL*-phenylalanine), it is nevertheless still on the cards that it may lead to a proper understanding of the characteristic meridional arc in the true α-diagram; for it is to be remembered that the postulated α-fold may be thought of as stabilized by what amount to *side*-linkages—not simply between adjacent main chains, of course, but between short consecutive lengths of one and the same main chain[9].

We are also investigating possible cases of polymorphism among the products obtained from base-catalysed and uncatalysed polymerizations.

The X-ray photographs discussed above were taken by Mr. E. Beighton, to whom we should like to express our thanks.

Infra-Red

The general resemblance between the near infra-red spectrum (between 3,500 and 1,500 cm.$^{-1}$) of a synthetic polypeptide and that of any protein molecule has already been remarked[10]. This arises from the fact that the main absorption bands in this region of the spectrum are due to characteristic vibrations in the —CO—NH— group and to CH-stretching frequencies. As we proceed farther into the infra-red (that is, to the lower frequencies between 1,500 and 700 cm.$^{-1}$), many of the absorption bands are due to characteristic vibrations of the hydrocarbon side-chains of the various amino-acids. It was suggested[10] that differences in this region of the spectrum might be made the basis of a method of identifying an amino-acid residue in a protein, provided sufficient data were available on the spectra of polypeptides synthesized from various amino-acids. We have accordingly examined the spectra of a representative selection of synthetic polypeptides from various amino-acids. However, we have not confined our attention to the region of low frequencies but have also studied the high frequencies of the —CO—NH— group, since it is here that variations in the hydrogen bonding which plays such an important part in the structure of proteins may be most readily followed.

(*a*) *Low-frequency region*, 1,500–700 *cm.*$^{-1}$. The spectra of powders of the polymers of glycine, *L*-alanine, *DL*-alanine, *L*-phenylalanine, *DL*-phenylalanine, *L*-leucine, *DL*-leucine, *L*-*iso*leucine, *DL*-*iso*leucine, *DL*-phenylglycine and *L*-tyrosine are all different from one another and quite characteristic in the region 1,500–700 cm.$^{-1}$. The differences between the spectra of polymers made from *D*- or *L*-forms of any acid and the spectra of the corresponding *DL*-forms are small compared with the differences between the spectra of polymers of different amino-acids, but are none the less quite real. We may therefore take it as established that each amino-acid polymer has characteristic frequencies, and the next question is whether these persist in copolymers made from two or more different amino-acids.

The answer to this is not quite so clean-cut and is less certain in that the number of copolymers so far studied is small. The spectrum of a (glycine + *DL*-alanine) copolymer was found to correspond remarkably closely to the 'addition spectrum' of the individual polymers, showing that there are certain bands which are characteristic for each amino-acid even when copolymerized. The spectrum of a (glycine + *DL*-phenylalanine) copolymer was also found to resemble closely the corresponding 'addition spectrum', certain bands of the individual polymers being clearly distinguishable, although a few of the others either disappeared or shifted in position in the copolymer. In this case, these differences were used to follow the progress of the copolymerization, samples of the copolymer being withdrawn for spectroscopic analysis at various stages. The copolymer (*D*-leucine + *DL*-phenylalanine) was examined both as a film and as a powder. The two spectra were virtually identical, and again many of the bands of the separate polymers were easily recognizable in the copolymer. There were, however, certain marked differences, and in particular this copolymer had a fairly strong band at 795 cm.$^{-1}$ which was not present (at least in comparable intensity) in either of the individual polymer spectra.

The conclusion to be drawn from these results is that for each amino-acid there are certain frequencies which persist in copolymers and may therefore be expected to persist in proteins containing these amino-acids. Such frequencies must clearly be due to the hydrocarbon chain in the amino-acid, and in a few cases assignments (based on the interpretation of hydrocarbon spectra) have been possible, although these need not be discussed here. Certain other

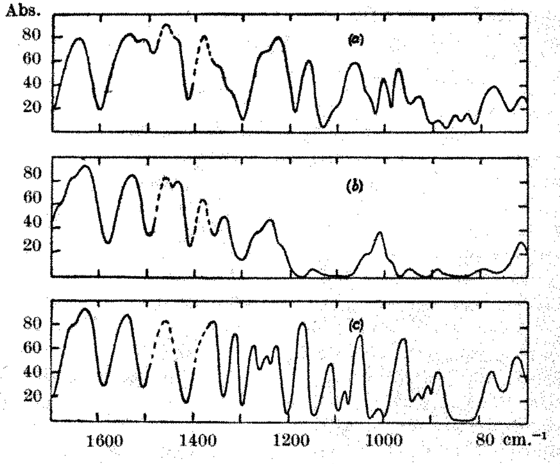

Fig. 3. Infra-red absorption spectra in the region 1,700–700 cm.$^{-1}$ of: (*a*) Silk fibroin (fibres immersed in nujol); (*b*) polyglycine; (*c*) poly-*L*-alanine (powders suspended in nujol). Broken lines indicate absorption due to nujol

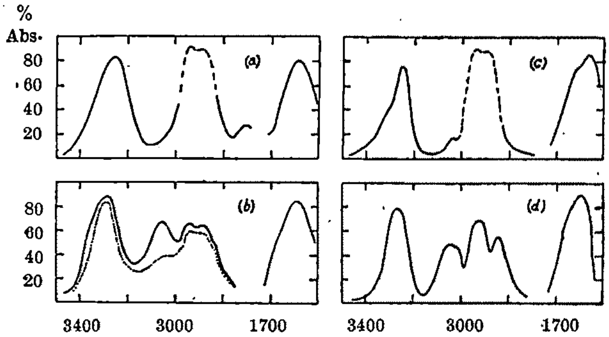

Fig. 4. Infra-red absorption spectra in the regions 3,500–2,800 cm.$^{-1}$ and 1,700–1,600 cm.$^{-1}$ of: (*a*) silk fibroin (fibres immersed in nujol); (*b*) tropomyosin film (—— film prepared at room temperature, ... after pressing in steam); (*c*) poly-*L*-alanine (powder suspended in nujol); (*d*) film of *D*-leucine + *DL*-phenylalanine copolymer (ratio 1 : 1).

Broken lines in (*a*) and (*c*) indicate absorption due to nujol

frequencies in this range appear in the simple polymer spectra but not in the copolymers and *vice versa.* The assignment of these is not yet clear, but they most probably arise from vibrations associated with the bonds involved in the link between the side-chains and the backbone.

We have successfully applied the above results to the identification of amino-acids in a protein, and believe that this is the first occasion on which this has been done without decomposing the protein molecule. In Fig. 3 are given the spectra of silk fibroin together with those of polyglycine and poly-*L*-alanine. The appearance of certain of the bands in the synthetic polypeptides in the natural protein is so obvious that it does not require detailed comment. It need scarcely be added that this method is unlikely to be successful except in very favourable circumstances for detecting amino-acids which are present in small proportions, although we might add that we believe that we have also identified tyrosine in silk fibroin. The amino-acid analysis of a complex protein by this method is, of course, quite impracticable. What we consider much more important is that further investigations along these lines with copolymers of controlled structure and composition may throw light on the arrangement of the amino-acids in some of the simpler proteins.

(*b*) *High-frequency region,* 3,500–1,500 *cm.*$^{-1}$. The NH- and CO-stretching frequencies near 3,260 cm.$^{-1}$ and 1,640 cm.$^{-1}$, respectively, are essentially the same in all the polymer and copolymer spectra, whether from *DL*-, or *D*-, or *L*-acids. This means that the CO . . . NH hydrogen bond must be similar in all the polymers. At first sight this seems to conflict with the X-ray evidence that the backbone spacing varies from 4·36 A. (in polyglycine) to 4·72 A. (in poly-*DL*-α-phenylglycine), since a variation of this magnitude in a distance controlled by the CO . . . NH-linkage would certainly lead to a large variation in the NH-stretching frequency. If the explanation of this apparent anomaly advanced in the preceding section be correct, it underlines an important distinction between the structural information provided by X-ray and infra-red methods in problems of this kind, the former giving a diffuse overall picture of the structure from which hydrogen bond distances are deduced, whereas the latter gives a direct measurement of the length of the hydrogen bond but no direct information on the structural pattern unless polarized radiation is used on highly oriented films.

Although the CO- and NH-bands are similar in all the polymers, there are indications in many cases of some fine structure on the high-frequency side of each band. This has not yet been fully investigated, but it must mean that in many polymers *slightly* weaker hydrogen bonds exist in addition to the usual CO . . . NH-bond associated with the backbone linkage. This might arise from distortion of the backbone spacing in accommodating the side-chains, and may even be connected with the fact that films of certain polymers are harder to produce than others. Alternatively, it may indicate another type of hydrogen bond arising from some other feature of the structure yet to be elucidated.

That more than one type of hydrogen bond can exist in these polymers and in proteins is clearly demonstrated by the occasional occurrence of an NH-stretching band near 3,040 cm.$^{-1}$. This band is very prominent in the spectrum of the copolymer film (*D*-leucine + *DL*-phenylalanine), but is either absent or comparatively weak in the spectra of all the other polymers (Fig. 4). The fact that the X-ray evidence at first sight indicated an α-configuration for this copolymer seemed to be consistent with the fact that this 3,040 cm.$^{-1}$ band is present in the spectrum of the α-form of tropomyosin but weakens very markedly when the tropomyosin is converted to the β-form by pressing between plates in steam[11]. Moreover, we find this band is absent in the spectrum of silk fibroin known to have a β-configuration (Fig. 4). However, what seemed a striking correlation between the presence or absence of this band and the existence of α- or β-configurations breaks down completely when one considers the spectrum of nylon. This band is present in nylon, which has been shown by Bunn and Garner[5] to have a β-configuration. All we can say at present, then, is that there are at least two very distinct types of hydrogen bonding present in many proteins and in some protein-like polymers (notably nylon and *D*-leucine + *DL*-phenylalanine), and that this bond appears to be connected in some way with folding of the polypeptide chain.

In this connexion two minor but important points should be mentioned. The first is that there is no doubt whatever that the 3,040 cm.$^{-1}$ band is due to an NH-frequency, the most direct proof being that we find it is absent in the spectrum of fully methylated nylon. Incidentally, we have investigated this very interesting band extensively in simpler amides, but a full account of this work must be given elsewhere. The second point is that it is just possible that the weakening of the 3,040 cm.$^{-1}$ band observed by pressing tropomyosin between plates in steam may arise from a known orientation effect[11]. This is being investigated further by using polarized radiation.

In the preceding section on X-ray diffraction it was noted that marked differences occurred in many cases between the patterns given by *D*- or *L*-polymers and those given by *DL*-polymers. Little or no correlation has so far been found between these results and the infra-red spectra of the corresponding compounds. In particular, no clear evidence of water molecules in the *D*- or *L*-polymers has yet been found. Although the weak band on the side of the main NH-band at 3,240 cm^{-1}. in poly-*L*-alanine might possibly be due to water, this extra band was not found in poly-*L*-phenylalanine.

The final elucidation of many of the above results cannot be given until much more experimental work has been carried out, particularly on oriented films with polarized radiation.

We are very much indebted to Dr. K. Bailey for the specimen of tropomyosin, and to Dr. G. R. Tristram for the specimen of silk fibroin.

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COLOUR AND COLOUR VISION IN ANIMALS

On September 13, a series of papers on colour and colour vision in animals was read before Section D (Zoology) of the British Association. The object of the discussion was to consider recent results on the physiology of colour production and appreciation in animals, and the bearings of these results on theories of the biological uses of colour—in protective resemblance, mimicry, warning coloration and other ways.

The discussion was opened by Dr. R. J. Pumphrey with a paper on the distribution of colour perception in the animal kingdom. He first pointed out the difficulties in the way of obtaining experimental proof of the presence of colour discrimination in animals, which can tell us of their perceptions only by their behaviour. Besides this, colour is itself a difficult experimental subject; it is never easy to exclude other stimuli such as those of variations in brightness—to the animal and not to us—and, if the animal's spectral range differs from ours, control of wave-lengths outside our visible range is needed. Further, the animal's behaviour will be influenced only if perception of the colour is important to it; and changes of behaviour can be interpreted only if the animal behaves in a consistent and intelligible manner, and is not disturbed by other stimuli or by its own nervous state.

Nevertheless, colour perception has been established beyond reasonable doubt in some insects and, among vertebrates, in some bony fishes, reptiles, birds and the primates. Dr. Pumphrey believes its presence in the Crustacea and Cephalopoda unproved. In the rest of the animal kingdom there is no sound evidence of its presence, and in many groups failure to demonstrate it makes its presence unlikely.

Animal colour perception, where it exists, resembles our own rather closely. There is no evidence of dichromatism as a primitive condition; but this may be due to inadequate experimental methods. Some birds and fishes may have a closed colour circle, that is, they may fail to distinguish red from violet, and may not recognize extra-spectral purples. Many insects see much farther into the ultra-violet than we do, and can distinguish ultra-violet from the parts of the spectrum visible to us. Insects see colours in weak light so long as they are able to see at all; in this they are in contrast with vertebrates, whose perception of colour fails in weak light. At night vertebrates have no colour sense; all nocturnal vertebrates are colour-blind.

Dr. R. W. Pickford spoke on the varieties of colour vision in man. Total colour-blindness is rare. The most usual abnormalities are deuteranopia, in which red and green are confused, looking yellowish, and protanopia, in which there is also a great darkening of the red end of the spectrum. In anomalous colour vision, discrimination of colours is retained; but either red or green may be greatly weakened as compared with the normal. With red anomalous vision there is in some cases also darkening of the red end of the spectrum. All are Mendelian recessives and sex-linked, except that in total colour-blindness the linkage is partial. About 7 per cent of men show red-green colour-blindness.

In addition to these major defects, minor variations from normality occur. The commonest is a weakness of blue discrimination; those with it tend to confuse greenish-blues, such as Cambridge blue, with green. Yellow weakness also occurs, and leads to confusion of yellow with white. These minor defects are not sex-linked.

Dr. M. G. M. Pryor discussed the conditions under which colour in an animal can be certainly said to be adaptive. Adaptiveness implies that the colour has selective value and that in the absence of selection the colour would be different from what it now is. To prove adaptiveness, we therefore need to know the natural non-adaptive colour. Often this is white, as in many cave animals that live in the dark, but not always so. Some cave insects are black or brown, the colour of the dark tannin with which their chitin is hardened. Dark colour in an insect therefore needs no 'adaptive' explanation. Whiteness in an insect is more unusual and is often due to a layer of unhardened—and undarkened—chitin outside the dark chitin within it.

Brilliant colours are not always adaptive. Golden colour, as in the pupa of the peacock butterfly, may be due to the natural colour of the chitin. Brilliant interference colours may be due to a number of thin, transparent films of chitin of the right thickness. Often these colours occur where they cannot be adaptive—inside the cast skins of bluebottle pupæ, or in the bristles of the sea-mouse which lives buried in mud. The blues and greens of the outer surface of bluebottles and dung-flies are due to interference at the layer of wax that covers the chitin.

Some of these colours may have been exaggerated or otherwise modified adaptively, but a knowledge of what the colours would be without adaptation and of the manner in which they are produced is necessary if we are to assess the adaptive element in them.

Dr. G. S. Carter discussed, in the light of the facts given by the previous speakers, the conditions under which colour as seen by other animals may be of importance in the biology of an animal. First, it is clear that not all animal colour has this importance. To the categories of non-significant colour already mentioned may be added much colour in lower invertebrates, such as many sea-anemones and sea-urchins, which have few enemies. This is at least true of the many species that do not catch large animals as prey. Much colour in physiological substances is non-significant—blood pigments, excretory substances. Some pigment may be used as defence against light, as probably the black pigment of many desert animals, but is not related to the animal's contacts with other animals.

Value in colour in the biological environment implies that the animal seeing it has colour vision. As Dr. Pumphrey showed, only some arthropods and some vertebrates have been shown experimentally to have this faculty. Perhaps some cephalopods should be added, on the evidence of their natural behaviour and not on experimental results. Such evidence may be as conclusive as the experimental.

Wherever colour is of value in the interactions of animals, except in the rare cases where the stimulus is a simple flash of colour, pattern appreciation as well as colour perception is necessary in the observing animal. It is therefore not surprising that a colour sense and an image-forming eye are associated in animals, for pattern appreciation is the characteristic of image-forming eyes.

In recognition of an animal by another, two distinct components of the process of recognition must be distinguished. First, the animal must be recognized as a discrete object on its background. This is prevented by the various forms of camouflage. Secondly, the animal must be recognized as of a particular kind—for example, of a kind suitable as food. To understand how the second can be prevented by adaptation in colour and pattern, we need to know how animals recognize the kinds of objects.

In much of their behaviour, animals, even such complex animals as birds and insects, recognize the kinds of objects not by an aggregate of many characters, as we do, but by one, or at most a few, 'valent' characters, such as the smell, shape, colour, pattern or type of movement. Not all animal behaviour is of this simple type; but so far as it is, a resemblance that includes the valent characters will be effective, although in other characters there is no resemblance. But if an animal is exposed to predators of many species, a detailed and complicated resemblance may be built up by combining the different valent characters required by the various species. We can thus see how the astonishingly accurate resemblances we find in Nature may have originated from very partial resemblances which, in spite of their incompleteness, would still have had some value. G. S. CARTER

PHYSIOLOGY OF LACTATION

AT a joint meeting of Sections M (Agriculture) and I (Physiology) of the British Association, held at Brighton on September 14, recent research on the physiology of lactation was discussed. Prof. H. Hartridge, president of Section I, was in the chair.

The discussion was introduced by Prof. H. D. Kay (National Institute for Research in Dairying, Shinfield) who said that in view of the importance of lactation both from the human and from the industrial points of view, it is remarkable that the physiology of the mammary gland had, until recent years, received so little attention. During the past dozen years, however, knowledge has advanced substantially as regards the endocrine control of mammary development and of milk secretion, including the artificial induction of lactation in the virgin or barren animal, the hormonal inhibition of lactation, the cytology of the gland in relation to function and the 'let-down' of milk as a conditioned neuro-hormonal reflex. The biochemistry of milk secretion, including both glandular metabolism and the factors affecting milk composition, have also undergone active study. Advances in knowledge of the neuro-hormonal mechanisms by which the mammary gland is controlled are already beginning to influence both milking technique and also clinical methods of dealing with problems of human lactation.

There is a very rapid blood-flow through the actively secreting gland, and a large consumption of oxygen. The respiratory quotient of the secreting tissue is, in the intact animal, well above unity, and in surviving slices of tissue suspended in a nutrient solution, figures as high as 1·5–1·6 have been obtained by T. H. French, suggesting fat formation from carbohydrate. A major difficulty in recent biochemical studies in the intact animal is the uncertainty of the extent of error due to lymph drainage, and all findings depending on arterio-venous changes must be interpreted very cautiously.

The practical significance was pointed out of the recent work of Dodd and Foot at Shinfield, who have found that more than 50 per cent of the fat originally present in the secreted milk in the bovine udder is *not* removed during the ordinary process of milking. Very recent findings which indicated that milk composition might be influenced by naturally occurring œstrogens present in young grass and clover were also described. The relationship between the texture of the teat and liability to udder infection, established in the last few months by J. I. Taylor at Compton, was mentioned as a new factor that seems of importance in buying or breeding a cow.

Mr. K. C. Richardson (University College, London) described with the aid of slides some of the results of his recent studies of the cytology of the mammary gland in relation to function. The milk-secreting alveoli are not usually spherical, but are rather elongated structures, the secreting cells of which show great changes in shape and size at different stages in the secretory cycle. The synthesized milk constituents pass from these cells into the alveolar lumen by recurrent rupture of the cell membrane. Whether or not there are nerve fibres ending in the secretory tissue is as yet unsettled, the available histological technique being insufficiently specific. He discussed the possible mechanism of 'let-down'. There is no doubt that during 'let-down' active pressure is brought to bear on the milk which has been secreted into the alveoli. Smooth muscle, though present in the mammary gland, is neither in the right places nor in sufficient quantity to make any serious contribution to the 'let-down' phenomenon. There are no sphincters on the ducts emerging from the lobules. However, as a result of a recent advance in histological technique, clear evidence has been obtained of the abundant presence in the gland of myo-epithelial cells, the large nuclei of which are usually to be found between the alveolar secreting cells and the basement membrane, and the processes of which can be shown to extend over the outer surface of each alveolus. Convincing histological evidence was brought forward by Mr. Richardson that these cells can and do contract at 'let-down'; the basket structure, tightly embracing the distended alveolus before 'let-down', does not become flaccid when the milk has been forced out and the alveolus diminished in size, but remains taut.

Dr. S. J. Folley (National Institute for Research in Dairying, Shinfield) briefly mentioned three stages in the history of research on the control of the mammary gland. In the earliest stage, the control appeared to be mainly of neural origin; but the establishment of the fact that mammary tissue could actively secrete when removed from any nerve connexion with the rest of the body, together with experiments showing the great importance of hormonal influences on the gland, led for a time to mammary physiology becoming almost a branch of endocrinology. The more balanced, modern view that neural and hormonal influences must be considered together in obtaining a satisfactory picture of the growth and function of this gland is now supported by increasing evidence. Thus the sucking stimulus apparently causes reflex secretion of prolactin by the anterior pituitary, by a pathway not yet understood, and is of importance not only in initiating milk secretion but also in maintaining it and in indirectly preserving the structural integrity of the milk-producing tissue.

The milk already secreted by the gland is, before suckling or cowshed milking, present in two portions. One can be obtained from the gland cisterns in the cow by careful cannulation (avoiding nervous stimulation); the other portion of the milk is more tenaciously held in the smaller ducts and capillaries and has to be forced out by an active (but involuntary) process. This latter process, 'let-down', though activated by a posterior-pituitary hormone, is in the intact animal a nervous reflex that can become conditioned, and is easily inhibited, both in the bovine and in the human. In the denervated udder, or in the isolated, perfused gland, 'let-down' can, however, be readily brought about by the introduction of oxytocin into the circulating blood. There is no evidence for the 'erection' of udder tissue by engorgement with blood; the true nature of the contractile tissue in the gland, hitherto uncertain, has now been established for the first time by the experiments just described by Mr. Richardson.

Dr. K. L. Blaxter (Hannah Dairy Research Institute, Ayr) described recent applications to dairy cattle of hormonal treatment for initiating or increasing milk secretion. Widespread treatment of thousands of normal animals presupposes a large supply of endocrine preparations, and for this reason synthetic sources of hormones are of the greatest potential use; synthetic œstrogens and iodinated proteins containing thyroxine can now be made on a large scale.

Lactation in barren cows and virgin heifers can be induced in a large proportion of such animals, though not, apparently, in all, by administration of synthetic œstrogens of the stilbœstrol type. There is great individual variability in the quantitative response to such treatment, for reasons that are not yet clear. Another practical handicap is that the treated animals are 'on heat' during the whole period during which the œstrogen is being administered; this leads, if the treated animals are allowed to run with other cows, to coital mimicry and the serious risk of pelvic fracture, since the œstrogen causes relaxation of the pelvic ligaments.

The feeding of iodinated proteins to lactating cows induces an increase in milk production, the magnitude of which depends on the dose given to the cows. A reasonable practical increase, say, of 20–25 per cent, can readily be obtained. Experiments were described showing the effect of such treatment on both milk-yield and composition and on the condition and behaviour of the animals. The milk obtained after feeding iodinated protein shows no thyroxine-like effect when taken in quite large quantities by human consumers, though its iodine content is increased. From the economic point of view, the value of the extra milk produced is considerably greater than the cost of the iodinated protein plus the extra feeding stuffs required. The margin of safety between an optimal dose and one which causes breakdown in the cow is not sufficiently large to allow the material to be used by other than competent farm staff. So far, in experiments lasting several months during which carefully controlled quantities were fed, there were no bad effects on the cow's health either at the time or in the next lactation; but until long-range experiments, now in progress, are completed, iodinated protein feeding cannot be regarded as a practical method for increasing the nation's milk supply.

Dr. Gaines (Glasgow) showed, by lantern and microscope, recent results of histological examination of human nipples. There are very abundant nerve endings in the nipple, many of them associated with smooth muscle cells, and associated with the erection that takes place after stimulus. The sucking stimulus of the infant is remarkable—the suction on the nipple could be as great as 100 or even 200 mm. of mercury. So far, though their presence had formerly been assumed in the nipple, no Meissner corpuscles had been found.

A discussion followed the papers referred to above.

PRIMITIVE TECHNIQUES, AGRICULTURE AND ECONOMIC ORGANISATION

PRIMITIVE techniques and their influence upon economic organisation was the subject of a discussion in Section H (Anthropology) of the British Association on September 10 at Brighton. Mr. R. U. Sayce, president of Section H, was in the chair.

The discussion was opened by Mr. Adrian Digby, who laid stress on the importance of the time factor. The study of society and the study of technology have, he said, been drifting apart under the influence of the functional school. The welter of closely integrated, not to say tangled, data with which social anthropologists have to deal has led those with leanings towards sociology to jettison the study of material culture as of least value to their particular interests and to specialize in social structure as a way out of their difficulties. On the other hand, those interested in material culture have paid more attention to the 'anatomy', as it were, than to the 'physiology' of their material. But there is a very close relation between social organisation and the manner in which people set about satisfying their needs in life.

There are, said Mr. Digby, six essential factors necessary to the daily life of any community: namely, (i) food, (ii) clothing, (iii) housing, (iv) fuel, (v) social integration for the distribution of the results of labour, and for security, and (vi) social integration for emotional and intellectual satisfaction. Under this latter head he included religion marriage and relaxation. The relative importance of these six factors would vary according to circumstances, but the growth of any one in importance, or in time occupied, would be at the expense of some other factor or factors of the six enumerated. This he illustrated by reference to the Australians, whose dependence on hunting and food-gathering, a slow method of producing food, leaves relatively little time for anything else except the elaborate rituals which satisfy the sixth need in their case and were also partially or largely directed to improving the food supply. With the Australians he contrasted the modern Maya, who, cultivating maize on the *milpa* system (analogous to the dry cultivation of rice), can with 190 days work in the year produce nearly twice as much maize on a ten-acre plot as a family of five needs for consumption, and have 175 days left for the other five basic needs. These figures, derived from Steggerda, represent an economy that relies upon steel tools; the ancient Maya relied upon stone ones. Their production would therefore be much less, but one could still assume that they produced sufficient food to give them, without surplus, a similar 175 days of leisure. With that they built themselves ample wooden dwelling-houses, developed textile and ceramic arts to a high degree, attained great intellectual achievement in mathematics and astronomy, and constructed elaborate ceremonial centres such as Copan and Tikal. The bulk of the population seem to have been peasant farmers; but the life occupation of each child was predetermined by a system of casting horoscopes—direction of labour by divine sanction which any bureaucratic government might envy to-day. If more time had been required for food production, all these other developments could not have occurred in the same degree; greater or less stress on any one of these would have had a major effect on their culture as a whole. No general rule can be deduced owing to lack of data from a quantitative point of view.

In the case of techniques other than agriculture, data are even scantier. Thus in West Africa men and women use different looms with entirely different technique of weaving; the differentiation is not based apparently on any physiological grounds; the reasons for it may be historical or psychological; but, without data as to time, labour and production, it is impossible to tell how these different methods of weaving fitted into the social and economic organisation of the people who practised them. New ools may create demands requiring a departure from raditional practice; new methods may involve hanges, economic or social, which social or psychoogical considerations are unlikely to invalidate. Changes in material culture tend to be adopted far more rapidly than social changes; but the impact of Western civilization on the social side is none the less reat for being exercised through material objects.

The corrective element to the unfortunate centriugal tendencies of modern anthropology is to be ound in the study of the time factor as applied to all productive techniques and the labour forces available. It was for the more careful study, by eld workers, of technical processes, and especially of he time and labour required for them, that Mr. igby particularly pleaded.

Mr. G. I. Jones followed Mr. Digby with a paper n the north-eastern tribes of south-east Nigeria, known to their neighbours as the Ndi Ogu Uku—the people of the Big Hoe. These tribes have a social nd economic structure very different from their eighbours, and Mr. Jones suggested that this is rimarily and mainly due to the use and development f their superior agricultural tool. The normal Ibo ibal structure lays emphasis on concentration and consolidation into compact, and therefore politically safe, communities subsisting on hoe cultivation, but using the normal small hoe at the end of a crook-shaped handle. The Ndi Ogu Uku, however, use a hoe with a blade of similar shape, but much larger and hafted into a heavy club-shaped handle. This implement makes it possible to extend yam plantations rapidly over a much larger area; thus shifting the basis of economic importance from labour to land. Other Ibo tribes also have a colonizing system; but, apparently owing to the slower rate of cultivating and to the concentration of populations, colonies once thrown off tend to become independent units, with their own separate communal life, at a distance from the parent community. In the case of the Big Hoe people, however, their rapidity of expansion in uncultivated land has led to the throwing out of colonies on a periphery of perhaps twenty miles or more without any break in family or political organisation, the younger members of a family retaining an interest in the parent village site and sending back colonists to replace elder members of their line in tribal councils and in family properties as places fall vacant. The peripheral communities of Big Hoe Ibo may be numerically weak in themselves, but the retention of close integration with their parent villages provides the reliance on numbers necessary to political security; while the use of the big hoe makes possible a rapid territorial expansion and a rapid increase in population and in organised political power. The Ibo communities therefore illustrate the very marked change in social and economic structures which can be brought about by a very minor change in material culture.

In the short discussion that followed Mr. Jones' paper, it was made clear that the use of the big hoe among the Ibo seemed to have developed gradually and was not attributed to any particular invention or to any given 'culture hero'; the other tribes using the traditional small hoe professed inability to use the big hoe, but this was due rather to the absence of the tradition than to any physical incapacity. Prof. Gordon Childe congratulated Mr. Digby on having illustrated the true function of functionalism in anthropology.

Prof. J. H. Hutton followed with a comparison between the cultivation of wet and dry rice in the Naga Hills of Assam. Food was clearly the most important of Mr. Digby's six basic needs, since without it the others would not arise; the available leisure, and the surplus food, after the needs of the community were assured, would vary, and their utilization would vary, and different patterns of society would be determined accordingly. The common physical affinities and common ecological background of the Naga Hills has made possible the elimination of many variables and therefore a valid comparison between the two contrasting economies. The hilly terrain had probably led to some sort of terracing even for dry crops; rice was later in time than millet and had possibly been first introduced as an irrigated crop purely, and used also as a dry crop afterwards. Terraced irrigation on the very steep hillsides involves very long-term commitments and a much greater initial effort than dry cultivation, and the occupation of permanent village sites is implicit. But the periodic labour is very much less than in dry cultivation, and much greater periods of leisure are made possible as well as a generally greater economic surplus. Only when very long-standing forest is felled for dry rice is the yield greater than from irrigated fields, and even then the labour of felling is greatly enhanced and leisure correspondingly restricted.

Prof. Hutton illustrated the point by describing the comparative agricultural years of the Angami and Sema Nagas, emphasizing the much more continuous labour of the latter on their dry fields, and the much greater leisure enjoyed by the former as well as a greater economic surplus from their irrigated terraces. This gave the Angami a much richer and more colourful social life, since more leisure and wealth are available for the fifth and sixth needs. Moreover, a concentration of population is possible, with consequent political influence and stability. He suggested further that the absence of leisure in dry cultivation may be a contributory factor in the specialization of village industries like pot-making and weaving, which (in the Naga Hills) are often alternatively practised in one village and *taboo* in a neighbouring one, and may thus have contributed to the formation of occupational castes. He described the difficulty, enhanced by ritual considerations and by the absence of perennial forest, of effecting a change from a dry to a wet economy; but when once achieved, such a change leads to much greater independence on the part of individual villagers and tends to reduce the power of individual chieftains.

Dr. E. R. Leach, who followed with a paper on dry rice cultivation in Burma and Borneo, took a very different view from Prof. Hutton. He repudiated any general dichotomy in the wet and dry cultivation, regarding them as complementary rather than alternative methods of agriculture, and treating the administrative condemnation of dry rice cultivation as based on incomplete knowledge and mere prejudice; advocates of a change from dry to wet, he said, ignore problems such as that of redistribution of labour involved in the change. Dr. Leach had worked out a most detailed analysis to compare the labour and results of three methods of agriculture: 'slash and burn' methods of cultivating on dry ground, cultivating with the hoe for dry or wet rice, and cultivating with the plough. The difference between them, he said, is more fundamental than that between dry and irrigated rice. His general conclusion was that the cultivation of dry rice is more productive in yield per unit of labour than wet rice unless the plough be used. This conclusion, he maintained, is confirmed by the preference both among the Kachin of Upper Burma and the Dusun of Borneo for the cultivation of dry rather than wet rice where both methods were available. He suggested that the Angami terracing is due to military considerations rather than economic. With the plough, of course, the area cultivated by a normal household can be so much increased that there is a much greater economic surplus.

Prof. Christoph von Fürer-Haimendorf discussed the two preceding papers in the light of his experience on the north bank of the Brahmaputra in Assam, where the Apa Tani tribe, using hoes and not ploughs, support a population of 1,000 to the square mile on irrigated rice, of which they have a considerable surplus to trade for cattle and cloth to the neighbouring Daflas, who live in comparative poverty on the cultivation of dry rice, also by the use of the hoe, and have repeatedly to shift their villages as land becomes exhausted. This supported Prof. Hutton's view that irrigated rice is economically more profitable than dry. The Apa Tani system of wet cultivation preserves all the soil fertility and yields a perfectly balanced agricultural economy. The Apa Tani are a peace-loving people whereas it is the Daflas who have a bias towards war.

In the discussion that followed, it became pretty clear first that there was general agreement that, *provided* a long enough cycle of rest can be depended on, dry cultivation of the hillsides, which may b the only possible form of cultivation, need not in th long run be destructive of the soil fertility, or at an rate is not so wasteful or deleterious as administrativ and forest officers are inclined to assert; an secondly, that the question of the economic return of irrigated as compared to dry rice, per unit o labour expended, depends very largely on the rainfall and on the presence of a perennial water supply a point which largely accounts for the different view put forward by Prof. Hutton, from his experience o the Assam hills, and by Dr. Leach, whose experienc is of the drier climate of Upper Burma.

It was perhaps a pity that the discussion o primitive techniques was so largely limited to agriculture; but the importance of the subject was no left in any doubt.

NEWS and VIEWS

Prof. G. R. Goldsbrough, C.B.E., F.R.S.

PROF. G. R. GOLDSBROUGH'S retirement from the chair of mathematics at King's College, Newcastle-upon-Tyne, breaks a long and distinguished association with the College. He is an old student of the College, who returned to it in 1919 as lecturer in applied mathematics; in 1928 he was promoted to a professorship, and he has been head of the Department of Mathematics for the last three years. His research work has been mainly on two lines: in hydrodynamics he has made important contributions to the dynamical theory of the tides, and in astronomy he has elucidated the classical problem of the divisions in Saturn's ring. He was elected to the Royal Society in 1929. His interest in astronomy and geodynamics has been of special value in connexion with the work of the University Observatory at Durham. In addition to teaching and research, Prof. Goldsbrough has taken a leading and influential part in administrative and other activities in th University, and his sound judgment and advice hav been greatly appreciated. He was sub-rector of th College for the period 1942–47; and among man other duties he undertook the arduous task o chairmanship of the Joint Recruiting Board. H was awarded the C.B.E. in 1948. His colleagues an old students will wish him in his retirement man pleasant years of fruitful activity. He has bee succeeded at King's College by Profs. A. E. Gree and W. W. Rogosinski (see *Nature*, September 1 p. 445).

Biological Chemistry at Aberdeen :
Dr. W. O. Kermack, F.R.

DR. W. O. KERMACK, for many years in charge o the Chemical Laboratories of the Royal College o Physicians, Edinburgh, has been appointed to th recently established chair of biological chemistry the University of Aberdeen. This appointment will be received with a great deal of interest by all in the biochemical field, and with an element of surprise perhaps by some, for the appointment is probably unique in scientific circles in that Dr. Kermack is blind. To proceed to such an appointment in a laboratory subject has something in it of an act of faith, based not alone on the high scientific attainments but also on the rich mental endowments and sterling qualities of the new professor.

Dr. Kermack is an honours graduate in chemistry of the University of Aberdeen, where he received his B.Sc. degree in 1918. It was while a postgraduate research worker at Edinburgh that, in the course of an experiment, he met with the tragic accident which deprived him of all vision. To a lesser spirit such a catastrophe might well have spelt defeat; to Kermack it was but a challenge to re-orient his life to the steady continuance of his scientific work. That success has attended his efforts to a remarkable degree is seen in his activities in the spheres of mathematics, chemistry and music. His early research work was carried out in Oxford under the supervision first of Prof. W. H. Perkin and latterly of Sir Robert Robinson; his later work in colloid chemistry, on certain reactions of serum and cerebrospinal fluid, led on to the synthesis of compounds of possible antimalarial activity. This work has resulted in the synthesis of pyridoacridine and of *p*-phenanthroline derivatives, which have considerable chemotherapeutic activity on avian malaria. Dr. Kermack is joint author with Dr. P. Eggleton of "The Stuff We're Made Of" (1938); he is a D.Sc. of Aberdeen, was awarded the Freeland–Barbour Prize of the Royal College of Physicians, Edinburgh, the Macdougall–Brisbane Prize of the Royal Society of Edinburgh (1929), received the honorary degree of LL.D. of the University of St. Andrews in 1937 and was elected a fellow of the Royal Society in 1944.

Genetics at the John Innes Horticultural Institution

Dr. D. Lewis

Dr. D. Lewis is succeeding Dr. Mather, recently appointed to the chair of genetics at Birmingham, as head of the Genetics Department at the John Innes Horticultural Institution. Dr. Lewis was appointed from Reading in 1935 to work in the Pomology Department at the Institution. He has collaborated with Mr. M. B. Crane in the breeding of pears, raspberries and other fruits. For the last ten years, however, he has concentrated on the study of the incompatibility reaction in plants, using especially the Californian *Oenothera organensis*. He began with simple tests on the temperature relations. Later he introduced polyploidy and mutations, both spontaneous and induced, into his experiments. He has been able to split the incompatibility gene in *Oenothera*, with results of great physiological interest. He has also been able to calculate its natural mutation-rate in the sweet cherry, and at the same time use the mutations in producing self-fertile types in a hitherto self-incompatible species—a breeding device of great practical interest. Dr. Lewis' versatile experimental gifts should find suitable scope in his new post.

Women as a Labour Force in Britain

In Broadsheet No. 285, "Employment of Women", *Planning* (P.E.P.) examines some of the implications of the task of maintaining, and if possible increasing, the female labour of Britain at a time when the number of women of working age is declining. The difficulty is enhanced by the even greater decline in the number of women under forty-five years of age, from whom the bulk of the female labour force is drawn. The broadsheet points out that it is very important that employers should not be unprepared for the probable fall in the number of women in employment during the next fifteen years. The Ministry of Labour should forecast the probable trend in the number of women available for work in the various industries and regions, and should make the findings widely known. It must then be considered whether rising productivity will make good the loss of women workers, and if not, what adjustments should be made; in particular, whether to try to maintain the proportion of women in certain industries and occupations, or whether to allow the proportion to fall in all. Two conclusions stand out: first, that any substantial increase in the number of women in employment must come from married women; and, secondly, that if the female labour force is not to fall greatly, there must be a big rise in the number of middle-aged and elderly women in employment. By far the most hopeful means is to extend the opportunities for part-time workers. This is a desirable solution from the women's point of view; but from the employers' aspect entails careful organisation, additional supervision, and flexibility. In compensation there is evidence that part-time workers give good service, that their output is often higher than that of full-time workers, and that absenteeism and labour turn-over do not compare unfavourably. The importance of improving working conditions and providing more nurseries is stressed, and also of employing women who are in jobs to the best advantage. Those who aspire to a skilled, professional or executive job should have the opportunity, and the size, composition and distribution of the female labour force must not be left to chance.

French Abstracts

The *Bulletin Analytique*, published by the Centre National de la Recherche Scientifique, Paris, is an abstracting journal which appears monthly in two parts, Part 1 covering scientific and technical papers in the mathematical and physical sciences and their applications, Part 2 the biological sciences. The *Bulletin*, which started on a modest scale in 1940 with an average of 10,000 abstracts per part, now averages 35,000–40,000 abstracts per part. The abstracts summarize briefly papers in scientific and technical periodicals received in Paris from all over the world and cover the majority of the more important journals in the world scientific press. The scope of the *Bulletin* is constantly being enlarged to include a wider selection of periodicals. It thus provides a valuable reference book both for the laboratory and for the individual research worker who wishes to keep in touch with advances in subjects bordering on his own. A microfilm is made of each article as it is abstracted, and negative microfilm copies or prints from microfilm can be purchased from the editors. The subscription rates of the *Bulletin Analytique* for Great Britain are 4,000 fr. (£5) per annum for each part. The *Bulletin* is also issued in sections covering specific subjects. Subscriptions can be paid directly to the editors: Centre National de la Recherche Scientifique, 18 rue Pierre-Curie, Paris 5ème. (Compte-chèque-postal 2500–42, Paris), or through Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, London, W.C.1.

University of the Witwatersrand: Nuclear Physics Exhibition

THE chair of physics at the University of the Witwatersrand, Johannesburg, became vacant last year upon the retirement of Prof. H. H. Paine. The newly appointed head of the Department of Physics, Prof. G. T. R. Evans, delivered his inaugural lecture in the Great Hall of the University on September 23, taking as his subject "Radium: 1898–1948". Prof. Evans took the opportunity of paying a tribute to the memory of Madame Marie Curie and her husband. The vice-chancellor, Principal H. R. Raikes, who presided, expressed the appreciation of the University at the presence of M. Lancial, the Minister Plenipotentiary of the French Republic in South Africa. In connexion with the inaugural lecture there was held a two-day Exhibition in the Department of Physics under the direction of Prof. G. T. R. Evans. The film, "Marie Curie", was shown in the Great Hall; shorter films, "The Nuclear Structure of the Atom" and "Atomic Energy", were shown in the lecture theatre of the Department. The exhibition of nuclear phenomena, apparatus and films was open daily from 2.30 p.m. and attracted several thousand people. The exhibits included items of historic interest contributed by Madame Irene Joliot-Curie. Prof. A. M. Tyndall, of the University of Bristol, exhibited a collection of photomicrographs of nuclear tracks in photographic emulsions. The National Physical Laboratory of Pretoria demonstrated artificial radioactivity in biology. Other exhibits appreciated by the lay public were a working model of a cyclotron, a Wilson cloud chamber, Geiger counters and scalars, the medical use of radium and South African fluorescent minerals. This is the third exhibition organised by the Department of Physics since 1945; the crowds which gathered round the demonstrators until long after the hour for closing constituted convincing evidence of the appreciation of the Department's efforts to meet the layman's desire for a better understanding of modern physics.

Medical Research Council: New Members

BY an Order of the Committee of Privy Council for Medical Research, Lord Addison and Sir George Schuster have been appointed members of the Medical Research Council. With the approval of the Committee of Privy Council, the Medical Research Council has appointed Lord Addison to be its chairman in succession to Lord Balfour of Burleigh, and Sir George Schuster to be treasurer in succession to Sir William Goodenough. By the same Order, made in this respect after consultation with the Medical Research Council and with the president of the Royal Society, the following have also been appointed members of the Council: Sir Frederic Bartlett, professor of experimental psychology in the University of Cambridge; Sir Howard Florey, professor of pathology in the University of Oxford; and Prof. Geoffrey Jefferson, professor of neurosurgery in the University of Manchester.

Permanent International Association of Navigation Congresses

THERE has recently been formed, with the approval of the Ministry of Transport, a British National Committee in connexion with the Permanent International Association of Navigation Congresses. The main objects of the Committee are to foster interest in the Association, to promote papers for presentation at the congresses (in particular for the next congress to be held in Lisbon in September 1949) and generally to act as the co-ordinator of British interests in this connexion. The membership of the Committee is as follows: Sir William Halcrow (chairman), Mr. M. G. J. McHaffie, Mr. W. P. Shepherd-Barron, Mr. R. D. Gwyther, Mr. A. L. Harvey, Mr. C. A. Wilson, Mr. L. Cleaver, Sir Gilmour Jenkins, Mr. L. Leighton, Sir Cyril Kirkpatrick, Sir Arthur Whitaker and Mr. Maurice Nachshen. The Council of the Institution of Civil Engineers will administer and provide secretarial facilities to the National Committee. The Committee, at the request of the Secretary-General of the Association, has agreed to distribute in Great Britain bulletins, etc., received in bulk from Brussels, and also to receive on behalf of the Association subscriptions from members resident in Britain for onward transmission in a bulk sum or sums. Correspondence should be addressed to the Secretary, British National Committee, Permanent International Association of Navigation Congresses, at the Institution of Civil Engineers, Great George Street, London, S.W.1.

Royal Aeronautical Society

THE Royal Aeronautical Society has decided to form Divisions of the Society within the British Commonwealth, and steps are being taken to establish such Divisions in Australia and also in New Zealand by January 1, 1949. These Divisions (and those in other Dominions as formed) will have power to form branches of the Royal Aeronautical Society in their own countries, similar to those formed by the Society in Great Britain. Members of the Division will all be full registered members of the Society, and the Division will have the power to act in most respects exactly as the parent body in London. The only important exception is the actual election of members as associate fellows, so that a consistent standard will be set throughout the world; all such technical members will be elected by the Royal Aeronautical Society in London. But the Divisions will follow their own activities in their own countries in the ways which best suit that country and local conditions, and they will not be tied down in any way by rules or regulations which apply to Great Britain or the other Divisions.

Society for General Microbiology

AT a general meeting of the Society held at St. Andrews in September, the following were elected honorary members of the Society: Prof. O. T. Avery, Prof. Jules Bordet, Sir Alexander Fleming, Prof. A. J. Kluyver and Sir Charles Martin. In addition, a paper-reading session was held over two days, and thirteen demonstrations were given.

The officers and committee of the Society for 1948–49 are as follows: *President*, Dr. Marjory Stephenson; *Hon. Treasurer*, Mr. H. J. Bunker; *Joint Hon. Secretaries*, Dr. W. E. van Heyningen and Dr. J. G. Davis. The *Journal* of the Society is issued at about four-monthly intervals, and is edited by Dr. B. C. J. G. Knight and Dr. A. A. Miles, assisted by Dr. G. C. Ainsworth, Prof. W. B. Brierley, Dr. T. Gibson, Dr. A. T. R. Mattick, Dr. K. M. Smith, Dr. A. W. Stableforth and Dr. D. D. Woods.

Fourth Empire Mining and Metallurgical Congress

THE Fourth Empire Mining and Metallurgica Congress convened by the Empire Council of Mining and Metallurgical Institutions will be held in Great

Britain in July 1949, under the presidency of Sir Henry Tizard. The chief object of the Congress is to afford an opportunity for scientific men, engineers and others concerned with the mining and metallurgical industries to meet and discuss technical progress and problems, including the development of the mineral resources of the Commonwealth. The programme will be divided into three parts: July 9–12, inaugural meeting, official functions, exhibitions, visits, etc., in London; July 13–17, technical sessions in Oxford; July 18–23, excursions based for the most part on universities in Great Britain. Further information can be obtained from the General Secretaries, Fourth Empire Mining and Metallurgical Congress, 436 Salisbury House, Finsbury Circus, London, E.C.2.

Colonial Medical Research Fellowships

The Secretary of State for the Colonies has instituted a limited number of research studentships for graduates in medicine and cognate sciences, who desire by this means to prepare themselves for research work in tropical medicine and related subjects. They will be awarded on the advice of the Colonial Medical Research Committee, and will be tenable for two years at any university or other appropriate institution as approved by the Committee. The maximum rates of allowance payable are £300 per annum at the Universities of Oxford, Cambridge and London, and £260 per annum at other universities in the United Kingdom. Candidates must be British subjects and graduates of British universities. Application should be made, through the head of the candidate's Department, to the Secretary, Colonial Medical Research Committee, c/o Research Department, Colonial Office, Sanctuary Buildings, Gt. Smith Street, London, S.W.1, and should include, in addition to details of the candidate's academic record, some indication of the subject preferred.

A General Solution for the Force Constants of Polyatomic Molecules

Mr. P. Torkington writes with reference to the communication under the above title in *Nature* of September 4, p. 370: "It was stated that in the proposed solution the normal co-ordinate for ν_i involved only the co-ordinates Δ_i to Δ_n. In fact, it involves only the co-ordinates Δ_1 to Δ_i. The linear transformation giving the (unnormalized) normal co-ordinates η_i is found to be

$$\eta_i = \sum_{j=1}^{i} ({}^{i}|A|_{ij})\ \Delta_j.$$

The quantities on the right-hand side of equations (7) and (8) are coefficients in the reverse transformation, giving here the components in the displacement for ν_k in terms of η_k. In (8), the coefficients for Δ_1 to Δ_{k-1} are zero; it is therefore the form of the vibration, not the normal co-ordinate, which involves Δ_k to Δ_n only. Where $(\nu_i - \nu_{i+1})$ is small, and Δ_i and Δ_{i+1} overlap, η_i would be expected to involve Δ_{i+1}; η_{i+1} involves Δ_i in any event."

Announcements

The Lords Commissioners of the Treasury have appointed Dr. A. E. Trueman to be chairman of the University Grants Committee in succession to Sir Walter Moberly, who retires on October 1, 1949. Dr. Trueman, who has had a distinguished career as a geologist and a university administrator, became deputy chairman of the Committee in 1946 (see *Nature*, August 31, 1946, p. 299).

Dr. Robert Cruickshank, since 1945 director of the Central Public Health Laboratory of the Public Health Laboratory Service, has been appointed to the chair of bacteriology tenable at St. Mary's Hospital Medical School, London, as from January 1, 1949.

Dr. R. A. M. Case, until recently a principal scientific officer in the Royal Naval Scientific Service at the Royal Naval Physiological Laboratory, has taken up appointment at the Chester Beatty Research Institute of the Royal Cancer Hospital as research fellow under a scheme inaugurated by the Association of British Chemical Manufacturers, for the field and experimental investigation of the industrial incidence of papilloma of the bladder.

Dr. T. T. Paterson, who has resigned his post as curator of the Museum of Archæology and Ethnology, Cambridge (see *Nature*, September 18, p. 445), is to devote his time to research in the social anthropology of Britain, with special reference to problems of social medicine and group phenomena in the industrial, rural and urban fields. The investigation is being financed by a grant from the Medical Research Council.

The Leon Gaster Memorial Premium of the Illuminating Engineering Society, given annually for the best contribution submitted to and published by the Society during the session, has this year been awarded to Mr. J. N. Bowtell and Mr. H. G. Jenkins for their paper entitled "High Voltage Fluorescent Tubes". In view of the high standard of papers eligible for the award this year, the Council has made a second award to Messrs. H. K. Cameron, E. H. Rayner, E. R. Thomas and G. T. Winch for their paper entitled "Photometry of Searchlights" which forms part of the "Symposium on Searchlights" recently published by the Illuminating Engineering Society.

The Tilden Lecture of the Chemical Society will be delivered by Prof. C. E. H. Bawn in the rooms of the Society on November 11 at 7 p.m. Prof. Bawn will speak on "The Structure and Reactivity of Free Radicals".

A course of eight lectures on practical psychical research, beginning on October 16, has been arranged by the Society for Psychical Research and will be given at its house, 31 Tavistock Square, London, W.C.1. The topics to be discussed include the investigation of cases, extra-sensory perception experiments, and psychological and statistical methods. Tickets of admission (one ticket covers the whole course) can be obtained free from the secretary of the Society.

Dr. B. P. Dudding, honorary lecturer in industrial statistics, University of Sheffield, will give a course of eight lectures at the Sir John Cass Technical Institute, London, E.C.3, on Monday evenings at 7 p.m., beginning on October 25, on "Statistical Methods in Industry". A further course of lectures, also on Mondays at 7 p.m., beginning January 24, will be given by Mr. K. A. Brownlee on "Design of Experiments". The fee for either course is £1. Application for enrolment forms should be made to the Principal of the Institute prior to the opening date of the courses.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of Calciferol

For some time it has appeared very desirable to undertake, for a calciferol derivative, a detailed X-ray analysis similar to that achieved for cholesteryl iodide[1]. Such an analysis should settle once for all many doubtful points in sterol chemistry and, incidentally, resolve the conflict between the early crystallographic and chemical evidence on the structure of calciferol[2]. The X-ray analysis of cholesteryl iodide was possible owing to the presence of the heavy iodine atom in the molecule, which permitted the direct calculation of electron-density projections. In the case of calciferol, our chief difficulty has been in finding any crystalline heavy-atom derivative. Dr. and Mrs. Cornforth were finally successful in preparing for us crystals of calciferol-4-iodo-5-nitrobenzoate, and from these we have now obtained evidence, by X-ray analysis, on the molecular structure of calciferol.

The crystals of calciferol-4-iodo-5-nitrobenzoate, $C_{35}H_{46}NO_4I$, are deep yellow prisms. They are orthorhombic with four molecules in the unit cell of dimensions: $a = 31 \cdot 2$, $b = 6 \cdot 98$, $c = 15 \cdot 3$ A., and space group $P\,2_12_12_1$. Their investigation followed a somewhat similar course to that adopted in the case of cholesteryl iodide. The x and z parameters of the iodine atoms were first found from a calculated Patterson (F^2) projection based on the intensities of the ($h0l$) reflexions. The first electron density projection was then calculated, using reflexions the phases for which could be determined from the iodine atom contributions alone; this projection indicated the configuration of the molecules and their general arrangement in the crystal. Approximate x and z parameters were then assigned to the other atoms in the crystal from this first projection. These parameters were refined and, in some cases, entirely changed through the calculation of two further electron density projections, based on phases calculated for all the atoms in the molecule. The final projection obtained is shown in Fig. 1 *a*, and its interpretation in terms of atomic positions in Fig. 1 *b*.

We have not so far completed the measurements on other zones of the crystal, so that we have, at present, no evidence on the y parameters normal to this (010) projection. While it should be simple to determine the y parameters of the iodine atoms, a prolonged and difficult three-dimensional analysis will be required to derive the y parameters of the remaining atoms.

We have, however, been fortunate in the crystal found for X-ray analysis. The fact that b is so short, 6·98 A., has given us a projection normal to this axis in which atoms of neighbouring molecules do not overlap; as a result, we have a projection of the calciferol structure which provides surprisingly good evidence on almost every detail of the chemical and stereochemical nature of the molecule. There is, in the first place, no doubt that ring *B* of the sterol skeleton is broken and that structure I, deduced on chemical evidence[3] for calciferol, is correct. In our crystal, however, the molecule does not maintain the curled-up configuration suggested by I, but exists in an extended form which may be approximately represented by II.

The detailed stereochemical relations of the atoms within the molecule (Fig. 2) are naturally interdependent; they may conveniently be traced from the point of attachment of the iodonitrobenzoyl group. First, the direction of the C(3) — **O** bond is only consistent with that described by Ruzicka, Furter and Goldberg as *t* or '*trans*'[4] in the original sterol skeleton (that is, *cis* to the methyl group at C(10) and C(13) in the ergosterol skeleton before ring breaking). This configuration is the same as that found for C(3) — I in cholesteryl iodide (cf. Dimroth[5]). Ring *A* itself has the expected appearance of a puckered six-membered ring in the 'chair' or *Z* form seen on its side. The directions at which the bonds C(10) — C(19) and C(5) — C(6) project are consistent with these being double bonds;

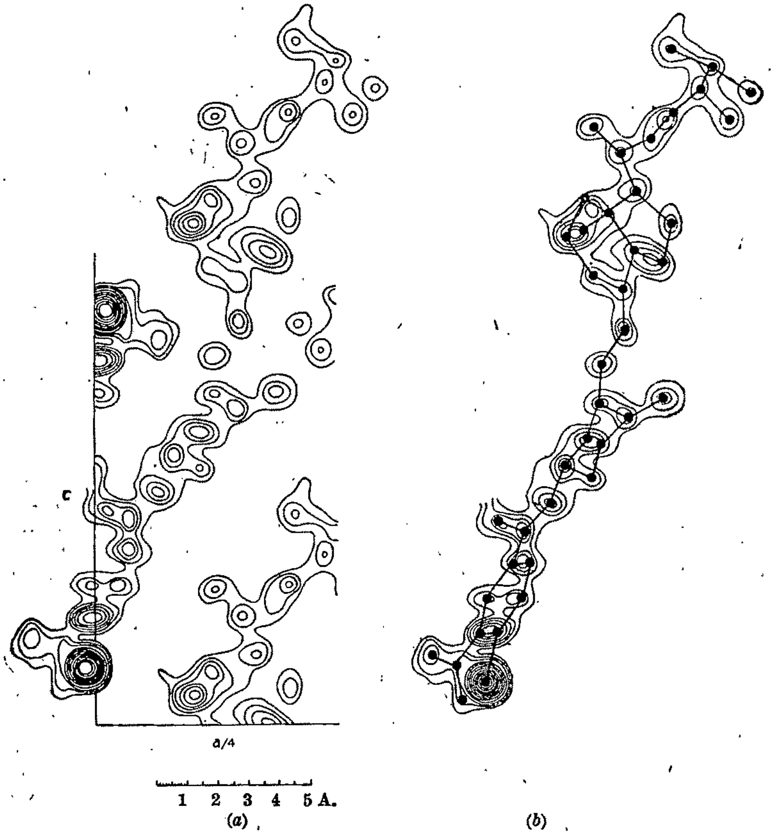
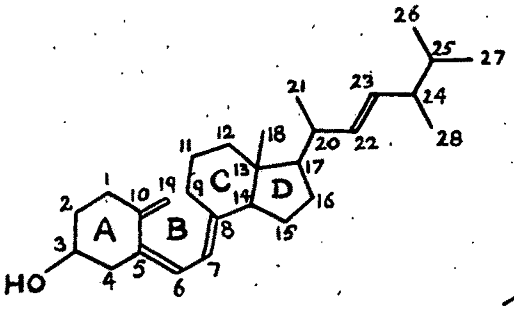
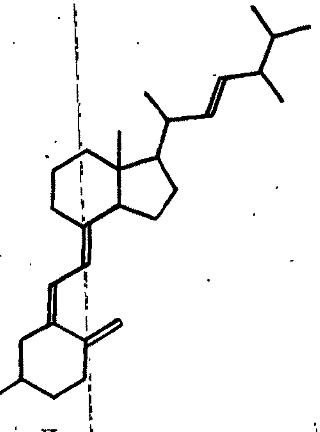


Fig. 1. (*a*) Electron density projection on (010) calculated for calciferol-4-iodo-5-nitrobenzoate. (*b*) The same with, superimposed, the positions derived for the atoms in the molecule. In both (*a*) and (*b*) only the electron density contours covering one of the four molecules which appear in this projection are shown in full



I



II

again, C(7) — C(8) is nearly parallel in projection with C(5) — C(6), as might be expected in a double-bonded system. Rings *C* and *D* are seen open in projection. Their appearance, particularly the parallel projection of bonds C(9) — C(8) and C(14) — C(15) combined with the position of C(16), seems only consistent with *trans* fusion of these two rings. The stereochemical relations at the centres C(13), C(17) and C(20) are as found in cholesteryl iodide, and the relation of these to the new asymmetric centre in calciferol at C(24) is shown. The main doubt that exists at present in the determination of these different points in configuration is in the relation of the two parts of the molecule separated by C(6) and C(7) (hence in the C(3) — O bond configuration). The relation described above depends on the probability that the bonds C(5) — C(6) and C(7) — C(8) are parallel in three dimensions. This probability is high, both on theoretical grounds and through the appearance of the projection. It will in any case be checked by the three-dimensional X-ray analysis of the structure.

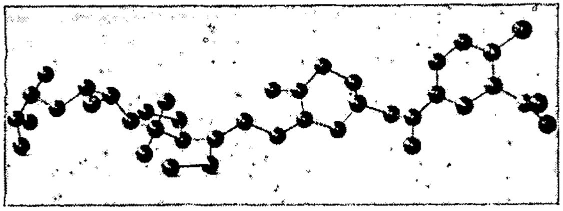


Fig. 2. Photograph of model showing the spatial arrangement of the atoms in calciferol-4-iodo-5-nitrobenzoate required by the electron density projection 1 *a*. This model shows one of the two permissible mirror-image forms of the molecule. The form chosen corresponds to the usual convention in the sterol series; compare, for example, Ruzicka *et al.* (ref. 5): it is not that given for cholesteryl iodide (see ref. 1). Hydrogen atoms are omitted

The way in which the molecules are fitted into the crystal structure as a whole is very intricate; it is one to which the unit-cell dimensions give no clue. It seems, therefore, quite possible that some similar unsuspected crystallographic complications exist in the calciferol crystals which were earlier examined, and that these led to a misinterpretation of the preliminary X-ray data. It is also conceivable that the calciferol molecule may adopt more bent or curled-up configurations in other crystals than that found here. Such differences could not affect the detailed chemical and stereochemical relations which are now clearly established.

In conclusion, we should like to thank those who helped us in our search for heavy-atom derivatives of calciferol, particularly Sir Robert Robinson, Dr. E. H. Carr, Dr. E. R. H. Jones, Dr. and Mrs. Cornforth and Dr. P. Meunier. The compound we used was first prepared in the Dyson Perrins Laboratory, Oxford, by Mrs. R. Cornforth from material given to us by Dr. E. H. Carr (British Drug Houses, Ltd.). It was later prepared in larger quantities at the National Institute for Medical Research, Hampstead, by Dr. J. W. Cornforth.

DOROTHY CROWFOOT
J. D. DUNITZ
Laboratory of Chemical Crystallography,
Oxford. July 12.

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Surface Layers of Crystals

CERTAIN treatments of crystal surfaces result in the formation of surface layers with physical properties different from those of the undisturbed material[1–3]. It has hitherto been possible to measure the thickness of such a layer only by etching it away until the properties of the surface thereby revealed correspond to those of the crystal as a whole[4]. This method is unsatisfactory in that the effect of etching is uncertain: it does not take place uniformly, and it results in pitting, which may lead to erroneous estimates of layer thickness.

We have devised an X-ray method which yields the thickness of the surface layer without altering it physically. The method is described in detail elsewhere[5]: it involves measurement of the variation in the intensity of X-ray reflexion from a crystal, as the angle φ (Fig. 1), between the surface and the Bragg reflecting planes, is varied. The surface of the crystal is cut so that it is inclined at an angle ω to the Bragg planes, and by rotating the crystal about an axis normal to the planes the effective value of φ

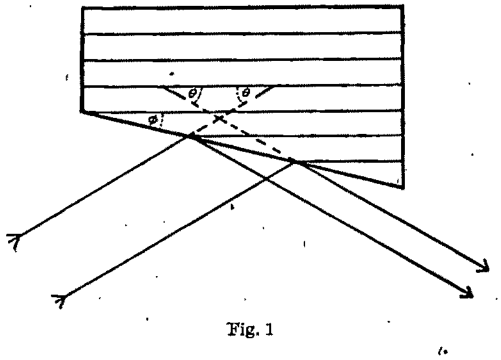

Fig. 1

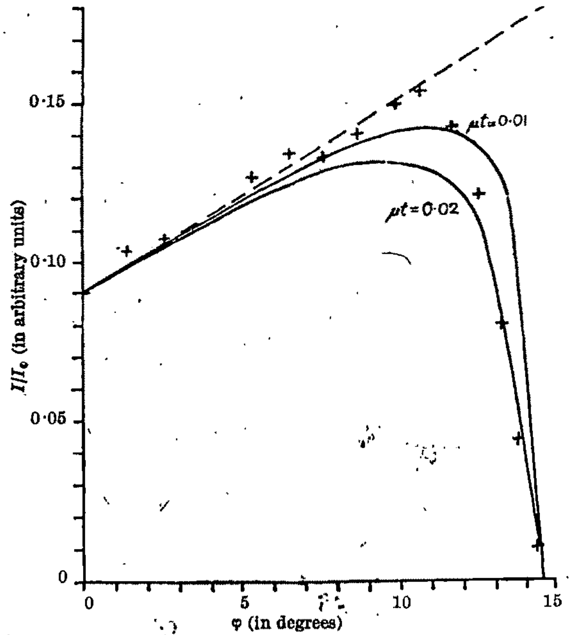

Fig. 2

may be made to vary from zero to ω, without disturbance of the surface.

For a crystal with no surface inhomogeneities an expression has been developed[6] for the ratio I/I_0 of reflected to incident beam intensity which is represented (suitably scaled) by the dotted line in Fig. 2. If, however, there are surface inhomogeneities such that the reflexion coefficient (K_θ') and absorption coefficient (μ') differ from the values ($K_\theta \mu$) appropriate to the main part of the crystal, then the variation of I/I_0 will follow a different law. A type of inhomogeneity particularly convenient for mathematical treatment is one where there is a surface layer of thickness t in which $K_\theta' = 0$ but $\mu' \neq 0$. The variation of I/I_0 with φ, for $\mu' t = 0{\cdot}01$ and $\mu' t = 0{\cdot}02$, is represented (suitably scaled) by the full lines in Fig. 2.

Other assumptions may be made about the variation of K_θ' with depth (for example, a linear increase up to the full value K_θ); but provided it be taken as an increasing function and μ' be taken as constant throughout the layer, curves very similar to those shown in Fig. 2 result. If the layer thickness be defined as the distance between the surface and the point where $K_\theta' = \frac{1}{2}K_\theta$, then it is found that the values of this thickness are almost independent of the particular assumptions made about the variation of K_θ'. Thus the method, while yielding a reasonable estimate of this half-value layer thickness, which is, of course, subject to some uncertainty about the value of μ', gives no information about the way in which K_θ' varies; except that, to explain the zero or very low value of I/I_0 at $\varphi = \theta$, it is in all cases necessary to assume K_θ' to be zero or very small at the surface.

We have applied this to determine the thickness of the surface layer on a crystal of calcite, ground and polished at an angle ω of 15° to a natural cleavage face. Electron diffraction photographs taken by reflexion from this surface showed intense background with slight central halation, such as one would expect from an amorphous material[2], justifying the assumption that K_θ' is zero at the surface. Applying the X-ray method described above, we obtained the experimental points shown in Fig. 2, which agree reasonably well with a theoretical curve, based on the above simplifying assumptions, and for a value $\mu' t \sim 1{\cdot}5 \times 10^{-2}$. For crystalline calcite $\mu = 205$ cm.$^{-1}$ for copper $K\alpha$ radiation, and it is reasonable to assume that it is not very different throughout the layer. Hence $t \sim 7{,}500$ A.

We are using this method to study ground and natural surfaces of single crystals and polycrystalline aggregates. It should be possible to measure by this means the thickness of any surface layer in which the value of K_θ' is different from that of the substrate material: one example is the layer on a polished metal surface, for which we have obtained interesting preliminary experimental observations; another is an electrodeposited layer of one metal on a base of a different metal.

We wish to express our thanks to Dr. V. E. Cosslett and Mr. G. R. Crowe for their aid in taking the electron diffraction photographs.

P. B. Hirsch
J. N. Kellar

Crystallographic Laboratory,
Cavendish Laboratory,
Cambridge. April 20.

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Ionization in Liquid and Solid Argon

Ionic mobilities in liquids are of the order of 10^{-3} cm.^{2}/volt/sec., and ion chambers filled with liquids are therefore generally useless in connexion with pulse amplifiers. Free electrons should have a much higher mobility; but their path before capture is extremely short in most liquids. We have been unable to detect them in carefully purified hexane. However, in condensed argon, charge carriers with a mobility greater than 40 cm.^{2}/volt/sec. have been found, and these are undoubtedly electrons.

The argon was purified by repeated passage over copper turnings at 400° C., and then condensed into the chamber by cooling, with liquid oxygen to produce the liquid, or with liquid nitrogen to produce the solid. The chamber had parallel, horizontal plates the distance apart of which could be varied between 1 and 5 mm.

The biggest pulses observed with liquid argon irradiated with gamma rays from radium C were, with fields of 10,000 volts per cm., about what was expected from complete electron collection (assuming an average energy loss by the Compton electrons of 25 eV. per ion pair formed). The pulses are distinctly smaller in fields of 2,500 volts per cm.

In solid argon much bigger pulses were found with fields of more than 13,000 volts/cm., indicating electron multiplication by a factor of more than 12. This phenomenon is, however, transient and disappears at a rate depending on the rate of charge collection as the cell polarizes. The polarization is not just due to the possible presence of a gas space between the solid and the top electrode, because it still occurs when the top portion of the cell is filled with liquid. The effect is similar to that reported in diamond and selenium[1].

If, after polarization had occurred, the chamber potential was removed, pulses continued with the same sign, in contrast to the reported behaviour[2] of silver chloride crystals, which show pulses of the opposite sign. This difference may be connected with the occurrence of secondary ionization in the argon in the fields used. If the cell contained a layer of solid argon below and liquid argon above, the predominant sign of the pulses after switching off the field always corresponded to an accumulation of positive space charge in the solid, no matter which had been the sign of the polarizing field.

An attempt was made to observe electron multiplication in the liquid by the use of a proportional counter made with a 15-micron wire in a cylinder of 5·2 mm. diameter; but only ordinary sized pulses were observed up to the maximum potential of 4,000 volts. In the solid, multiplication greater than ten-fold was found at potentials as low as 500 volts, but polarization was too rapid for accurate measurement.

Further information was obtained with a chamber in which the upper (collecting) electrode was screened by a fine wire grid. Pulses were observed with solid argon in part of the lower portion of the cell (the remainder containing the gas), but not when the solid was replaced by liquid. This indicates that in the fields used (greater than 500 volts/cm.), some electrons in the solid but not in the liquid have enough energy to escape into the gas phase.

Properties of ionization pulses in liquid and solid argon and other condensed media have recently been reported[3]. These experiments were done with alpha-particles and produced pulses about half the expected size. This is perhaps due to recombination, because of the denseness of the ionization tracks, and the effect may well be absent when ionization is due to fast electrons as in our experiments.

G. W. HUTCHINSON

Cavendish Laboratory,
Cambridge.
Aug. 13.

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Sound Velocity and Temperature Change of Molecular Association

USING an acoustical interferometer (frequency of the quartz crystal, 539·6 kc./s.), we have measured the velocity of sound in various liquids (carbon tetrachloride, benzene, ethyl ether and carbon disulphide) between 80° C. and the melting point of these liquids (see Fig. 1). In order to check the degree of association of the liquids at low temperatures, we computed from our measurements the relative ssociation: $R = (v_m{}^{1/3}/d_m)/(v^{1/3}/d)$, using the empirical equation of Rao[1], which has also been applied by Weissler[2].

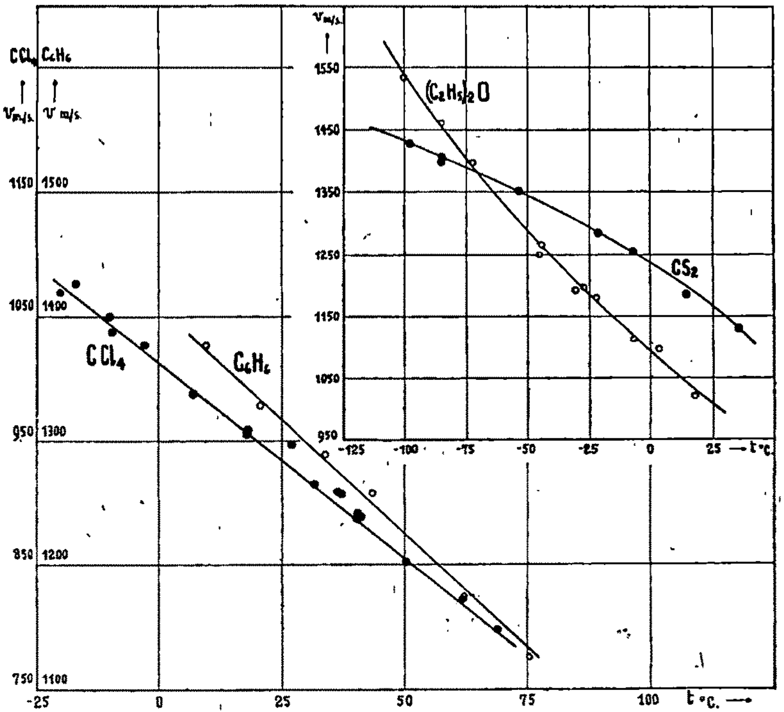

Fig. 1

v and d are the velocity of sound and density corresponding with the same temperature. In the case of no association, R is a constant.

This relative association (see Fig. 2) is taken as 1·000 at the respective melting points. The values for v_m are obtained by extrapolating our data down to the melting point. The values for the densities are taken from data published respectively by Isnard[3], Meyer[4], and by Richards, Speyers and Carver[5]. From Fig. 2 we see that an approximately straight line is obtained for carbon tetrachloride, while for the other liquids the lines are curved. The result for water obtained by Weissler[2] is also indicated.

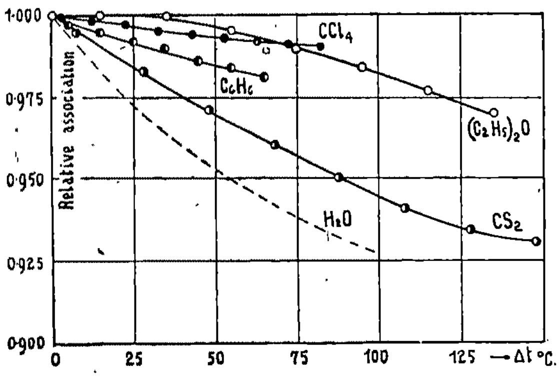

Fig. 2

In connexion with this problem of association, it is interesting to compute the relative association for helium I and II, using for this purpose the known experimental data for the velocity of sound obtained by Findley, Pitt, Grayson Smith and Wilhelm[6], and Pellam and Squire[7], and the densities of liquid helium under its saturated vapour pressure (Keesom and Keesom[8]).

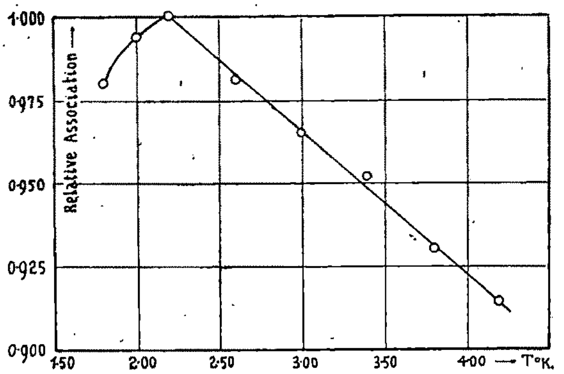

Fig. 3

The relative degree of association is taken as 1·000 at the λ-point. The results obtained are given in Fig. 3. We see that for helium I a straight line is found, whereas for helium II the line is curved. Further, the decrease of relative association is of the same order as for water[2] (see Fig. 2).

A. VAN ITTERBEEK
A. DE BOOK

Physical Laboratory,
University of Louvain.
July 13.

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Magnetism of Celestial Bodies and Gravitation

BLACKETT's formula[1] involving a relation between mechanical and electromagnetic quantities seems to indicate a new kind of connexion between gravitation and electromagnetism. This appears more distinctly in Wilson's relation :

$$\sigma = \sqrt{K}\rho, \tag{1}$$

where the charge density σ is associated with the mass density ρ by the Newtonian gravitational constant K. There is no room in Newtonian theory for an explanation of (1). The situation is better in the relativistic theory of gravitation.

For an isolated and limited fluid surrounded by a static gravitational field, and at rest with respect to a co-ordinate system which is Galilean at infinity, the total energy is given by[2] :

$$E = \int (T_4^4 + t_4^4)\, dV = mc^2, \tag{2}$$

where T_4^4 is the temporal component of the momentum-energy density tensor of the fluid, t_4^4 the temporal component of the gravitational energy density, dV the element of proper volume and *m the proper mass of the fluid*, equal to the constant of Schwarzschild's external line element[3]. For a sphere it is approximately equal to[4]:

$$E = \int_{v} \rho c^2\, dV + \tfrac{1}{2} \int_{v_0} \rho\psi\, dV_0, \tag{3}$$

where ψ is the Newtonian potential and dV_0 the elementary Euclidean volume, the integral being extended to the domain occupied by the fluid. When the body is a perfect spherical fluid[5] we have :

$$-3 \int p\, dV_0 = \tfrac{1}{2} \int \rho\psi\, dV_0, \tag{4}$$

where p is the internal pressure. In Newtonian approximation, dV reduces to the Euclidean elementary volume dV_0 and (3) yields: $E = mc^2 - W$ ($W = -\frac{1}{2}\int \rho\psi\, dV_0$). Therefore (2) indicates that there is in relativity a supplementary energy W which is such that according to (2) $E = mc^2$. The same conclusion is valid if the field of force inside the body is given by Schwarzschild's line element for a spherical incompressible fluid. This can be easily checked by computation of (2), using Dingle's formulæ[6].

The existence of W is due to the fact that the first integral in (3) is extended over a non-Euclidean space, for which the total volume occupied by the fluid is greater than that obtained by using a Euclidean metric. In spite of the very small difference between these volumes, the supplementary energy obtained in this way is not negligible. In Schwarzschild's case, with a as the Euclidean radius of the sphere, we get[7] :

$$m'c^2 = \int \rho c^2\, dV = \rho \frac{4\pi}{3} a^3 \left[1 + \frac{3}{5}\frac{Km}{c^2 a} + \dots\right], \tag{5}$$

and thus we obtain the supplementary energy[8]:

$$W = m'c^2 - mc^2 = \frac{3}{5}\frac{Km^2}{a}. \tag{6}$$

The physical origin of this energy is unknown. Obviously, it cannot be attributed to the internal pressure or to the Newtonian action of the gravitational field. Let us assume that it is due to a partial separation of the charges contained in the atoms of the neutral fluid. To support this hypothesis we must notice that an atom which possesses spherical symmetry and no permanent electric moment in a Euclidean space has ellipsoidal symmetry and a small permanent electric moment in Schwarzschild's internal field, as will now be shown. Schwarzschild's internal spatial line element is :

$$dl^2 = dr^2 \Big/ \left(1 - \frac{2Kmr^2}{c^2a^2}\right) + r^2\,(d\theta^2 + \sin^2\theta\, d\varphi^2). \tag{7}$$

According to (7), the length measured in the direction perpendicular to the radius r is the same as in Euclidean geometry, while the length measured along this radius,

$$\int dR = \int \left(1 + \frac{Kmr^2}{c^2a^3}\right) dr, \tag{8}$$

is greater[9]. Therefore, a sphere is changed into an ellipsoid by penetrating into the fluid. This involves, owing to the structure of the atoms, a small polarization.

But we cannot directly use such a precise mechanism, because it is special to Schwarzschild's co-ordinate system. In an isotropic system, the Euclidean length is modified by the curvature of the space in the same manner whatever the orientation[10]. However, in spite of the indeterminacy of the co-ordinate system, since the electric charge is a relativistic invariant, the existence of such a charge in a special co-ordinate system ensures its existence in all others. We have only to admit that the relativistic expansion of the internal space induces a partial separation of the charges of the two signs composing the neutral fluid. Having assumed that the electrical energy which results from such a separation is equal to the supplementary energy (6), we now obtain (1).

According to (5) and (1) the total charge resulting from the separation is $e = \sqrt{K}\int\rho\, dV$. The fact that the non-Euclidean volume of the fluid exceeds the Euclidean volume of the Newtonian physics gives rise to an additional charge which is given by:

$$\varepsilon = \sqrt{K}\int\rho\,(dV - dV_0)$$

$$= \sqrt{K}\rho\,\frac{4\pi}{3}a^3\left(\frac{3}{5}\frac{Km}{c^2a}\right) = \left(\frac{\sqrt{K}\rho\, Km}{5c^2}\right)4\pi a^2. \qquad (9)$$

This can be regarded as a surface charge of density $\eta = \frac{K^{3/2}\rho m}{5c^2}$. For the earth, the computation gives $\eta = 1{\cdot}26 \times 10^{-4}$ e.s.u./cm.². The experimental facts indicate that the surface of the earth possesses a negative charge the average density of which is $-\,2{\cdot}7 \times 10^{-4}$.

J. MARIANI

School of Mathematics,
Institute for Advanced Study,
Princeton, New Jersey.
July 28.

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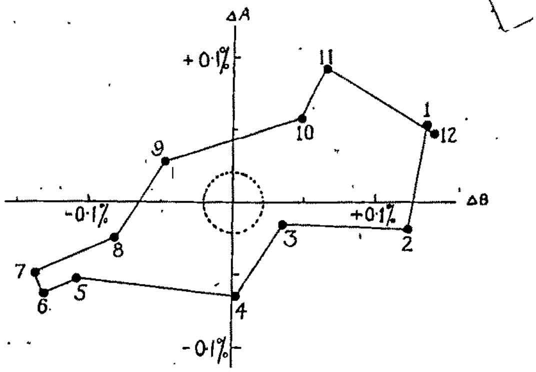
Sidereal Variations of Cosmic Rays

DUPERIER[1] has analysed the first harmonic of the apparent solar diurnal variation of cosmic rays at London, using a method due to Thompson[2]. He inds that the first harmonic for any month has three components, namely, (i) a mean solar vector M, i) a vector, A, altering the amplitude of M, and ii) a vector, P, controlling the change of phase of M. 'he P vector may arise from either (*a*) a sidereal iurnal variation, (*b*) an annual solar variation, or) a combination of these effects. This communication iscusses the interpretation to be placed on the P ector, by comparing Duperier's figures for London ith the results obtained at Canberra.

Analysis of the first harmonic of the apparent solar diurnal variation of cosmic rays

Vector	London (local mean time)		Canberra (local mean time)		Canberra (local apparent time)	
	Amplitude % ± p.e.	Time of maximum	Amplitude % ± p.e.	Time of maximum	Amplitude % ± p.e.	Time of maximum
M	0·41 ± 0·02	16·3h. (L.M.T.)	0·67 ± 0·02	15·0 ± 0·1h.	0·67 ± 0·02	15·0 ± 0·1h.
A	0·36 ± 0·02	June-	0·22 ± 0·02	Mar. 27 ± 12d.	0·20 ± 0·02	Apl. 7 ± 12d.
P(*a*) Sidereal ..	0·21 ± 0·02	21h. (L.S.T.)	0·05 ± 0·02	9·6 ± 0·7h. (L.S.T.)	—	—
(*b*) Solar	0·21 ± 0·02	March-	0·05 ± 0·02	Sep. 25 ± 12d.	0·03 ± 0·02	Nov. 12 ± 12d.

The Canberra results were obtained with an ionizaon vessel and were corrected for bursts, pressure ıd temperature[3]. A harmonic analysis was made of ıe apparent solar diurnal variation averaged for each month of the year over a period of five years. From these analyses a harmonic dial was constructed showing the month-to-month change of the first diurnal harmonics. Smoothed points in this dial progressed clockwise in a closed figure, as found also by Duperier. An ellipse was fitted to the unsmoothed points by harmonic analysis of the deviations from the mean solar vector, and this gave the vectors A and P for comparison with Duperier's data. The accompanying table shows that the P vector, interpreted as a sidereal effect, exhibits a phase difference of about twelve hours between the northern and southern station. It seems preferable, therefore, to regard the P vector as representing, in the main, merely an annual change in the phase of the true solar diurnal variation, making the diurnal maximum occur earliest in the spring at both places.



Annual changes in the deviations from the mean of the cosine (A) and sine (B) components of the first harmonic of the apparent solar diurnal variation of cosmic rays at Canberra, arranged according to local mean time. 1 = Jan.; 2 = Feb., etc. The central circle indicates the probable error of the monthly points (± 0·02 per cent)

If the P vector is regarded as being of solar origin, it is appropriate to reduce the results according to local apparent time rather than local mean time. Local apparent time values for A and P are slightly smaller for the former than for the latter. It seems that any sidereal variation of cosmic rays with a 24-hour period would be extremely small, for the P vector (local apparent time) of 0·03 per cent (equivalent to a maximum change of phase of about 10 min.) would have to take account of not only the sidereal process, but also of any change in the lag between the cosmic rays and the sun's position. It seems likely that no 24-hour sidereal variation has been detected in these measurements, and that, in terms of the theory advanced by Compton and Getting[4], an interstellar rather than an intergalactic origin should be assigned to cosmic rays.

A. R. HOGG

Commonwealth Observatory,
Canberra, A.C.T. April 24.

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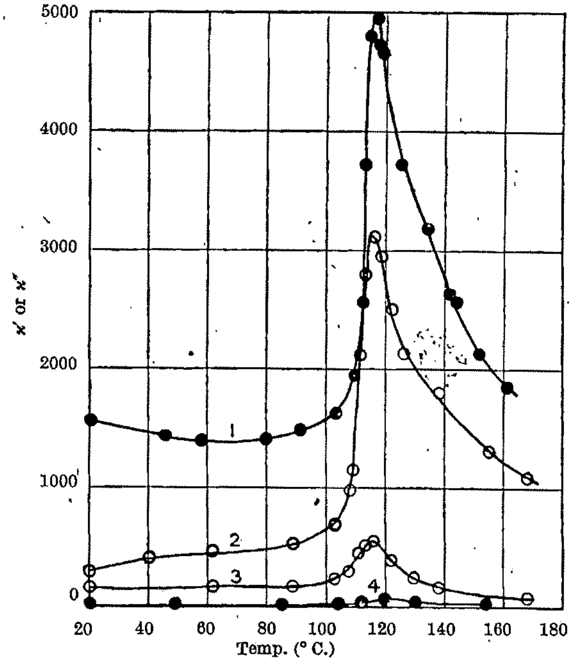
Dielectric Properties of Titanates at Ultra-high Frequencies

The complex permittivity ($\kappa' - j\kappa''$) of a series of titanates, magnesium, calcium, strontium and barium, has been measured at 21° C. and frequencies of 1·5 and 9,450 Mc./s., and of the barium titanate at 24,000 Mc./s. also. In addition, the behaviour of barium titanate at 1·5 and 9,450 Mc./s. has been studied over the temperature-range + 20° to + 170° C. The results of these measurements are recorded in the accompanying table and diagram. The electric field-strength applied to the test specimens was estimated as less than 1 volt/cm.



Dielectric properties of barium titanate at 1·5 Mc./sec. and 9,450 Mc./sec. Curves 1, κ' at 1·5 Mc./sec.; 2, κ' at 9,450 Mc./sec.; 3, κ'' at 9,450 Mc./sec.; 4, κ'' at 1·5 Mc./sec.

The loss tangent ($\tan \delta = \kappa''/\kappa'$) of the magnesium, calcium and strontium titanates at 9,450 Mc./s. was sufficiently small to permit the use of a technique, described in an earlier communication[1], which consists in measuring the variation with frequency of the energy transmitted through a slab located in, and filling, the cross-section of a wave-guide. The attenuation in barium titanate, however, proved to be so high that this method could not be used, and the complex permittivity was determined by measurement of the reflexion from and transmission through a slab, at fixed frequency. For the reflexion measurements it was sufficient to consider only the front face of the specimen, since internal reflexions were highly attenuated. In order to reduce the power standing-wave ratio in front of the face to measurable values, quarter-wave 'matching' slabs of lower permittivity materials were used. For example, with 'Tempa S', $\kappa' = 11\cdot3$, the power standing-wave ratio was reduced by 320 : 1 and with polystyrene, $\kappa' = 2\cdot56$, by 17 : 1. The attenuation in the material was obtained by measurement of the transmission through specimens with matching slabs at each side. From a combination of the results of the two measurements, values of κ' and κ'' can be calculated.

At 21° C.

Material	κ'			$\tan \delta = \kappa''/\kappa'$		
	1·5 Mc./s.	9,450 Mc./s.	24,000 Mc./s.	1·5 Mc./s.,	9,450 Mc./s.	24,000 Mc./s.
$MgTiO_3$	13·0	11·3	—	0·0012	<0·05	—
$CaTiO_3$	140	132	—	0·0007	<0·015	—
$SrTiO_3$	264	232	—	0·0009	<0·03	—
$BaTiO_3$	1,500	300	126	0·015	0·53	0·59

It will be seen from the table that the room-temperature permittivity values at 9,450 Mc./s. of the magnesium, calcium and strontium titanates are not appreciably different from the 1·5 Mc./s. figures, but that for barium titanate a substantial decrease has occurred at the higher frequency, and a still further decrease at 24,000 Mc./s. In keeping with these observations, while the loss tangent of the magnesium, calcium and strontium titanates does not exhibit a particularly marked increase with frequency, that of barium titanate has risen to a very high value at the two ultra-high frequencies. It has not yet been possible to extend the range of frequency measurement, but there can be no doubt of the existence of dispersion in barium titanate in this region of frequency, a fact which will be of considerable significance in the interpretation of its genera behaviour.

The variable temperature measurements at 9,450 Mc./s. on barium titanate show that although the permittivity is lower throughout than at 1·5 Mc./s., the rapid rise to a peak value occurs at substantially the same temperature in the two cases.

A full report of the work will appear elsewhere; but I wish to acknowledge here the help afforded by the United Insulator Co. and the Mullard Radio Valv Co. in supplying the ceramic specimens, and to thank the Department of Scientific and Industrial Research for financial support of the work.

J. G. POWLES

Electrical Engineering Department,
Imperial College, London, S.W.7.
June 2.

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New Photoconductive Cells

So far there are few substances known to posses photoconducting properties with a quantum yiel appreciably greater than unity. The chief ones ar selenium, oxidized thallous sulphide, and the sulphid selenide and telluride of lead.

Two questions arise : (1) Are the above-mentione substances the only possible ones, and, if so, wh is the reason for that ? (2) What is the role of th oxygen in sensitizing at least thallium and lea sulphides, lead selenide and lead telluride ?

Experiments with various types of semi-conducto suggested to me that the particular action of tl oxygen can be best accounted for if it is assume that the oxygen is adsorbed on the semi-conduct particles during evaporation and after the depos has been formed, and not, or only partly, as secondary process, taken up by the lattice. It known that adsorption of gases on finely divid metals is much increased if an electric discharge passed through the vessel containing the adsorben

If the above-mentioned view is correct, metho which produce a layer of material by a process which an electric discharge is active should yield photoconductive sensitive deposits. Several methods were tried and it was possible to produce highly sensitive cells not only with materials already known to possess photoconductivity, but also with a great number of new substances.

The following methods were used: (1) cathode sputtering with the substance as the cathode; (2) electric discharge between aluminium electrodes and evaporation of the substance from a heater spiral; (3) low-voltage arc with the substance as the anode; (4) a molecular beam of the substance crossing a beam of gas ions before condensing on the carrier. The gas used was oxygen or air and the pressure varied between wide limits depending on the substance ($0\cdot5$–10^{-4} mm. mercury).

Using one or the other of the above methods[2], it was possible to produce photoconductive cells of a series of substances which can be divided into two groups. The first group is characterized by the following properties: if the carrier is kept at room temperature or lower during the production, the film has a high resistance, a high negative temperature coefficient of resistance β and has its optimum sensitivity in the near infra-red. Heating the film in air or oxygen afterwards reduces the sensitivity, the resistance and β, and in some instances, for example, platinum, a film with normal metallic properties results. Some substances belonging to this group are platinum, nickel, antimony and germanium.

Substances of the second group have properties similar to those of the first group before heating. Heat treatment of the film in air or oxygen at a low temperature and for very short time reduces the resistance, β, and the sensitivity appreciably; but a prolonged heat treatment at a higher temperature increases the three properties again and, if the conditions are properly chosen, a cell of very high sensitivity may result. The substances investigated up to now and belonging to this group are: the sulphides, selenides and tellurides of lead, tin, indium, thallium, cadmium, bismuth and antimony, and some intermetallic compounds, for example, CdSb. Most of the tellurides show high sensitivity only at − 78° C. or at liquid-air temperature. Some of the sulphides are very sensitive even at room temperature.

Although the general behaviour of all the deposits produced up to now is similar, there are very wide variations in the absolute values of the resistance, β, the sensitivity, and the spectral distribution of sensitivity for even the same substance, depending on the conditions of production and on the following heat treatment. The properties of a layer of indium telluride are given as an example to indicate this general behaviour. Evaporation of the substance was carried out according to method 3 in air ($p = 0\cdot05$ mm. mercury) and the deposit formed on a glass strip, fixed at 40 mm. distance from the source and cooled by running tap water. The deposit thus formed after several seconds was just transparent and brown in transmission. The resistance of a sensitive area of 4 mm. length and 1 mm. width was of the order of 250 megohms at room temperature. The sensitivity for visible light and the near infra-red was very low and β was negative. Heating the layer in air to approximately 100° C. for 2 min. reduced the resistance to 0·3 megohms. Further heating in air at 160° C. for 15 min. produced a resistance of 2·4 megohms at room temperature and the sensitivity increased manifold. At liquid-air temperature the resistance was 120 megohms, and the cell was superior in performance to a Schwarz–Hilger vacuum thermopile as far as 2·2 μ.

It is common to all the cells, with the exception of thallium sulphide and of selenide, that they are stable in air. It is easily possible to produce cells of any size and shape and, as a great number of cells can be produced at the same time, the uniformity and reproducibility are very good. The colour in transmission of most sensitive cells is brown to red-brown, indicating that this property is not so much dependent on the special substance as on a specific arrangement and size of the deposited particles, which must be similar in all cases.

The primary condition which must be fulfilled to produce a sensitive layer is that β should be negative; this depends on the gas pressure, the length of the path the evaporated particle travels before it reaches the carrier and the electrical conditions of the discharge.

If dissociation of the substance is too high, the metallic part of the compound is evaporated first by one of the above methods and this metal deposit afterwards transformed into the compound by heating it in an evacuated tube and passing a stream of the other constituent over it. With this method it was possible to produce, for example, photoconductive sensitive cells of silver sulphide, selenide and telluride.

The theoretical implication of these discoveries and a full description of the experimental results will be given elsewhere.

E. Schwarz

Hilger and Watts, Ltd.,
98 St. Pancras Way,
Camden Road,
London, N.W.1.

Aug. 9.

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[1] Pietsch, *Ergeb. exakt. Naturw.*, 5, 212 (1926).

[2] British and U.S. patents applied for.

Hydrogen Peroxide and the Indirect Effect of Ionizing Radiations

In a recent paper, Allsopp[1] has suggested that the old 'poison' hypothesis for the action of ionizing radiation on living cells might be revived in terms of the 'hydroxyl radical' as the specific poison. Results of experiments on bacteriophage *S*13, undertaken at the instigation and with the support of the late Dr. D. E. Lea, suggest that for certain *in vitro* experiments, at least, on the indirect effects of ionizing radiation, a poison hypothesis in quite direct terms will explain the results satisfactorily, the specific poison being hydrogen peroxide. As has been pointed out[2], the fact that hydrogen peroxide is formed in irradiated water itself requires explanation in terms of a theory such as that of Weiss[3]; but it has become evident that all the observed facts on 'indirect' action of radiation on this particular phage are fitted by the explanation that when the phage is in dilute solution the hydrogen peroxide formed by ionizing radiations will inactivate it. The following results support this explanation.

(1) Tests with titanium sulphate show that the quantity of hydrogen peroxide produced when the phage is in dilute solution is of the expected order of magnitude[4].

(2) Survival curves for the phage irradiated in dilute solution were sigmoid; that is to say, the rate of inactivation increased with increasing dose

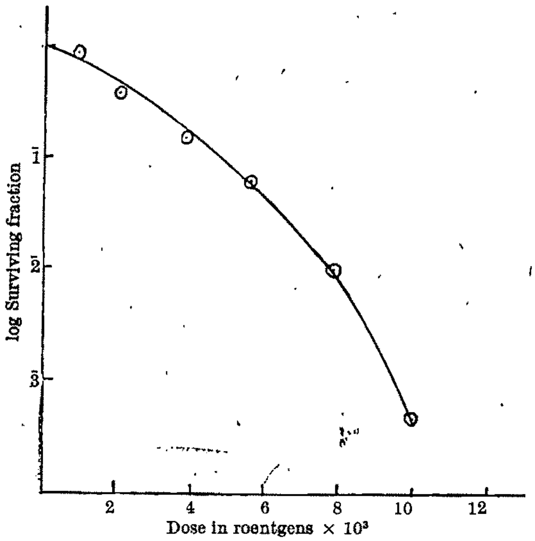

Fig. 1. Inactivation of phage *S*13 suspended in clean phosphate buffer. Composite curve, three experiments

(Fig. 1). When the buffer in which the phage was suspended had received a previous irradiation of some hundred thousand roentgens, however, the survival curve was exponential (Fig. 2), indicating that such a curve is obtained after the quantity of hydrogen peroxide in the solution has reached an equilibrium, or at any rate a minimum value.

(3) Disinfection experiments using a quantity of hydrogen peroxide of the same order as that formed in the suspension in the irradiation experiments yielded the usual form of exponential disinfection curve.

(4) A temperature effect was discovered in the irradiation experiments, the rate of inactivation being lower at lower temperatures. This is not easily explained on the 'active radical' hypothesis, but fits in with the well-known temperature effect in any disinfection process.

(5) The increase in activation dose with increasing concentration was found to be analogous with that found in other virus experiments[5,6]. The addition of protein to a dilute solution was found to protect the phage in irradiation experiments. In hydrogen peroxide disinfection experiments, similar results are obtained; for example, the addition of 5 per cent peptone to a dilute phage solution in the irradiation experiments fully protected the phage, so that the inactivation dose equalled that required for a dry phage suspension. The same percentage of peptone protected the phage fully against the hydrogen peroxide in concentrations which inactivated the phage rapidly when suspended in buffer free from organic material. Here again is the usual action of organic material in protecting organisms against disinfection by an oxidizing agent.

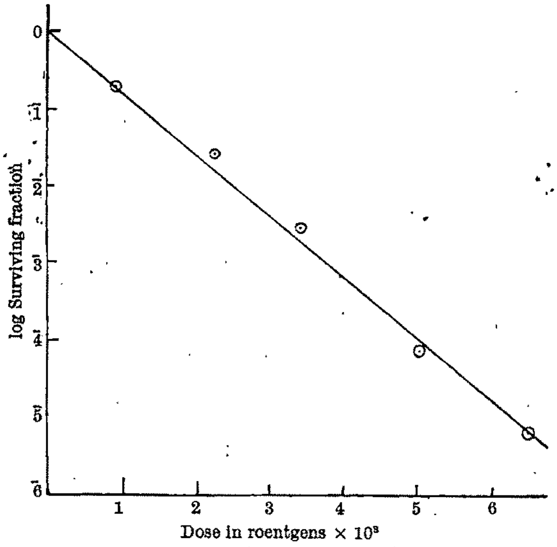

Fig. 2. Inactivation of phage *S*13 suspended in pre-irradiated buffer. Composite curve, three experiments

In experiments on 'indirect effect' of ionizing radiations, the ratio of ionic yield for direct action only to ionic yield in dilute solution is of importance for gaining an insight into the 'active radical' mechanism. It is clear that where the experimental material is in any way sensitive to hydrogen peroxide, this ratio may, in fact, be yielding information only on the production of hydrogen peroxide.

This work was begun at the Strangeways Research Laboratory, Cambridge, and continued in the Medical Research Council Radiotherapeutic Research Unit, Hammersmith Hospital, London, and at the Onderstepoort Laboratories, Transvaal. I have to acknowledge with gratitude the kind hospitality of all three institutions and the interest and assistance of Dr. F. G. Spear of the Strangeways Research Laboratory. The work was started as part of the experimental programme of the late Dr. D. E. Lea, and was continued with the support and constant advice of Dr. L. H. Gray.

The results will be more fully published elsewhere.

TIKVAH ALPER
South African Council for Scientific and
Industrial Research,
National Physical Laboratory,
Pretoria.

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Air-Cored Synchrotron

THE air-cored synchrotron[1,2] appears to have a number of very attractive features, especially if only infrequent pulse operation is required, say, for cloud-chamber experiments, for in such a case the condensers provided to store the magnetic field energy can store perhaps twice as much as when used on alternating current. If, in addition, it proves possible to hold the electrons to a very narrow region so that the guide field is used efficiently, then energies in the 500-MeV. region seem attainable with condenser banks already available in physical laboratories. The upper limit of energy is then set by the deformation of the conductors under the mechanical forces, so that the total impulse becomes the relevant quantity. Thus it is important to use rapidly rising magnetic fields, and a condenser-coil system either nearly critically damped or incorporating a rectifier, so that a slowly damped train of oscillations do not add unnecessarily to the impulse handed on to the coil system. We are pursuing experiments which indicate that impulsive forces greatly in excess of the static ultimate strengths of the coil materials can be withstood.

Particle accelerators of the synchrotron (and cyclotron) type are characterized by the fact that of the three fundamental quantities *H* (magnetic field), *r* (orbit radius) and *f* (frequency of accelerating electric field), two in general must vary during the acceleration. The exceptions are for the extreme cases of non-relativistic particles (cyclotron acceleration, *r* only varies) and extreme relativistic particles (synchrotron acceleration, *H* only varies).

The acceleration of electrons from relatively low energies to extreme relativistic energies by conventional synchrotron techniques may be accomplished in two ways: either the frequency of the electric field may be kept constant and the equilibrium radius allowed to vary, or the radius may be kept constant and frequency modulation employed. The first of these is excluded when we wish to keep the guide-field energy low, and the second does not seem to have been adopted, doubtless due to the technical difficulties of frequency modulating. These difficulties are made worse for air-cored machines, where for the reasons given the modulation would have to take place rapidly.

Betatron acceleration for bringing the electrons up to relativistic energies as in conventional iron-cored synchrotrons is also possible, but unattractive, since it is extravagant in condensers and furthermore the central betatron flux must be steered away from the guide-field region, a difficult problem in coil design.

The object of this communication is to propose a method of bringing the electrons up to the relativistic region, which while generally applicable may be specially attractive for an air-cored machine, since the radial drift of the electrons is limited, the exciting oscillator frequency is constant, and the effect is obtained by blanking off the oscillator at appropriate moments.

The principle of this method is to make the frequency of the accelerating radio-frequency field an integral multiple, ν, of the frequency of revolution of the electrons at injection, which takes place at the inside of the doughnut. If the injection voltage is sufficiently high, a synchronous beam will be obtained, individual electrons oscillating about an equilibrium orbit which expands as the magnetic guide-field is increased. This expansion is allowed to proceed until the electron energy is such that if it were at the inside of the doughnut its frequency of rotation would be $1/(\nu - 1)$ times that of the applied electric field, which is then suppressed until the equilibrium orbit shrinks to the inside. The radio-frequency field is reapplied, and this sequence is repeated until the electron energy reaches the extreme relativistic region, when the machine becomes identical with the conventional synchrotron, except that the applied radio-frequency will still be some multiple (less than ν) of the frequency of electron rotation. The greater the number of expansions and contractions (that is, the larger ν), the smaller the range of variation of the orbital radius during acceleration and thus the greater the machine efficiency from the point of view of energy storage.

To obtain adequate injection efficiency, the radio-frequency voltage must be sufficient to give a fairly large initial amplitude (Δr) of the radial oscillation corresponding to the phase oscillations of the electrons, so that one fills an annulus of width $2\ \Delta r$. Subject to this condition, one finds in practice that the range of phase stability extends over a large fraction of the radio-frequency cycle.

The theory of Bohm and Foldy[3] enables us to determine the fraction of electrons accepted at each expansion, assuming the radio-frequency amplitude builds up instantaneously, and for the machine detailed below this would average about 70 per cent, that is, an overall loss of 50 per cent for the two expansions. By suppressing the radio-frequency oscillator of a normal synchrotron for various time intervals and observing the effect on gamma-ray output, we find that the efficiency of electron capture can approach 100 per cent. This favourable correction can be explained by taking into account the build-up of the oscillations in the synchrotron resonator after a period of suppression.

We are indebted to Mr. D. W. Fry (Atomic Energy Research Establishment, Malvern) for the use of the 15-MeV. synchrotron for these experiments, which will be reported elsewhere.

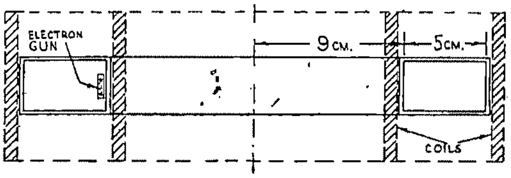

Fig. 1. Doughnut cross-section, with a possible coil arrangement shown dashed and shaded

The calculations for a small machine of this kind on the scale of Fig. 1 are given in the accompanying table with $f = 1{,}200$ mc./s., $\nu = 5$, and *H* varying as $1/r^{0\cdot5}$.

	Equilibrium radius	Energy	*H* (at Δ =10 cm.)	Δ *r*
Beginning of 1st expansion	9·95 cm.	0·080 MeV.	99 gauss	0·50 cm.
End of 1st expansion	12·43	0·148	123	
Beginning of 2nd expansion	9·95	0·148	138	0·40 cm.
End of 2nd expansion	13·28	0·430	228	
Beginning of 3rd expansion	9·95	0·430	263	0·25 cm.
End of 3rd expansion	11·92	—	—	

The sequence of events is also illustrated by Fig. 2, assuming that $dH/dt = 2\cdot5$ gauss/microsecond.

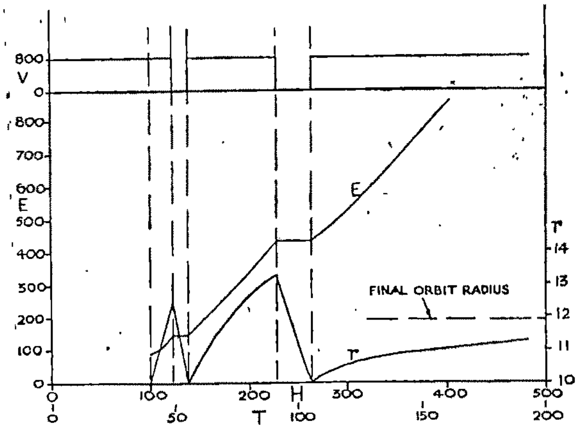

Fig. 2. Variation of resonator voltage *V*, equilibrium orbit radius *r* cm., and particle energy *E* keV., with magnetic field *H* gauss at 10 cm. radius and time *T* microseconds. Injection occurs at $H = 100$, $E = 80$ keV.

For a peak resonator voltage of about 800 volts, the range of stability in phase is about 340°, with an associated radial oscillation of amplitude given by Δr in the table.

Taking an intermediate estimate for the ratio of magnetic energy in working volume to total condenser energy as 1/3, we find that 10,000 joules stored energy will produce 85 MeV. electrons with a peak force on the coil of the order of 500 lb./in.[3] directed away from the accelerating region.

T. R. KAISER
J. L. TUCK

Clarendon Laboratory,
Oxford.
July 15.

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Renal Regulation of the Extracellular Fluid

THE behaviour of the kidney in relation to the electrolytes of the extracellular fluid is usually described in terms of two mechanisms operating to maintain the homœostatic state: (*a*) Regulation of the concentration of several individual electrolytes and non-electrolytes within a limited range of variability. The concept of 'renal threshold' is implied in this proposition. (*b*) Regulation of the osmotic pressure of the extracellular fluid, so as to maintain isotonicity with intracellular fluid.

A patient with a duodenal fistula was studied in some detail. He lost up to the equivalent of one quarter of the extracellular fluid of the body each day. The fluid from the fistula contained an average of 121 milli-equiv. per litre of sodium and 55 milli-equiv. per litre of chlorine. Thus there was an excess of 66 milli-equiv. per litre of sodium relative to chloride. In these circumstances, the level of sodium in the extracellular fluid would tend to fall by a greater amount per unit time than the chlorine, and the loss of this alkaline secretion would impose a severe strain on the *p*H control of the extracellular fluid.

The following observations were made: (*a*) Large amounts of chloride were present in the urine over a period of six weeks, during which time the level of chloride in the plasma was constantly below the accepted 'renal threshold'. (*b*) There appeared to be a commensurate variation between the quantity of chloride ion in the urine, and the volume of fistula secretion per day. (*c*) On the thirty-sixth day after the development of the fistula, the blood sodium and alkali reserve were restored to within normal limits by the intravenous administration of two-thirds of a gram molecule of sodium lactate, over a twelve-hour period. This caused a cessation of the large chloride excretion by the kidney. When the blood sodium fell again the chloride excretion recommenced. Over the time interval during which these variations occurred, the plasma chloride remained relatively constant at a level below the 'renal threshold'.

The most interesting feature of the findings was the relative constancy of the ratio of chlorine to sodium in the extracellular fluid, despite the continued loss through the fistula and from the body of 2–4 litres per diem of fluid containing approximately twice as much sodium as chloride. On the thirty-seventh day after the development of the fistula plasma, values were Cl = 82·7 and Na = 148·7 milli-equiv. per litre with the ratio $Cl_p/Na_p \doteq 0{\cdot}56$. Over the following six days 11·5 litres of fluid containing 766 milli-equiv. of sodium in excess of chloride were lost from the fistula. This is equivalent to 766/14 = 55 milli-equiv. of Na per litre of extracellular fluid, assuming this latter to have a volume of approximately 14 litres[1]. However, the ratio was $Cl_p/Na_p = 80/138{\cdot}3 = 0{\cdot}58$ at the end of the period. The probable explanation was the excretion by the kidney of fluid containing a sufficient excess of chlorine over sodium to maintain homœostasis. The cation used in this latter mechanism was predominantly potassium from intracellular fluid.

It would therefore seem possible that to account for the factors affecting the renal regulation of the quantity per unit volume of extracellular ions, it is necessary to consider plasma *p*H as a major variable.

It has become apparent that the maintenance of the equilibrium state within the tissue fluids in circumstances of disease is a basic problem of medical practice. Marriott, in the Croonian Lectures[2], has suggested that the quantity of chloride in the urine, as determined clinically by the simple Fantus test[3], can be used as a diagnostic criterion of the presence or absence of chloride depletion in the extracellular fluid. A correlation of the above observations with clinical phenomena to be described elsewhere would indicate the necessity of an experimental investigation to determine in what clinical circumstances the test is valid. It is suggested that the logical first step in clinical practice of ionic replacement therapy is qualitative analysis and quantitative record of the material which the body is losing.

DEREK A. DENTON

Royal Melbourne Hospital,
Parkville, N.2.
May 12.

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Isophosphorylase and the Formation of Branched Polysaccharides

THE combined action of isophosphorylase and phosphorylase on glucose-1-phosphate results in the formation of branched polysaccharides like amylopectin and glycogen. Isophosphorylase is the enzyme which catalyses the formation of α-1,6-glucosidic links from glucose-1-phosphate as well as their phosphorolysis[1].

Whereas phosphorylase obtained from potato, yeast or muscle is strongly inhibited by phlorhizin, we have established that isophosphorylase from potato or yeast does not suffer any diminution in activity in the presence of phlorhizin (see table).

By adding phlorhizin to a mixture of phosphorylase and isophosphorylase, the activity of the former enzyme is diminished but not that of the latter.

Effect of phlorhizin on the action of potato isophosphorylase (phosphate buffer *p*H 6·6)

Concentration of phlorhizin	Degradation of residual dextrin by β-amylase	
	Isophosphorylase present	Isophosphorylase absent
0 $6{\cdot}0 \times 10^{-3}$ mol.	25 per cent 25 ,,	0 per cent 0 ,,

Thus the addition of phlorhizin brings about a change in the relative effective amounts of the two enzymes.

By allowing a mixture of potato phosphorylase and potato isophosphorylase to act on glucose-1-phosphate in the presence of increasing amounts of phlorhizin, we have obtained a series of polysaccharides which give with iodine a range of coloration from blue-violet, violet, purple to brown, that is to say, which have increasing degrees of branching, ranging from that of amylopectin to that of glycogen.

The degree of branching of the polysaccharide obtained by the combined action of phosphorylase and isophosphorylase depends, therefore, on the proportion of the two enzymes. The larger the relative amount of isophosphorylase the more branched is the polysaccharide formed.

We wish to thank Prof. K. H. Meyer for his interest in this investigation.

P. BERNFELD
A. MEUTÉMÉDIAN

Laboratoires de Chimie
Inorganique et Organique
de l'Université, Geneva.
May 20.

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Microbiological Oxidation of Sterols

IN a previous communication[1], we described a method by which we oxidized cholesterol with *Azotobacter*. Our present experiments had a double purpose: (1) to limit the direction of the oxidation as narrowly as possible; (2) to work out a simple reproduction method, for our *Azotobacter* react with extreme sensitivity to antagonistic bacteria, so that their culture can be made only under the strictest sterile conditions.

For this double purpose we used bacteria which grow selectively on a certain medium, and investigated bacteria which decompose pyridine. We found that for oxidation of cholesterol *Proactinomyces roseus* was the most suitable[2]. This bacterium simultaneously decomposes the pyridine most effectively, and in the presence of a source of carbon multiplies fairly intensively. The presence of pyridine prevents the growth of other bacteria in the culture, so we could always carry out these experiments without any special sterilization. If we used cholesterol as source of carbon in the pyridine medium and aerated it for a suitable time, oxidation occurred and 7-oxycholesterol and cholestenone formed as oxidation products.

The formation of 7-oxycholesterol means that in the sterol series the $-CH_2-$ group can be oxidized to alcohol bacteriologically. As under suitably selected experimental conditions principally 7-oxycholesterol is formed, the results have a practical significance for the manufacture of the 'D_3' provitamin, as we succeed in obtaining it from cholesterol in very good yield in one step.

The experiments were made under the following conditions. We dispersed 0·5 gm. cholesterol in a litre of 0·2 per cent pyridine synthetic culture, and inoculated the mixture with *Proactinomyces roseus*. The culture was kept 14 days in a thermostat at 34° C. with constant aeration, and the pyridine used up was replaced from time to time. At the end of the cultivation period we extracted the medium with petrol-ether. The products were separated by chromatographic absorption on aluminium oxide. Besides the remaining minimal cholesterol we isolated as chief product 7-oxycholesterol and 4,5-cholestenone. Other oxidation products also formed in minimal quantities, identification of which is now in progress. We are continuing these experiments with *Proactinomyces roseus* in the sexual hormone series.

A. KRÁMLI
J. HORVÁTH

Hungarian Biological Research Institute,
Tihany.
May 12.

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The Sommelet Reaction

IN a recent communication, Angyal and Rassack[1] show that the Sommelet reaction[2] is an oxidation-reduction process with the aldimine Ph.CH=NH as a probable intermediate,

$$\mathrm{PhCH_2NH_2 + PhCH_2N:CH_2 \xrightarrow{H_2O} PhCHO + NH_3 + PhCH_2NHCH_3},$$

and does not involve, as originally suggested by Sommelet[2], and stated by Graymore and Davies[3], prototropic conversion of methylenebenzylamine (I) to benzylidenemethylamine (II).

$$\text{(I)}\quad \mathrm{Ph.CH_2{-}N'{=}CH_2} \rightleftharpoons \left[\mathrm{Ph.CH \overset{\frown}{-N-} CH_2}\right]^- \rightleftharpoons \mathrm{Ph.CH = N - CH_3}\quad \text{(II)}$$

It is desirable to point out that this mechanism, now disproved, was inherently improbable. Ingold and Shoppee[4] showed that the methyleneazomethine system is one of the least mobile of triad prototropic systems; mobility in the phenylmethylene-azomethine system (I—II) is only achieved in the catalytic presence of hydroxide ions at 300° or of a considerable concentration of ethoxide ions at 190°, 2·92 *N*-sodium ethoxide in ethanol at ~ 85° being ineffective. These results were considered by Graymore and Davies, who, however, dismissed them with the remark that they are not comparable with those obtained by them in the presence of hexamine in dilute aqueous solution (boiling approx. 0·3 *N*-hydrochloric acid), and who state that under these conditions isomerization of methylenebenzylamine (I) to benzylidenemethylamine (II) ensues. While suitable prototropic systems are capable of catalysis by acids, methylenebenzylamine (I), like other Schiff's bases, is readily hydrolysed by hot dilute mineral acid[4]; even if, owing to the presence of an excess of formaldehyde, some proportion of methylenebenzylamine is always present under the experimental conditions used by Graymore and Davies, facile catalysis of a prototropic system so refractory as (I — II) under these conditions seems in the highest degree unlikely.

Graymore and Davies also suggest that the conversion of only some 10 per cent of methylenebenzylamine (I) to benzylidenemethylamine (II) in the presence of catalytic anions, reported by Ingold and Shoppee, is due to the removal of methylenebenzylamine (I) from the reaction by polymerization. It seems more probable that the proportion of isomerides, (I) 90 per cent : (II) 10 per cent, observed experimentally, is an example of the kinetic control of ion-recombination as opposed to the thermodynamic control of equilibrium, which is frequently encountered in prototropy and generally leads to the production of more than the equilibrium proportion of the thermodynamically less stable isomeride[5]. Owing to conjugation of the phenyl group with the double bond in (II) but not in (I), (II) is thermodynamically the more stable isomeride since the conjugation energy will contribute to its free energy. Neglecting other factors of a constitutional or environmental character, and taking the conjugation energy of the system Ph—CH=N· (for which no value appears to be available) as closely similar to that of the system Ph—CH=CH· (7 kilocal.)[6], it can be calculated using the relation $-\Delta F = RT \log K$ that the equilibrium proportion of (I) is about 0·005 per cent at 358° K., 0·008 per cent at 373° K., 0·03 per cent at 463° K. and 0·2 per cent at 573° K.; and, in fact, both at 190° and 300° C. the proportion of methylenebenzylamine (I) was too small for experimental detection[4].

C. W. SHOPPEE
Chester Beatty Research Institute,
The Royal Cancer Hospital,
London, S.W.3,
and University College, Swansea.

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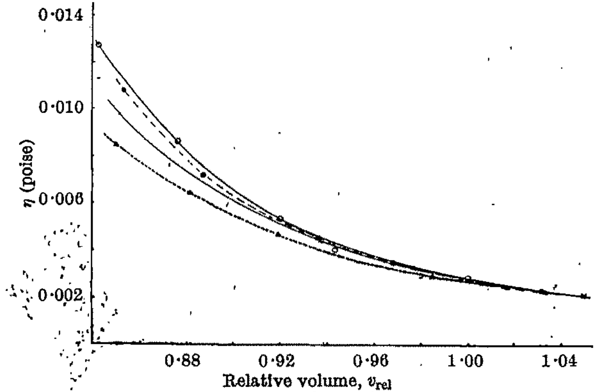
Viscosity-Volume Relation for Ether

It has recently been shown[1] that the theoretical expression for the viscosity of a liquid derived from Born and Green's[2] general kinetic theory of liquids consists of two parts, one due to the thermal motion of the molecules and the other to molecular attraction (that is, a volume effect). The latter effect greatly predominates.



O——O, 0° C.; ●····●, 20° C.; ×——×, 30° C.; ▲····▲, 75° C.

Experimental justification for this conclusion is provided by the accompanying isothermal viscosity-volume curves, calculated for ether, from the combined data of Bridgman[3] and Faust[4] on viscosities at high pressures. The temperature effect becomes progressively less as the volume increases until, in the region $v_{rel} = 1 \cdot 0$, it disappears completely. To the right of this point, the viscosity is a function of volume alone and is independent of temperature, and it is in this region that the empirical equation proposed by Batschinski[5],

$$\eta = \frac{c}{v - \omega},$$

where c and ω are constants and v is the specific volume, is so successful in representing observed behaviour.

Certainly in the case of ether above 0° C. therefore, and probably for many other liquids, the decrease in viscosity on heating at atmospheric pressure is a secondary effect, due entirely to expansion of the volume which in turn lowers the viscosity.

This is precisely the early view of the mechanism of the temperature variation of viscosity, first propounded by Warburg and von Babo[6] in 1882, and since then by many other authors, notably Batschinski (*loc. cit.*), which is now seen to be quite correct over the limited experimental range for which evidence was then available.

A. JOBLING
Dept. of Inorganic and Physical Chemistry,
Imperial College of Science and Technology,
London, S.W.7.
May 20.

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British Species of *Polycelis* (Platyhelminthes)

In 1884 Ijima[1] described *Polycelis tenuis* Ijima, a species which closely resembled the well-known *P. nigra* Ehrbg. More recently, interest in the legitimacy of this species has been shown by Continental workers, particularly Komarek[2] and Sekera[3]. These two authors agreed that both *P. nigra* and *P. tenuis* are good species; but they differed on the external features whereby the species might be distinguished. Lender[4] concluded that they could only be distinguished on the basis of internal anatomy and discounts such differences as shape of head, number of eyes and colour; he also regarded them as ecologically similar. Latterly, Tu[5] has questioned their separation as true species, but, like Lender, he found them in the same habitat on the Continent.

There is no mention in British literature of *P. tenuis*, all records referring to *P. nigra* or the distinctive *P. cornuta*. While studying the ecology of *Urceolaria* spp. (Peritricha) living on flat-worms[6], an apparent colour variety was noted which either carried few *Urceolaria mitra* v. Sieb. or none. This variety was distinguished by the much more uniform distribution of pigment compared with other worms in which the darker pigment occurred in blotches; that is, there was a pattern difference. Both types showed the usual colour range from yellow through brown to black. Fig. 1 records the population of *U. mitra* found on these two colour patterns—the uniform variety averaged 0·7 *Urceolaria* per worm, while the mottled variety averaged 22.

Examination of the reproductive organs of these two types showed that those with the uniform colour pattern agreed with *P. nigra*, whereas those with the mottling agreed with *P. tenuis*. These anatomical differences are quite marked[2,3,4] and relate to the shape of the penis, the type of spines carried on it and the presence or absence of musculo-gland organs. Fig. 2*a* shows the elongated penis of *P. tenuis* with about twenty rows of spines, mostly of a simple type

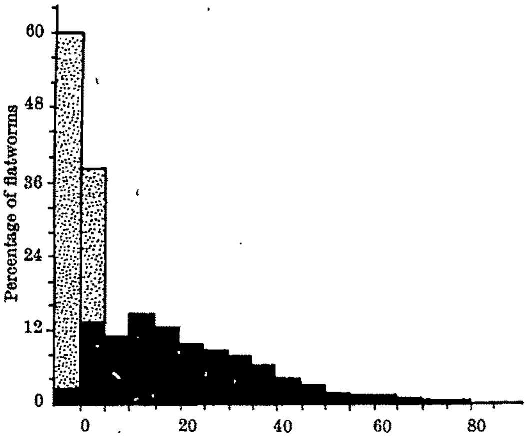

Fig. 1. Comparison of the Urceolarian population of the uniform (stippled) and mottled (black) varieties of flatworm

(Fig. 2*b*), Fig. 2*c* the shorter penis of *P. nigra* with four to eight rows of compound spines (Fig. 2*d*). The former has two musculo-gland organs. The worms referred to were taken from the College pond where the population of *P. nigra* is small compared with *P. tenuis*, in ratio about 1 to 28. The presence of *P. tenuis* has also been confirmed in a sample of flatworms from Lake Windermere kindly sent by Dr. T. T. Macan. Of 17 worms examined, 13 were *P. tenuis* and 4 *P. nigra*.

The discrimination shown by *Urceolaria mitra* suggests that the physiology and perhaps the ecology of the two flatworms differs. This is borne out by their distribution in the pond and behaviour in the laboratory. *P. nigra* occurs most abundantly near the inlet to the pond where the water moves slowly; *P. tenuis* prefers regions where the water is still. This is supported by examination of other habitats; for example, *P. nigra* occurs alone in a stream at Aber below the zone of *P. cornuta*. There may also be differences in the type of pond the two species favour, but overlap occurs. In the laboratory under conditions resembling a pond habitat rather than a stream, *P. tenuis* thrives much more than *P. nigra* and produces cocoons more freely.

P. nigra has been a favourite type for physiological work, and also figures in many ecological surveys. It is conjectural to what extent it has been confused with *P. tenuis* in the past, in Great Britain, and how this may have affected conclusions. If, as I suggest, the two species can be distinguished on colour pattern, then they can be easily separated under the binocular microscope. This only becomes difficult when the worms have fed heavily and are distended.

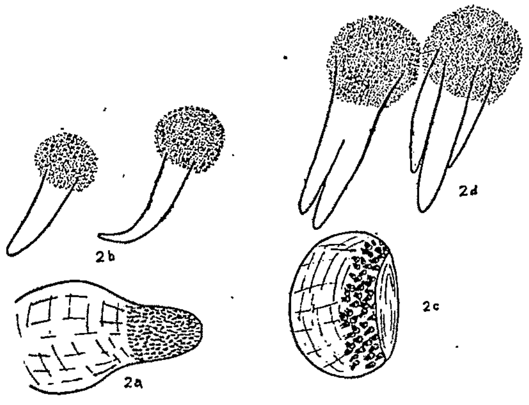

Fig. 2. Comparison of the penis and typical penial spines of *Polycelis tenuis* (*a*, *b*) and *P. nigra* (*c*, *d*)

T. B. REYNOLDSON

Zoology Department,
University College of North Wales,
Bangor.
June 4.

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Determination of Plant Densities

E. J. MACHIN[1] appears to be unaware of the extensive study by G. E. Blackman[2] on the relation between plant density and percentage absence. In a theoretical appendix to this paper, I have pointed out that the most efficient size of quadrat corresponds to about 20 per cent absence, or a product of quadrat size and plant density of about 1·6 (the efficiency remains reasonable over a range of, say, 0·7–3·0, compared with the rather wider range 0·3–3·3 implied by Machin).

It should also be noted that, while the method is only applicable as an exact method when the distribution of plants is random, it may be used in the more general class of cases for which the relationship between the logarithm of percentage absence and plant density is still linear to provide a comparative index of abundance.

M. S. BARTLETT

Department of Mathematics,
University of Manchester.
Aug. 24.

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[1] *Nature*, **162**, 257 (1948).
[2] *Ann. Bot.*, **49**, 749 (1935).

Groundnut Breeding

IN view of the increasing economic importance of the groundnut, a new investigation of its chromosomes should be made known at once. Mendes[1] reports from São Paulo that *Arachis diogii*, *A. marginata*, *A. prostrata*, and a cultivated form from the Mato Grosso, all have 20 chromosomes, the previously known species and cultivated forms[2] all having had 40. Evidently the cultivated forms are mostly tetraploid, and their diploid ancestors are now revealed to us for the first time. The tetraploidy of the groundnut may well have arisen at an early stage of its peregrination when it passed from Brazil to Peru in pre-Columbian times[3].

The diploid species now offer us a ready means of protecting our very vulnerable groundnut industry from disease if we are willing to enrich the store of available variation in this hitherto unresponsive crop by crossing with the new wild sources.

C. D. DARLINGTON

John Innes Horticultural Institution,
London, S.W.19.
Sept. 28.

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[1] Mendes, A. J. T., *Bragantia*, **7**, 257 (1947).
[2] Darlington, C. D., and Janaki Ammal, E. K., "Chromosome Atlas", 169 (Allen and Unwin, London, 1945).
[3] *ibid.*, 18.

ANTI-TUBERCULAR ACTIVITY OF OXIDATION PRODUCTS OF SUBSTITUTED *o*-PHENYLENE DIAMINES

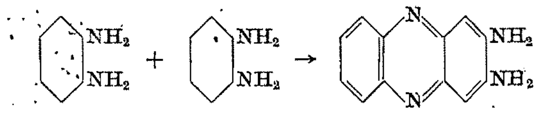
By DR. VINCENT C. BARRY, J. G. BELTON, M. L. CONALTY and D. TWOMEY

Department of Chemistry, University College, Dublin, and School of Pathology, Trinity College, Dublin

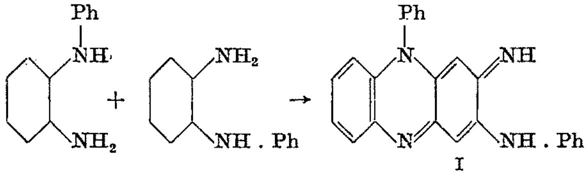
AS reported in an earlier communication in *Nature*, we have been examining the anti-tubercular properties of substituted diphenyl ethers and related compounds[1]. In extending this study to include diphenylamine derivatives, a curious phenomenon was encountered with 2-aminodiphenylamine. When freshly prepared, an aqueous solution of the hydrochloride of this base completely inhibits the growth of *Myco. smegmatis* at a dilution of 1/100,000. On keeping, and occasional warming, the inhibitory power of this solution increases gradually, the five weeks old solution producing complete inhibition at a dilution of 1/1,000,000. At the same time it was noticed that the colour of the solution rapidly changed from an initial pink to a very dark red. The highly coloured product formed in the solution was obviously of great interest. It was afterwards found that addition of ferric chloride solution to an acid solution of the base produced an immediate deep red coloration and separation of a dark crystalline precipitate. This proved to be the hydrochloride of a base, $C_{24}H_{18}N_4$, from which the base itself was liberated by ammonia in the form of a brick-red crystalline powder.

When tested in broth against *Myco. smegmatis* and *Myco. tuberculosis* (*H37Rv*), the dye salt proved to have a remarkable biological activity. Complete inhibition of growth of the former for six days is produced at a dilution of 1/1,500,000 and of the latter for 42 days at 1/20,000,000. The activity is retained to a considerable extent in the presence of five per cent pooled human serum.

A subsequent search of the literature showed that the rapid acquisition of a red colour by solutions of 2-aminodiphenylamine salts had been noted frequently, and a number of workers had investigated the oxidation of this aromatic base with ferric chloride[2-8]. Kehrmann[9] showed that the oxidation of *o*-phenylenediamine with ferric chloride yielded 2 : 3-diaminophenazine, the formation of which he explained as shown :



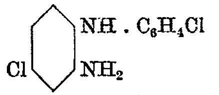
Fischer and Dischinger[8] maintained that the oxidation of 2-aminodiphenylamine followed on the same lines.



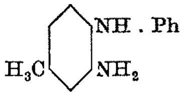
I

Analyses and molecular weight determinations of (I) as prepared by us agree with the above formula.

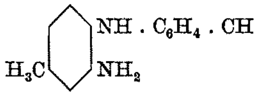
With the view of confirming the mechanism of the oxidation as outlined above, 2-aminodiphenylamine derivatives carrying a substituent in the aminated ring in the position *para* to the NH— bridge were oxidized under similar conditions.



II

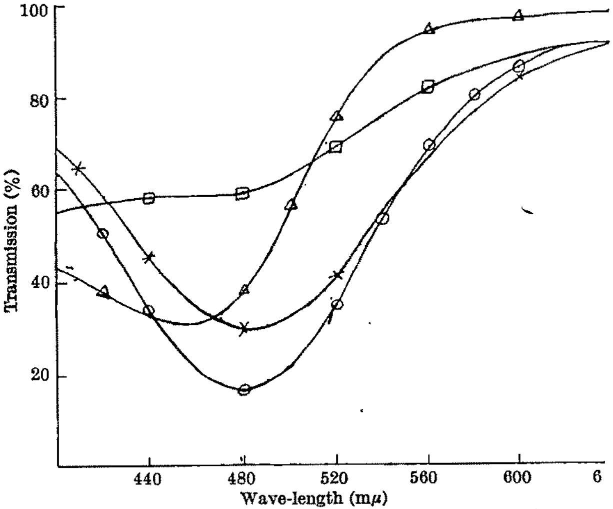


III



IV

(II) gave a pigment showing similar colour reactions to (I), and on analysis proved to have lost one chlorine atom in four during the oxidation. This compound could only have formed a pigment of this type by loss of chlorine. (III) and (IV), containing stable *para* substituents, gave highly coloured products also ; but these showed different colour reactions and absorption curves, and had low antitubercular activity. They clearly belong to a different class from (I) and constitute further evidence in favour of Fischer's formulation.

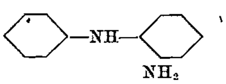
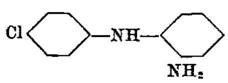
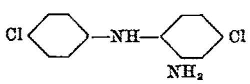
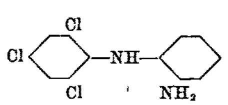
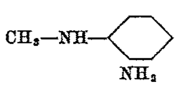
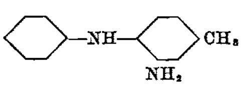
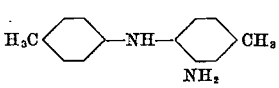


Pigments from : ⊙, 2-aminodiphenylamine ; ×, 4 : 4′-dichloro-2-amino-diphenylamine ; □, 4-methyl-2-aminodiphenylamine ; △, N-methyl-*o*-phenylene diamine

Further pigments were prepared from mono-, di- and tri-chlorinated 2-aminodiphenylamines, the chlorine atoms being substituted in the ring not carrying the —NH_2 group. As expected, these were very highly coloured, and their absorption curves and the colour exhibited by them in strong mineral acid resembled closely that of (I). As seen in Table 1 however, the antibacterial activity is low when th molecule contains more than two chlorine atoms. Th loss of activity in these molecules may be due t alteration in the lipoid/water solubility ratio consequent on the higher degree of halogenation.

When (I) was given in the feed to guinea pig experimentally infected with tuberculosis (Ravene *Rv* strain), at a dosage of 33 mgm. per day, it had n effect on the course of the infection. None of th pigment was excreted in the fæces of these animals and it is possible that it was decolorized by th intestinal flora. *In vitro* tests with (I) against *B. col*

Table 1. The numbers represent the dilutions which cause complete inhibition of *Myco. smegmatis* for 6 days and *Myco. tuberculosis* for 42 days

Pigment from	*Myco. smegmatis*	*Myco. tuberculosis*	
		Without serum	With 5 per cent serum
	1,500,000	20,000,000	3,000,000
	2,000,000	3,000,000	2,000,000
	20,000	25,000	—
	5,000	50,000	—
	200,000	2,000,000	1,000,000
	5,000	300,000	50,000
	5,000	50,000	50,000

showed that it had no inhibitory effect on this organism at 1/5,000, but that it was decolorized by he bacteria. Subcutaneous or intramuscular injecion of the hydrochloride of (I) in guinea pigs in doses of 5–35 mgm. produced severe local toxicity, and this node of administration could not be continued. Intravenous injection in rabbits proved rapidly fatal. When 2-aminodiphenylamine hydrochloride is oxilized by ferric chloride in the presence of human serum, a very deep red pigment is formed which does not separate. Menkin[10,11] has successfully administered ferric chloride intravenously. In view of this and in the hope that the toxic effect might be reduced f the pigment were produced in the blood stream, rabbits were injected intravenously with 2-aminodiphenylamine (15 mgm., 2 c.c.), followed by ferric chloride (15 mgm., 6 c.c.). The rabbits died, however, after an average total quantity of 100 mgm. of 2-aminodiphenylamine had been given over a period of fourteen days, a quantity comparable to the amount of (I) which had already proved lethal intravenously.

Table 2. Antibacterial activity of the pigment (I) from 2-aminodiphenylamine. The figures given in the third and fourth columns represent the dilutions which cause complete inhibition of growth

Organism	Period of growth (days)	Inhibitory dilution in broth	Inhibitory dilution in broth + 5 per cent human serum
Myco. tuberculosis	42	20,000,000	3,000,000
Myco. smegmatis	6	1,500,000	1,500,000
Corynebacterium diphtheriæ (mitis)	3	7,500,000	60,000
Staph. aureus	3	200,000	< 60,000
Strep. fæcalis	3	100,000	10,000
Strep. pyogenes	3	200,000	< 60,000
Strep. viridans	3	80,000	20,000
Vibrio 10	3	10,000	10,000
B. typhosus	3	80,000	5,000
Bact. coli	3	< 5,000	—

While it is clear that the high toxicity of (I) for animals renders it unsuitable for therapeutic use, it may be possible to reduce the toxicity of this structure without destroying its antibacterial power. This might be achieved by increasing the solubility of the pigments by including an OH, COOH or similar group in (I), or alternatively by synthesizing pigments of lower molecular weight. The pigment produced from N-methyl-*o*-phenylene diamine (Table 1) has very high activity against the tubercle bacillus, and its toxicity to animals should be lower than that of (I). These alternatives are being investigated.

These synthetic pigments are of added interest because of their relation to the bacterial pigments, pyocyanine, chlororaphin and iodinin, all of which are phenazine derivatives. Also Iland has reported recently on the high antitubercular activity *in vitro* of N-oxides of phenazine[12].

This investigation is being conducted and financed by the Medical Research Council of Ireland, to which grateful acknowledgment is made. The strains of *Myco. tuberculosis* used in these experiments were provided by the Trudeau Foundation. Our thanks are due to Mrs. E. Philbin for assistance.

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[2] Fischer, O., and Seeder, L., *Berichte*, **22**, 3798 (1889).
[3] Schöpff, M., *Berichte*, **23**, 1839 (1890).
[4] Ernst, O., *Berichte*, **23**, 3426 (1890).
[5] Kehrmann, F., and Messinger, J., *J. Präkt. Chem.*, **46**, 568 (1892).
[6] Fischer, O., and Heiler, O., *Berichte*, **26**, 378 (1893).
[7] Kehrmann, F., *Berichte*, **28**, 1709 (1895).
[8] Fischer, O., and Dischinger, A., *Berichte*, **29**, 1602 (1896).
[9] Kehrmann, F., *Berichte*, **22**, 1983 (1889).
[10] Menkin, V., *J. Exp. Med.*, **60**, 463 (1934).
[11] Menkin, V., *Amer. Rev. Tub.*, **35**, 134 (1937).
[12] Iland, C. N., *Nature*, **161**, 1010 (1948).

TENTH INTERNATIONAL LIMNOLOGICAL CONGRESS, ZURICH

THE International Association for Theoretical and Applied Limnology, the object of which is to provide a common meeting ground for those interested in the biology and utilization of fresh waters, achieves its purpose by means of congresses which are ordinarily held every two years and the proceedings of which are afterwards published. Between successive congresses, matters requiring attention are dealt with by the president, the secretary and a small executive committee, while reference can also be made to the members of an international committee upon which each participating country has one or more representatives. The last congress met in Sweden in 1939 and, apart from all other considerations, that held this year in Switzerland will be memorable for the renewal of old friendships and the opening up of new avenues of scientific intercourse. It was attended by about a hundred and sixty individuals representing twenty-one different nations, and the British group was one of the largest.

The opening session on the first evening, at which formal business tempered by interludes from a first-class string quartette was transacted, was held in the spacious Zurich Congress House. On this occasion Naumann Medals, which are awarded for distinguished services to limnology, were presented to the American Society for Limnology and Oceanography and to the Freshwater Biological Association of the British Empire. The evening concluded with a supper, at which the Swiss organising committee were our hosts, and which served to a remarkable degree to establish contact between the different nationalities present.

The scientific work of the Congress was largely concentrated into the mornings of August 19 and 20 and the morning and afternoon of August 22. On each occasion there were simultaneous sessions concerned with general limnology and with freshwater fisheries, while on August 22 there were other sessions devoted to water utilization and water sanitation. The many short papers read at these various sessions, a considerable number contributed by the British members, covered a wide range of topics. The ecology of river-populations and self-purification in rivers, phytoplankton problems and the fungal parasites of the phytoplankton, the ecology and distribution of diverse freshwater Invertebrata, the regional limnology of Switzerland, seasonal changes at the mud-surface and detritus-drifts in lakes, fish-culture and sex in fish, the chemistry of sewage disposal waters, and the biology of filters were among the numerous subjects discussed. There were also several lectures on major topics. Of quite special interest, in view of its relation to the many lakes visited on the excursions, was the symposium on the recent development and present biological condition of the lakes bordering the Alps, in which Profs. Jaag (Zurich), Baldi (Pallanza), and Ruttner (Lunz) took part. On August 20 Profs. Steinmann (Aarau) and Willer (Hamburg) dealt with the taxonomic problems afforded by the genus *Coregonus*, discourses which proved of great interest even to those not directly concerned with fisheries, while on August 22 F. W. Mohlman (Chicago) gave an account of recent developments in industrial waste disposal. On this, the last evening in Zurich, the Town Council entertained the members of the Congress to dinner.

The excursions, which were designed to illustrate much of the matter that had been discussed during the scientific sessions, were excellently organised and were marked by the lavish hospitality that accompanied them. The afternoons of August 19 and 20 were devoted respectively to a visit to the Cantonal Fish Breeding Station at Stäfa, and to a trip by motor coach to various small lakes in the vicinity of Zurich. The whole of August 21 was taken up by a visit to the falls of the Rhine at Schaffhausen and to the "Untersee" (Lake of Constance), while on August 24 most of the members visited the laboratory on the Jungfraujoch. Both these full-day excursions were favoured by good weather and must have left a deep impression on the participants. On August 23 we travelled from Zurich to Interlaken via Lucerne and the Brünig Pass, making a stay of several hours at Kastanienbaum to visit the small but well-equipped hydrobiological station, originally founded by H. Bachmann and now maintained by the Natural History Society of Lucerne. The latter very generously entertained us to lunch.

The concluding session on August 25 was held at Montreux. Dr. Gunnar Alm (Drottningholm, Sweden) was re-elected president of the Association, while Dr. Rohde (Uppsala) was elected secretary in succession to Prof. Lenz (Plön), who had filled this office since the foundation of the Congress in 1922. It was decided that the next congress should meet in Belgium in 1950, and the ensuing one in Britain in 1952.

It is impossible to say too much in praise of the general organisation that rendered the Congress so unqualified a success, or in acknowledgment of the generosity that made so much available to the members for so small a financial outlay. Among the many Swiss men of science who were concerned, special mention should be made of the head of the Organising Committee, Dr. Huber-Pestalozzi, and of his associates Prof. O. Jaag and Dr. U. Corti, while Mrs. Minder, though never to the front, was a help and guide to all participants.

F. E. Fritsch

SEMICONDUCTORS AND THEIR APPLICATIONS

The summer meeting of the Manchester and District Branch of the Institute of Physics at the University of Manchester took the form of a two-day conference on semiconductors and their applications. The chairman of the branch, Prof. E. G. Cox (Leeds), presided.

The purpose of the conference was to bring together those working on the fundamental physics of semiconductors, those making such substances commercially, and those applying them in various branches of science and engineering.

The opening session was concerned with the fundamental theory of the behaviour of electrons in semiconductors. Dr. J. W. Mitchell, of the University of Bristol, began by distinguishing between conduction in metals, in semiconductors and in insulators. In semiconductors, conductivity increases with temperature and with the amount of impurity present. The characteristic relation between conductivity, σ, and absolute temperature, T, is

$$\sigma = ae^{-E/kT}, \qquad (1)$$

where E is an activation energy. Dr. Mitchell then developed most concisely the wave-mechanical concepts of electrons in ionic crystals and the conditions obtaining in periodic lattices which lead to the splitting of allowed energy-levels for the electrons into large numbers of closely spaced levels, that is bands. The effects of the presence of defects and impurities in such a lattice were considered, and the distinctions between excess (n-type) and defect (p-type) semiconductors made clear. In the first type the carriers of charge are electrons, and in the second they are 'positive holes'. For example, sodium chloride when heated to 600° C. in an atmosphere of sodium vapour turns orange, due to the formation of 'F-centres', and at 300° C. under the influence of an electric field the coloration moves towards the anode. With potassium bromide after heating in an atmosphere of bromine, under an applied field the coloration moves toward the cathode. The coloured materials behave as n- and p-type semiconductor respectively. Much of the work on the properties of alkali halides had been carried out by Pohl at Göttingen, and Dr. Mitchell emphasized the importance of such work on relatively simple lattices in gaining an understanding of the behaviour of more complex semiconductors.

Lead sulphide can be given semiconducting properties either by heating in sulphur vapour, in which case it becomes a defect or p-type semiconductor, or by heating *in vacuo* (giving an excess semiconductor). Barium oxide when heated in barium vapour turns orange-yellow due to the production of F-centres. The oxides of titanium, zinc, cadmium and aluminium when heated *in vacuo*, and cuprous oxide, nickel oxide and uranium dioxide when heated in excess oxygen, all show semiconductor properties. Finally, Dr. Mitchell considered magnetite, a substance the conductivity of which (200 ohm^{-1} cm.$^{-1}$) lies approximately midway between that of a metal and of the average semiconductor. Its unit cell is twice the size of the normal cell and includes 32 oxygen ions and 24 iron ions. Of these 24 iron ions, 16 are ferric and 8 ferrous. Consideration shows that 8 of the ferric ions can be considered as 8 ferrous ions each with an extra electron, thus giving rise to additional energy-levels above the normal filled band and so accounting for its conducting properties.

Dr. R. A. Smith (Telecommunications Research Establishment, Malvern) then followed with a paper dealing principally with conductivity measurements. Previous work indicated that a of equation (1) varies to some extent with amount of impurity, and E varies considerably. Also there is a difference between measurements made on polycrystalline samples and those on single crystals of the same substances. Plots of log σ against $1/T$ give straight lines, the slopes of which decrease with increasing quantity of impurity. In most substances, measurements of Hall coefficients and thermo-electric powers have shown that conductivity is by electrons or by positive holes. For others, notably lead and tin sulphides, conductivity can either be by electrons or positive holes, depending on whether there is excess of metal or electronegative constituent, and near the stoichiometric composition the number of carriers of each type is approximately equal. In the latter case, the conductivity is a minimum and the temperature coefficient a maximum. For polycrystalline materials conductivities range from 10^{-8} to 10^{-2} ohm^{-1} cm.$^{-1}$; but for single crystals the range is 10 to more than 1,000, and the temperature coefficient is small and usually slightly negative. Single crystals thus appear to behave as semi-metals. The difference between single and polycrystalline materials might arise through the presence of intercrystalline barriers, and to investigate this, R. P. Chasmar has made measurements at the Telecommunications Research Establishment on evaporated layers of lead sulphide at radio frequencies up to 50 Mc./s. The results are difficult to interpret, but it appears that at high frequency the temperature coefficient of conductivity is small and negative, while at low frequency it is large and positive.

Dr. G. G. Macfarlane (Telecommunications Research Establishment) spoke about some theoretical aspects of the work done on lead sulphide cells, especially the variation of resistance at low temperature. He explained the form of the resistance-temperature curve by assuming that at low temperatures (below 150° K.) the supply of electrons is constant, independent of temperature, but that their mobility varies with temperature.

Dr. C. J. Milner (B.T.H. Research Laboratory, Rugby) described and demonstrated various recently developed semiconductor devices useful in infra-red work and now available. A 'coolable' type of lead sulphide photoconductive cell with 10 mm. × 1 mm. element size has a detection limit (signal equal to noise for 1 c./s. band-width) of 5×10^{-10} watt at 20° C. and 5×10^{-11} watt at $-$ 80° C. (that is, filled with solid carbon dioxide). At 20° C., peak spectral response is at $2{\cdot}2\,\mu$ and the long wave limit at about $3{\cdot}0\,\mu$; at $-$ 80° C., $2{\cdot}8$ and $3{\cdot}4\,\mu$ respectively. Bolometers formed of (reduced) magnesium titanate are able to detect about 10^{-6} watt/cm.^{2}; a unit with element size 2 mm. × $0{\cdot}2$ mm., suitable for spectrometer use, has been standardized. The sensitivity of these types of detector in radiation pyrometry is comparable for source temperatures of 100–200° C. Nernst filaments (zirconia rods with platinum leads) operating as radiation sources at 2,000–2,100° C. in free air were also shown.

Dr. Milner referred to the theory of Sosnowski, which explains the experimental result of Starkiewicz and others, that maximum photosensitivity in lead sulphide coincides with zero (overall) thermo-electric power, by identifying this state as that giving maximum frequency of alternation between n- and p-regions. He suggested that the theory also associated high sensitivity with an uneven distribution of impurities, and that this might explain the wide variations encountered in processing evaporated cells.

Dr. R. W. Sillars (Metropolitan-Vickers Electrical Co., Ltd.) gave a paper on non-linear resistors, in which he dealt with the properties of silicon carbide. Polycrystalline silicon carbide bonded by clay showed non-linearity of its current-voltage relationship and other properties quite different from specimens of sintered silicon carbide. Besides demonstrating these properties he outlined methods of using such semiconductors as circuit elements.

Mr. H. Wolfson (Standard Telephones and Cables Co., Ltd.) presented a paper on thermistors in which he began by reminding his audience of the researches of Faraday on the properties of silver sulphide over a hundred years ago, and the development which has taken place up to the present time. The use of silver sulphide was abandoned some years ago because of the occurrence of polarization effects due to ionic conduction and the presence of a 'hysteresis' loop when temperature changes occur. At the present time the most common materials used are the oxides of cobalt, manganese, nickel, iron, chromium and copper. In production, beads of the oxides, mounted on fine platinum wires, are fired in controlled atmospheres. Typical thermistors have a 'half-temperature' of 20° C. at 300° K., that is, a temperature change of 20° C. at 300° K. will double or halve the electrical resistance of the bead. Another type of bead has a cold resistance of 2,000 ohms, but if 20 milliwatts is dissipated in the bead its resistance will fall to 60 ohms. The use of thermistors as circuit elements was described, as well as some of their applications in medical research as temperature indicators.

Dr. H. L. Penman (Rothamsted Experimental Station) described the development of a portable thermistor bridge for micro-meteorology among growing crops. A portable unit had been built to measure temperature, humidity and wind speed among growing potato-crops in connexion with an investigation into factors affecting the spread of virus disease.

Mr. S. L. Martin (Philips Electric, Ltd., London) described recent experiments carried out by Vink on the conductivity of mixed barium and strontium oxides, which were explained in terms of conduction through crystallites in contact and thermionic emission from crystallite to crystallite. The curve of conductivity as a function of temperature showed three different slopes for the temperature ranges, less than 700°, 700–800°, and above 800° K., the values agreeing with those previously reported. In discussion, the need for consideration of much simpler substances was emphasized as well as the elimination of uncontrollable variables, and it was suggested that magnesium oxide would be the easiest oxide to study since large single crystals have recently become available.

Photo-conductivity of the lead sulphide type of semiconductors attracted some discussion, especially as the literature appeared to indicate that the method of preparation of the lead sulphide films affected considerably their photo-conducting properties. It was suggested that the lead telluride type of cell should be studied since its production does not involve contamination by oxygen, etc.

The final session of the Conference was devoted to an exhibition of properties and applications of semiconductors, many of which had been discussed in the main sessions. A clutch using the Johnson–Rahback effect was shown using polished magnesium titanate in contact with polished brass, as well as a lead sulphide cell showing the high temperatures reached at hot spots at frictional contacts.

The papers and discussions made clear the growing interest in the theory and applications of semiconductors, and directed attention to the work proceeding in government, industrial and university laboratories. Some of the papers presented will lead to contributions to other journals.

W. GRATTIDGE
F. A. VICK

SELECTION OF STUDENTS FOR UNIVERSITIES

ON the morning of September 14, Section L (Education) of the British Association discussed "Selection at the University Level". Mr. W. O. Lester Smith, president of the Section, presided.

Mr. J. O. Roach spoke from experience of the Civil Service Selection Board, and previously as a Cambridge tutor. He said that some well-known modern methods of selection depended essentially on a careful job analysis. But in the case of university students, for what were we selecting ? For success in examinations, for success in life, or for what ? There was no one criterion and therefore no one method of selection. He felt strongly himself that there must on no account whatever be any interference with those of exceptional intellectual powers; no non-academic criterion must be allowed to exclude these. Also he was against a health test—too many men of intellectual distinction had suffered from poor health since the beginning of the world. Forecasts of employability, too, were extremely difficult to make successfully. We must not exaggerate the ill-success of the present method; at least it satisfied public opinion as non-political and generally fair. Still, methods of selection were certainly an important problem, now that there was hope that all, or nearly all, the boys and girls of ability in the nation would reach the sixth forms of schools; and the dissatisfaction with to-day's students expressed by Lord Lindsay of Birker in the House of Lords had met with wide agreement. Mr. Roach emphasized that the need for a new approach was being widely recognized in the universities; and he warned the meeting against assuming that there was any one quick and easy solution to be found.

Mrs. J. L. Stocks found wide agreement among those present with views she had formed from her experience at Westfield College, London. There she had, with very small exceptions, been concerned only with honours women students for arts subjects. She thought that there was a serious danger of paying too much attention to the requirements of the various professions, and too little to the quality of life inside universities. She was herself impressed with the qualities of to-day's women students, who were drawn from a wider range than the students of the '90's, with their cultured, keen but rather narrow backgrounds. In the sixth forms of schools nowadays, the girls had done all sorts of things outside formal classes, from dramatics and foreign visits to conferences on world citizenship and the organising of national savings. They had their shortcomings, of course; some of them, for example, had no idea how to talk to a stranger or how to go away from a party.

As for the present system of selection, Mrs. Stocks said there was rather an absence of system. The anxious queueing for Somerville, Westfield and other residential colleges was a ridiculous arrangement, infuriating for the selectors and very bad indeed for the adolescent selectees. She thought that any better method of selection would be likely to involve some degree of conflict with hitherto accepted individual liberties; but this might have to be accepted. A final solution might well take time to find, as the encouraging success of social democratic education was still a new thing. At all costs, universities must remain academic communities, and not become, for example, mere schools for leadership.

Mr. C. R. Morris spoke as a headmaster. He did not believe that the selection of individual students was the most important problem to-day, urgent as it was. The universities appeared to be dissatisfied with nearly all the students they were admitting, and not just with the small percentage of the total body who might be different if the system of selection were different. As a result, many people seemed to be toying with the idea that able boys ought to continue right up to the age of eighteen with work on the general type of school certificate work. If this were really intended, it would be a very serious mistake. It had been a great triumph on the part of the grammar schools to lead so many good students to the doors of the university and make the present university expansion possible. It must not be supposed that all able boys *wanted* to go to the university. Outside the professional and near-professional classes this was far from being the case. In the other sections of society, it was the schools which had to do the missionary work, and without doubt it was by their sixth-form courses that they succeeded.

Moreover, this sixth-form work, Mr. Morris claimed, was in principle educationally sound. After reaching the age of fifteen or so, an able boy, whose contemporaries were starting on their working careers, needed to feel that he was beginning to become a real scholar or expert in the group of studie for which he had the best aptitude. This gave him his initiation into the commonwealth of learning. Certainly his work in his special field ought to have a less crowded syllabus than at present and give him more elbow room to explore for himself; and outside his special field he should give a third of his time and energy to the continued study of the use of English and to the discussion of general problems, cultural, religious and social. Discussion really came to mean something if each boy could contribute to it on the basis of his own expertise and hear his friends do the same. Ideally, sixth-form work, outside the subjects of special choice, should not be subject to external examinations. It was necessary here to exploit idiosyncrasies in the teachers, not to steamroller them. The most important single thing was a real understanding between teachers and schools, and this would now be perfectly practicable if it were set about in the right way.

In the course of an interesting discussion, Mr. Clegg made the point that local education authorities had in effect asked the universities to organise through the joint matriculation boards the selection of students for financial grants, and the universities were now criticizing the students selected. The remedy, he thought, lay in the hands of the universities themselves.

The president of the British Association, Sir Henry Tizard, said that in his view university teachers should recognize that they were not experts in the education of schoolboys and schoolgirls, and should leave this to the schools. University students must be in the upper range of intelligence and must *want to do something.* Intelligence and zeal—provided students had these virtues on entering the university, it did not matter what subjects they had been taught at school.

A number of speakers emphasized that public opinion did not sufficiently appreciate the part that ought to be played in the higher education of the nation by technical colleges. It was most shortsighted to allow these to continue to fall so far short of the universities in prestige.

MORPHOLOGICAL ASTRONOMY

THE Halley Lecture for 1948, with the above title, was delivered at Oxford on May 12 by Dr. F. Zwicky, of the California Institute of Technology, Pasadena. The lecture covers such a wide range in astronomy that only the more important points can be referred to in this short summary; fuller information can be obtained from *The Observatory* (68, 845, August 1948), where it is printed in full.

The morphological method is merely an orderly way of looking at things, and its essence is direct thinking and direct action—a combination which is a great asset of free men and of the democratic way of life. A complete morphological analysis of astronomy is a very comprehensive undertaking, and Dr. Zwicky discusses only some of the basic elements of uch an analysis, among which he includes the following: observation of celestial phenomena; experimentation with celestial phenomena; theoretcal integration; use of the knowledge gained in onstruction; dissemination of the knowledge and ts bearing on all activities of man.

Under the first of these headings, Dr. Zwicky deals with the instruments to be used for observation and gives a very brief description of the photo-electronic elescope, which has introduced a number of new features. Even with such telescopes of relatively mited definition and light power, the search for ovæ, supernovæ, variable stars, comets, meteors, etc., can be put on a 'mass-production' scale because images from photo-electronic telescopes can be televised. Another of the different advantages of this telescope is the ability to steady moving or scintillating images resulting from unsteadiness of the atmosphere or motions in the telescope, and automatic guiding of the telescope can be accomplished through devices similar to those used for steadying the refocused image on the recording surface.

Reference is made to the devices for observing phenomena from points above the main portion of the earth's atmosphere, by the use of rockets carrying scientific instruments. V2 rockets have already carried various instruments to heights exceeding 200 km., and it is proposed increasing this range to 1,000 km. to eliminate the greater portion of the atmospheric absorption. There are visions of vehicles carrying observers to great heights, and even the high-flying conventional aircraft have possibilities in this direction which may some day be exploited.

The accomplishments of the 18-in. Schmidt telescope on Palomar Mountain during the last ten years are dealt with, and important results mentioned refer to work on clusters of nebulæ, nebulæ, stars, supernovæ of various types, common novæ, very blue faint stars, and the general theory of relativity and the theory of the expanding universe. In connexion with this last subject, it was proposed that compact nebulæ acting as gravitational lenses could be used as a check for the deflexion of light, and the idea of nuclear matter of a density of the order 10^{14} gm./c.c. was also suggested. Such matter, which should exist in neutron stars—perhaps ancient remnants of supernovæ—would act as gravitational stars *par excellence*, and it is intended to make a determined search with the 18-in. Schmidt. Bright supernovæ supply data for some interesting conclusions on nuclear chain reactions, knowing that such bodies emit during the first 200 days about 5×10^{48} ergs in the form of visible light. For a star of mass 100 times that of the sun and containing about 10^{59} protons, the energy liberated per proton is, therefore, much greater than the maximum energy liberated per proton in the most energetic chemical reaction. There is, therefore, some justification for the conclusion that in a supernova outburst there is a nuclear chain reaction attended probably with a gravitational collapse to nuclear matter. Some supernovæ, notably the object NGC 4636, have been caught on the rise, and in such cases the speed is in accord with the assumption of nuclear chain reactions. As Zwicky remarks, "We here therefore have one more example how apparently academic astronomical observations led the way to the discovery of phenomena of the greatest import". A short investigation suggests that there is the possibility that cosmic rays are generated in supernovæ.

Astronomical knowledge has been used in the past for the conduct of human affairs, and an extrapolation of these applications, which lies in the line of morphological thinking, is a reconstruction of the universe, in which that of the earth comes first. This is of fundamental importance as there is the danger that the whole earth might be exploded by large-scale nuclear chain reaction, and schemes for stabilizing the earth against such an eventuality are part of morphological astronomy. Possibly there will also be plans for making some of the planets habitable by changing them intrinsically and by altering their positions relative to the sun; and however fantastic such schemes may seem, Zwicky suggests that these thoughts are nearer to scientific analysis and mastery than were Jules Verne's dreams in his time.

The aim of the universities is to produce astronomers, chemists and so on; but this approach has failed us, especially if it is admitted that the purpose of education is the creation of realities that are in agreement with the avowed purpose of man. The purposes have frequently been stated, but the actualities present a state of affairs in which it is often difficult to recognize them. In the morphological reconstruction of human society and the material universe, astronomy and astronomers may be destined to play an important part.

SOCIAL SCIENCES AND INDUSTRIAL PRODUCTIVITY

BESIDES discussing the place of science in government and scientific man-power (see *Nature* of August 7, p. 199), the first annual report of the Advisory Council on Scientific Policy gives some account of the work of the committee set up to report to the Advisory Council regarding the directions in which a scientific approach is most likely to promote an increase in the national productivity. In an interim report submitted in September 1947, the committee concluded that current fundamental research in the physical and biological sciences was unlikely to have any material short-term effect in increasing productivity, whatever might emerge from its results in future. For short-term results the more effective application of scientific knowledge already available was likely to prove much more fruitful; but for this an adequate supply of qualified technologists and engineers is essential. The committee recommended that steps should be taken immediately to ensure that this demand is met. It was also suggested that the type of approach used so successfully by the Services during the War and commonly described as 'operational research' might also be very fruitful in yielding rapid results. Publication of a book on operational research was recommended and its preparation is in hand. The committee also suggested that it is important to try to establish scientifically whether the quantity and quality of the existing rations are likely to diminish the worker's potential outlook. Later, it strongly recommended the energetic pursuit of research on the nutritional consumption and physiological requirements of the main occupational classes in the United Kingdom, as well as obtaining relevant data from abroad, particularly from the United States and from the British Zone of Germany.

The Committee on Research and Productivity also appointed a special sub-committee to review existing technical information services and to consider their improvement. The work of this sub-committee was afterwards transferred to a Panel of the Committee on Industrial Productivity. It has been decided that the Information Unit in the Intelligence Division of the Department of Scientific and Industrial Research should be expanded to provide a national service for putting inquirers into touch with sources of specialist information. The possibility of achieving rapid results by the application of sociological principles was likewise explored. A memorandum issued on the human factor in production recommended a review of existing knowledge in this field, more effective co-ordination of the work being carried out by different bodies and further research into the basic conditions of good morale and efficient organisation, the characteristics of successful joint production committees, the status and position of the foreman, the differences of response as between male and female operatives, and the selection and training of managerial staff. It emerged in this general inquiry that the concrete objective of raising the level of the least efficient firms nearer to the level of the most efficient would go a long way towards effecting the general rise of ten per cent in overall output by British industry for which the Government had asked. The functions of this Committee have now, as announced last December, been transferred to the new Committee on Industrial Productivity, which, with its four subsidiary panels, is continuing and extending the work initiated under the Advisory Council.

This new Committee is quite independent of the Advisory Council on Scientific Policy, but Sir Henry Tizard is chairman of this Committee also, and three other members of the Advisory Council are also serving on it. Two of the panels under this Committee are continuing the earlier investigations into the potentialities of operational and sociological research, and a statement has recently been issued from the Economic Information Unit of the Treasury on the work of the Panel on Human Factors, of which Sir George Schuster is chairman. The Panel was constituted "to advise the Committee concerning the directions in which productivity could be increased by the application of research into the human factors in industry and to make recommendations for further researches into this field where called for". At its first meeting on February 2, 1948, the Panel decided to establish a research advisory group of representatives of the Medical Research Council, independent institutions engaged in research in the social sciences and departments of applied psychology in certain universities to advise the Panel on matters of research and on the availability of research workers.

The Panel was impressed at an early stage by the lack of workers with practical experience in the field of the social sciences, and has considered the means by which the number of workers could be increased and their training undertaken. In the meantime, it was decided to arrange for existing research institutions to undertake a series of investigations selected so as to cover points where it is important to acquire more scientific knowledge and so as to provide opportunities to train additional field-workers. The statement lists a number of projects which have thu been inaugurated, and the responsibility for supervising their completion and for making grants towards their costs has been undertaken by the Medica Research Council. In addition to these projects, certain activities of the British Institute of Managemen have been co-ordinated with the programme of th Panel, and a number of further projects from university departments are being considered.

The projects approved include studies of productivity in the Royal Ordnance Factories by the Industrial Health Research Board, and of work, desig and the measurement of human performance by th Cambridge Applied Psychology Unit. The Tavistoc Institute of Human Relations is investigating withi an engineering firm the effect of different metho of payment, joint consultation procedures, metho of communication within the firm and inter-manag ment relations, and is also examining methods disseminating knowledge by group discussion, film radio, etc. The Nuffield Research Unit, Cambridg has undertaken an investigation of the effects of ageing on productivity.

Since this statement was issued, some further information has been given by the National Institute of Industrial Psychology regarding the three research projects it is undertaking for the Panel. The first of these, on problems associated with the selection and training of foremen, includes a survey of present practice and of the status of foremen relative to the middle and higher levels of management. It is hoped that the survey will show how far recent advances are being utilized in industry, and that it will also provide material for a comprehensive job study on which to base further improvements in technique. Later it is proposed to carry out experiments to evaluate methods of selection and training under controlled conditions.

The second project is a study of methods of joint consultation in industry generally; by a survey of existing practice the Institute hopes to ascertain how many firms use consultative machinery and how effective it seems to management and men. Further work is planned to compare the effectiveness of various methods of consultation. A third study, of the effect on production of the size of unit of work, is intended to determine how far increase of job-breakdown reduces the will to work and how output varies with the size of batch handled in repetitive work.

Having inaugurated these projects, the Panel has turned its attention to more direct methods for improving industrial productivity by the wider adoption of techniques in the field of management and human relations which have already proved valuable. The projects already launched, however, besides providing for the study of a number of key factors affecting production, should serve as an experiment in a co-ordinated programme of allied research to be undertaken by a number of different organisations, and should build up a coherent body of research workers and thus increase the available strength for expanding field investigations. It is also hoped that interim conclusions may be drawn from the studies and applied as the work proceeds, even if the completion of the projects takes some time.

The Panel has clearly made a good start on the foundations laid by the Committee on Research and Productivity of the Advisory Council on Scientific Policy. Much remains to be done, for example, on the administrative side, where the responsibility of the Medical Research Council can scarcely be regarded as more than a temporary expedient while some satisfactory permanent scheme for financing and watching over the research projects for the Panel is elaborated. Nevertheless, a start has been made towards meeting the need for team work in this field on which *Planning* laid such stress in its recent broadsheet on the human factor (see *Nature*, **161**, 780; 1948), and it is interesting to note how largely the projects already initiated cover the suggestions made there.

Success in this field, as *Planning* rightly stresses, is essentially a matter of team-work, in which the leader of each team must have at his disposal a wider variety of scientific techniques and disciplines than can be compassed by even two or three workers. The central discipline involved is probably psychology, or one of a closely related group including psychiatry and industrial medicine. Experience in and some understanding of management or administration, as well as knowledge of the technical side of the industry under observation, are also important, as well as a high grade of understanding of such social sciences as economics and social anthropology. Inevitably, too, work of this kind demands ability in collecting and analysing statistics.

The second main point made in this broadsheet is that research should be done on the spot in industry, and it is clear that Sir George Schuster and his colleagues are already proceeding on such lines so far as the limited number of qualified workers permits, and that they are seeking to expand as swiftly as possible the number of trained workers necessary for such field-work on any considerable scale. We may be equally confident that the researches they are fostering will have regard to the third main point made by *Planning*, that the research should treat the industrial unit under observation as a functional whole, studying particular factors not in isolation but as elements in a total situation. The greater co-ordination between the research bodies themselves—including firms undertaking investigations on their own behalf—which the work of the Panel will promote will lead to improved methods both in the collection of data and in analysis, and it may be confidently expected that better arrangements will be made in the future than at present exist for the pooling of information as well as for the correlation of data.

Following the lead of the Advisory Council, Sir George Schuster and his colleagues have got to work swiftly on sound lines. The progress of their work will be followed with keen interest, as discussions at the recent meetings of both the British Medical Association and the British Association testify. There is growing appreciation that the informal social group lies at the bottom of any informal organisation and is the basis on which a good administrative structure must be built. The work of the Panel on Human Factors and indeed all the work of the Committee on Industrial Productivity can be counted upon to make even more widely known such results as those of the Hawthorne experiment, and to assist in overcoming the resistance of employers and of trade unions alike to the whole principle of scientific study and to the application of its conclusions.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 18

BRITISH MUSEUM (at the Natural History Museum, Cromwell Road, London, S.W.7), at 2.30 p.m.—Dr. J. Ramsbottom: "Edible Fungi".* (Further Lectures on Friday, October 22, Monday, October 25, and Friday, October 29.)

UNIVERSITY COLLEGE, LONDON, DEPARTMENT OF BIOCHEMISTRY (in the Physiology Theatre, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. E. M. Crook: "The Electron Microscope and its Biological Applications".* (Further Lectures will be given on October 25 and November 8.)

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. S. Morse: "Recent Developments in High Vacuum Technology".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the INSTITUTE OF SEWAGE PURIFICATION, at the County Technical College, Essex Road, Dartford), at 6.30 p.m.—Mr. A. E. J. Pettett: "Effect of Cyanides on Treatment of Sewage in Percolating Filters".

Tuesday, October 19

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. J. T. Edwards: "Chemical Control of Protozoan Parasites".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "What should be the Design Considerations of Services' Radio Equipment ?" (to be opened by Mr. S. J. Moss and Mr. G. C. F. Whittaker).

Chemical Society, Southampton Branch (joint meeting with the Portsmouth and District Chemical Society, in the Municipal College, Portsmouth), at 7 p.m.—Dr. F. P. Bowden, F.R.S. : "Tribochemistry and the Initiation of Explosives".

Wednesday, October 20

Institution of Electrical Engineers, Supply Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. O. Boyse : Inaugural Address as Chairman.

Royal Institute of Chemistry (joint meeting with the London Section of the Society of Chemical Industry, at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.30 p.m.—Dr. J. G. Fife : "Protection of Chemical Inventions".

Royal Statistical Society, North-Eastern Group of the Industrial Applications Section (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. B. P. Dudding : "A Statistical Contribution to Production Economy".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Science and Peace" (to be opened by Prof. J. D. Bernal, F.R.S., and Prof. N. F. Mott, F.R.S.).

Irish Chemical Association (in the Department of Chemistry, Trinity College, Dublin), at 7.45 p.m.—Prof. T. S. Wheeler : "The Training of a Chemist" (Presidential Address).

Thursday, October 21

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. A. M. Bensusan : "Notes on a Small Working in Southern Rhodesia" ; Messrs. E. J. Pryor and K.-B. Liou : "A Simple Flotation Cell".

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Annual General Meeting ; Mr. L. H. Bedford : Presidential Address.

Chemical Society, Hull Branch (joint meeting with the Local Section of the Oil and Colour Chemists' Association and the University College Scientific Society, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Dr. A. E. Alexander : "Surface Chemistry—its Achievements and its Future".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. G. W. Wilson and Squadron-Leader E. P. Bridgland : "Cold Weather Operation of Aircraft".

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. H. W. Best-Gordon : "Chemical Aids to Textile Processing and Finishing".

Textile Institute, Yorkshire Section (at the University, Leeds), at 7.15 p.m.—Mr. E. V. Giles : "Application of Plastics to the Textile Industry".

Chemical Society, Edinburgh Branch (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Prof. J. W. Cook, F.R.S. : "Some Aspects of the Chemistry and Biochemistry of Polycyclic Aromatic Hydrocarbons".

Friday, October 22

Chemical Society, Birmingham Branch (joint meeting with the University of Birmingham Chemical Society, in the Main Lecture Theatre, Chemistry Department, The University, Edgbaston, Birmingham), at 4.30 p.m.—Sir Cyril Hinshelwood, F.R.S. : "Cell Growth Phenomena and Chemical Kinetics".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

Manchester Statistical Society, Statistical Methods Study Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 5.30 p.m.—Mr. W. A. B. Hopkin : "Some Problems of Population Statistics".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Capt. (E.) W. Gregson : Presidential Address.

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Mr. H. L. Kirke : "Studio Acoustics and Modern Methods of Measurement".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned :

Senior Lecturer in Anatomy—The Secretary of University Court, The University, Glasgow (October 23).

Graduate Assistant Chemist in the Laboratory, Rookery Park, Erdington, Birmingham, to carry out work concerned with sewage purification—The Clerk to the Birmingham Tame and Rea District Drainage Board, 117 Colmore Row, Birmingham 3 (October 23).

Senior Lecturer in Soils and Fertilizers at the Canterbury Agricultural College, Lincoln, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (October 25).

Principal of the Shropshire Farm Institute—The Secretary for Education, Education Office, County Buildings, Princess Street, Shrewsbury (October 30).

Lecturer or an Assistant Lecturer in Structural Engineering—The Registrar, College of Technology, Manchester 1 (November 1).

Analysts for the analysis of samples of drugs and medicines taken on test prescriptions dispensed by pharmacists and authorized sellers of poisons under Part IV of the National Health Service Act 1946—The Chief Pharmacist, Ministry of Health, Whitehall, London, S.W.1 (November 1).

Chairs of Mining, Mechanical, Electrical, and Civil Engineering, in the New South Wales Technical University—The Agent General for New South Wales, 56 Strand, London, W.C.2 (November 1).

Foundation Chair of Chemical Engineering in the New South Wales Institute of Technology (Technical University)—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (November 1).

Poultry Officers (2, male) in the Department of Agriculture and Lands—The Secretary, Government of Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (November 3).

Senior Scientific Officer in the Ministry of Supply at the Atomic Energy Research Establishment, Harwell—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2298 (November 4).

Experimental Officers in the Chemical Inspectorate (Atomic Energy), Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2297 (November 4).

Lecturer in Anatomy—The Registrar, King's College, Strand, London, W.C.2 (November 8).

Senior Assistant in Physics—The Secretary, South-East London Technical College, Lewisham Way, London, S.E.4 (November 13).

Lecturer in Biology at the New England University (University of Sydney), Armidale, N.S.W.—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (November 15).

Lecturer in the Department of Geography of the Natal University College, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (November 30).

Lecturer in Botany (plant physiology)—The Registrar, University College, Southampton (November 30).

Lecturer in Chemistry in the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 1).

Lecturer in Economic Statistics in the Faculty of Economics of the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (Sydney, December 31).

Senior Leturer in Botany at Rhodes University College, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 31).

Plant Pathologist in the West African Cocoa Research Institute, Gold Coast, to undertake investigation into the diseases of cocoa—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Head of the Science Department—The Headmaster, Clifton College, Bristol 8.

Honours Graduate for training as a Fish Processing Expert—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in the Mathematics Department—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

Research Bursary in the Chemistry Department of the Imperial College of Science and Technology, for fundamental research on the physical chemistry of high-temperature reactions involving iron—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Laboratory Steward in the Department of Biology—The Principal, Technical College, Brighton.

Laboratory Assistant (man) for biology, chemistry and physics laboratories, at George Green's School, East India Dock Road, Poplar, London, E.14—The Education Officer (Estab. 2), County Hall, Westminster Bridge, London, S.E.1.

Junior Student Laboratory Technician (Grade C) in the Department of Morbid Anatomy—The House Governor, St. Mary's Hospital, London, W.2.

Laboratory Technician (Grade III) in the Department of Pharmacology—The Secretary, University College, Gower Street, London, W.C.1, quoting "Pharma/1".

Laboratory Assistant to take charge of the work in either the physics or chemistry laboratories—The Bursar, The College, Cheltenham.

Chemist by the East African Industrial Management Board, Nairobi—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21789/3E.

Technician in the Mozelle Sassoon Super Voltage X-Ray Therapy Department—The Clerk to the Governors, St. Bartholomew's Hospital, West Smithfield, London, E.C.1, endorsed 'Technician'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Catalogues

Chance Optical Glass. Pp. 14+7 plates. (Smethwick : Chance Brothers, Ltd., 1948.)

Periodica : a Catalogue of Periodicals and Journals, Proceedings and Transactions of Institutions and Academies, both British and Foreign, and also an Extensive Radio Library. (Summer Catalogue. Pp. 80. (London : Wm. Dawson and Sons, Ltd., 1948.)

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NATIONAL PARKS IN BRITAIN

THE implications of the revolution in the British system of land tenure which occurred on July 1, 1948, when the Town and Country Planning Act, 1947, came into force, are even yet far from being generally appreciated, although the Act immediately affects millions of property owners. It represents, indeed, a great experiment in social control. Old individual liberties are put in trust for the common good; but few as yet understand the methods of community planning or the discipline which planning requires of them. Nor are the technical implications fully realized—the need for development planners of higher quality and better training, for a new tradition in which economics, sociology and geography are blended with the skill of the architect, the engineer and the surveyor into something at least approaching a science.

The success of the Act depends at all points on the readiness of local authorities to use in the public interest the opportunities it offers them. No longer need the fear of cost to themselves inhibit the use of their powers to prevent bad development. Only experience and the growth of the science of planning can ensure that those powers are used positively and constructively, not merely to prevent bad but also to encourage the best development. Moreover, there is real reason to fear that the Act does not put power in the hands of those best qualified to exercise it from a regional or national point of view. It seems that regional advisory committees are unlikely to maintain even their former persuasive influence, and that there is no intention of creating executive joint planning boards. Until the structure of local government has been organised on even bolder lines than those suggested by the Boundary Commission, the machinery for planning will scarcely match the power at its disposal.

There are two main reasons for uneasiness. The Minister of Town and Country Planning, Mr. Silkin, has always been reluctant to admit that there might be needs which the Act does not meet, and in a recent speech at Cambridge he misrepresented seriously the views of the national park movement in seeking to defend his resolve to reject even the compromise for a national park authority represented by the recommendation of the Hobhouse Report. While he refrained from making suitable provision for national park planning until it automatically became vested in the county councils, he now protests that it would be unreasonable to take away from them what they have so recently acquired.

It has long been plain that the county councils do not accept the essence of the national park thesis: Great Britain is a crowded island; but a few areas must be reserved in which the claims of natural beauty and its enjoyment shall stand supreme. The Southampton Borough Council's proposal to invade a public park in Southampton, against which hundreds of objections have been lodged, is only one recent example which demolishes Mr. Silkin's contention. Such examples could be multiplied indefinitely in London, Manchester and many other places, where although some encroachments might be justified, most are due to the authorities taking the line of least resistance. The natural beauty of Britain cannot long survive such a process of attrition, and a great merit of the pamphlet "National Parks or 'Local Authority' Parks", just issued by the Friends of the Lake District, is that it displays clearly the picture of attrition in one particular area over the last twenty years. On any wide and general view, the Lake District has lost not a little which it can never regain, and has not had the treatment proper to a kind of national property. During the last generation, the best areas of our landscape have suffered steady attrition, and both the pace and the field of injury are increasing.

Even if the local authorities could be expected and trusted to take a national view, it is also clear that, as 'local' authorities, they would be unable to avert the second main danger—that of encroachment from the Departments of State, and especially the Service Departments. Strong opposition has been manifest to the Army's proposed requisition of 1,870 acres of Cannock Chase; opposition which was supported indeed by the Staffordshire County Council. Already the Armed Forces have demanded a gun site near Holy Island, a bombing range at Selsey Bill and battle-training areas across Norfolk and Wiltshire villages, and cynically disregard promises or pledges given during the War. Retention of the areas held at Stamford and at Purbeck for battle-training areas is leading to widespread distrust of the Government's sincerity or even good faith.

Nor is it only the Service Departments that are responsible. Water supply and catchment area authorities, the Ministry of Transport, and the Forestry Commission all sponsor demands which despoil the countryside, and often encroach on areas recommended for preservation as national parks or Nature reserves. Seldom is there any indication of an attempt to consider alternative means of meeting a sectional or local need without detriment to the interests of the nation as a whole. The report of the Gathering Grounds Sub-Committee of the Central Advisory Water Committee on "Public Access to Gathering Grounds and Afforestation and Agriculture on Gathering Grounds" (London: H.M. Stationery Office, 1948. 9*d.* net) constitutes an honourable exception, which deserves special mention. Under the chairmanship of Mr. A. P. Heneage, this committee has brought an admirable sense of national interest to bear on a special problem, and declined to allow unsupported sectional prejudice to prevail. Its recommendations relate to the conduct of the gathering grounds of upland reservoirs where adequate purification processes exist. Arrangements should be made, it urges, to dispose of the sewerage from human habitations, whether permanent or temporary, in a manner that will entirely preclude the possibility of its getting into the reservoirs. Farmyard manure should be prevented from draining directly into feeder streams or reaching the reservoir, and the public should be generally excluded from the banks of reservoirs and no bathing allowed. Fishing and boating may sometimes be allowed at the discretion of the authority, but only under rigorous control. Feeder streams may sometimes require like restrictions; but subject to these safeguards, the land should be put to the utmost agricultural use, and land which is incapable of agricultural use should, if possible, be afforested, but with due regard to amenity and the requirements of adjacent agriculture. Subject to these recommendations, the committee sees no reason for excluding the public from gathering grounds as such. Indeed, the report is a well-deserved rebuke to certain authorities which have relied on such negative restriction rather than on the positive safeguards which are still required even if the public are excluded. Incidentally, the committee was satisfied that many gathering grounds could be put to much greater agricultural production than at present.

Despite the admirable spirit of this report, there can be little optimism at present that due effect will be given to its recommendations in the absence of adequate authority. Provision of the essential requirements for a system of national parks and for co-ordinating at the highest level the competing departmental requirements for land would, of course, meet this requirement incidentally; but even the requirements urged by the Friends of the Lake District will scarcely avail while the Government refuses to establish a more effective authority than an inter-departmental committee, and continues to allow demands for land to be presented piecemeal and without regard either to available resources or competitive national needs.

Whether or not it was the intention that the Minister of Town and Country Planning should act as the co-ordinator in this matter, events have demonstrated that he possesses neither the stature nor the vision to exercise such authority. Meanwhile, it is clear, in view of the probability that the Government's programme for the forthcoming session will include a Bill to secure freer public access to mountains and moorland, to control holiday facilities in national park areas and to conserve wild life, that the essential requirements for an effective system of control should be understood.

The two essential principles outlined by the Friends of the Lake District and in the earlier reports are essentially the same both for national parks and Nature reserves, differing only in the details of application for the two purposes. The first requirement is to concentrate in a specialized body, a national parks commission, the duty of elaborating and maintaining a special code for the parks and Nature reserves. This would provide the means for dealing directly and on more or less equal terms with Government departments and public corporations, and it would also avoid the anomalies which will arise if the control is left with the county councils, as Mr. Silkin suggests, a scheme under which the Lake District would be administered by three, North Wales by four, and the Peak district by four or five separate bodies.

Secondly, on the plane of local planning, the national interest must be introduced by establishing a special park or Nature reserve committee. This would provide a unified planning authority for dealing with each park as a single whole, assessing the national need against local needs. Mr. Silkin himself and other participants in the recent controversy have misrepresented this function, in spite of overwhelming evidence that the local authorities cannot be relied upon to put national interests first, and indeed should not in fairness be expected to do so. In answering that criticism, moreover, the Friends of the Lake District in the pamphlet referred to also dispose of the suggestion that the parks committees, constituted as suggested in the Hobhouse Report, are undemocratic; and they quote pertinent instances in regard to roads, electricity and the National Assistance Board in support of the reasonableness of the Hobhouse compromise. Nor can it well be argued that from the purely administrative point of view the proposed system for national parks cannot be worked side by side with that laid down for other purposes in the Town and Country Planning Act of 1947.

What must be clearly understood at the present moment is that at no level is the necessary administrative machinery established or retained under the new Planning Act to enable a consistent planning policy to be applied either to national parks in general or throughout any one of the principal national park areas designated in the National Parks Committee's reports, or those of the Wild Life Conservation Committee. Even if the local authorities were really interested in national parks and there were not the difficulty of particular parks being the concern of three, four, or five county authorities with widely varying outlooks, populations and rateable values, the administration of such areas puts an unreasonable strain on the loyalties of the councils. County parks they might provide, but not national parks; and there would be no assurance that these parks would be secure against the intrusion of sectional interests, let alone of Departments of State.

It cannot be too strongly emphasized that in little more than a year after the publication of the Hobhouse Report, not only has no action been taken to implement its proposals, but also in the interval further irreparable damage has been done to our dwindling reserves of natural beauty, amenity, flora and fauna; urther, that the conception and prospect of both national parks and Nature reserves have become more seriously endangered than at any time since Mr. John Dower was asked to prepare his report, nd that by Government action—and inaction. It equally true that the new Planning Act, the Requisitioned Land and War Works Act and the White Paper on the Needs of the Armed Forces for Land for Training and Other Purposes, have done more on the whole to alarm than to reassure public opinion, and have to some extent tended to dissipate that considerable measure of goodwill on which the rospects of a general agreement and an effective afeguarding of Britain's heritage of natural beauty nd wild life must be based. In this respect the Government seems to be bent on evading the responsibilities conferred on it, with widespread pproval, by recent legislation.

RADAR, BEACONS AND NAVIGATION BY RADIO

(1) Radar Aids to Navigation

Edited by Assoc. Prof. John S. Hall. (Massachusetts Institute of Technology, Radiation Laboratory Series, Vol. 2.) Pp. xiii+389. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 30*s*.

(2) Radar Beacons

Edited by Prof. Arthur Roberts. (Massachusetts Institute of Technology: Radiation Laboratory Series, Vol. 3.) Pp. xx+489. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 36*s*.

(3) LORAN: Long Range Navigation

Edited by J. A. Pierce, A. A. McKenzie and R. H. Woodward. (Massachusetts Institute of Technology: Radiation Laboratory Series, Vol. 4.) Pp. xiv + 476. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

ALL those who have been in any way connected with the vast developments in radio and radar techniques during the past decade will be familiar with the extensive contributions made during the war years by the staff of the Radiation Laboratory of the Massachusetts Institute of Technology. Much of the basic scientific and engineering knowledge which resulted from these contributions has been collected together by an editorial staff working under the auspices of the United States National Defense Research Committee and is now being published in a series of volumes which has become familiarly known in the radio world as the 'five-foot shelf'. The general design and scope of this publication, and details of the introductory volume to the series, have already been described in *Nature* (June 5, p. 867). The present review is concerned with Vols. 2, 3 and 4 of the series, which together add another three inches to the shelf.

(1). As its name implies, the volume edited by Dr. John S. Hall describes the advantages and limitations of radar technique when applied to the problems of navigation and pilotage, whether the equipment is airborne, shipborne or ground-based. The book is divided into four parts, the first of which is of an introductory nature. An opening chapter on the principles of radar serves to make the book self-contained without reference to the first volume of the series. The second chapter has also been included to give the reader a more comprehensive picture of available techniques, and deals with what are termed non-radar navigational aids. These include various techniques for determining the direction of a sending station, and also the hyperbolic systems that measure range differences such as Decca, Gee and Loran: the latter is dealt with in considerable detail in volume 4 of this series (see below).

The real substance of the present volume begins in Part 2, entitled "Airborne Radar". The four chapters in this section are devoted almost exclusively to the characteristics, design and performance of the type of centimetre-wave radar equipment developed for precision blind-bombing purposes during the War, and now being applied to the navigation of civil aircraft. A series of excellent photographs illustrates the detailed display that can be obtained in this technique with systems of high resolving power used on a wave-length of 1·25 cm. Unfortunately, it has been found in practice that the presence of a water-vapour absorption band precludes the use of this wave-length except in very clear air and at short ranges; and with the longer wave of 3 cm. now being generally adopted, the features presented to the operator or pilot are less distinct, although they still retain considerable navigational value.

Part 3 deals with centimetre-wave radar equipment used on the ground, particularly for the guidance and control of aircraft traffic at and between airports. In this case the restriction on the size of the antenna system which may be used is not so severe as with mobile equipment, and high resolution can be obtained with the longer waves, up to 10 cm., which have been used so successfully for aerodrome approach and landing purposes. Chapter 8 is devoted to the important subject of air navigation and traffic control, which will present problems of increasing importance, particularly in bad weather conditions, as the use of civil aircraft grows in the next decade or so in all parts of the world.

The last two chapters in the book comprise its fourth part, entitled "Shipborne Radar". Much of the material here presented will be more familiar to those who have followed the recent application in Great Britain of centimetre-wave radar to mercantile marine navigation. But it is interesting to have this description of the earlier work done in the United States, upon which are based the corresponding developments there.

Altogether the preparation of this volume by the thirty-three authors responsible for it has been well worth while; but it is perhaps a pity that it was decided not to include a glossary, which would have made things a little easier for the reader who is not very familiar with radar technique and language.

(2) The next volume, by Prof. Arthur Roberts, can be regarded as in a sense complementary to the one referred to above. For a radar beacon is a device which is normally quiescent but which, when 'interrogated' by a suitable pulse-modulated signal from a radar sender, 'responds' by emitting another signal much stronger than that which would have been obtained by reflexion as in simple radar. It is learnt in the first chapter that the radar beacon was invented in 1939 by a group of British workers at the Bawdsey Research Station of the Air Ministry, in response to a need for distinguishing between enemy and friendly aircraft when using radar detection methods. From this simple beginning, the radar beacon was developed during the War for a variety of applications, of a navigational, offensive and defensive nature. This book describes the work on beacons which was carried out in the Radiation Laboratory, where a separate division was organised for the purpose in 1943.

For the general reader the first part of the book, entitled "Basic Considerations", is probably the most interesting. In the course of six chapters, prepared chiefly by the editor, a most useful account is given of the technical possibilities of beacons for ship, aircraft or ground-station use. The methods of interrogation and reply coding to discover, and identify beacons, the synchronization of signals for the determination of their range, and the effects of propagation conditions, choice of frequency and interfering signals are all described in a lucid manner. The sixth chapter deals with traffic and engineering considerations, and discusses such matters as the saturation of the interrogation link and the permissible density of beacons; subjects which are likely to be of great importance in the application of beacon technique to civil air navigation.

Part 2, which comprises about half the book, describes in some detail the component parts of a beacon and their assembly into the complete equipment. The experience and technical progress here recorded should prove invaluable to the engineer responsible for designing a radar beacon system for any purpose. In a similar manner, Part 3 supplies the corresponding information required for the design and development of the radar interrogation system with which the beacons are to co-operate in providing the desired information as to range and azimuth. Typical beacon systems for air-to-ground and ship-to-shore use are described in this part of the book; and brief reference is made to the Shoran precision beacon system, which, although not developed at Massachusetts, is referred to as the most accurate radar system for aircraft navigation to horizon ranges that had been developed up to 1945. In this method the navigator in the aircraft determines his position accurately by measuring range only to each of two fixed beacons at known locations on the ground.

The final chapter, comprising Part 4 of the book, gives a useful account of experience in the choice of sites for beacons on the ground and in ships and aircraft, and in the installation, operation and maintenance of beacons in such situations. In view of the large number of special terms and code letters which have arisen during the development of radar-beacon technique, the glossary given at the end of the book will be particularly welcomed by the student and reader who are not too familiar with this subject.

(3) The fourth volume of the Radiation Laboratory Series describes a long-range system of navigation, which depends upon the transmission and reception of pulse-modulated radio signals, but which differs from radar technique in using much longer waves and in not involving reflexion from a target. The Loran system, developed at the Radiation Laboratory during the War, is a hyperbolic navigational aid in which the position of a receiver is determined by the simultaneous observation of distances from two pulsed sending stations in known positions on shore It has many points in common with the Gee system developed somewhat earlier in Great Britain for the navigation of aircraft out to horizon range and somewhat beyond; but by the use of much greate wave-lengths, or lower frequencies, Loran provided a means whereby ships, as well as aircraft, could be navigated to distances of from 500 to 1,500 mile using both ground and ionosphere-reflected waves The progress made in the exploitation of the Loran system in America was very rapid, and at the end o the War some seventy transmitting stations were in operation in various parts of the world, and detail of these are given in an appendix to the book.

The purposes of the present volume are to describe first, the principles of the Loran and its possibilitie as a means of navigation over considerable distances and secondly, to record in some detail the positio which the development of the necessary equipmen had reached at the close of hostilities. After a introduction and a brief account of the history o the subject, the third chapter describes the principle of Loran, based on the measurement of the relativ times of arrival of received pulses emitted alternately with a known delay interval, from two fixed sendin stations. Both stations are equipped with cryst oscillators which define the pulse recurrence-rate, bu one of the pair acts as the master and is used t regulate the oscillator of the second or slave station. Assuming a knowledge of the speed of the radio waves and of the paths along which they travel from sending to receiving stations, then the relative distances of the two fixed stations can be determined to a very high accuracy from the time observations made at the receiver. The carrier frequencies chiefly used in the practical development of the system were about 2 Mc./s. for the standard Loran and 180 kc./s. for low-frequency Loran. In Chapter 5, the propagation of waves at these frequencies is discussed, first with the view of demonstrating that for ground-wave transmission the maximum useful range is about 700 miles at the higher of the above frequencies and about twice this distance at the lower frequency. Consideration is then given to the propagation of these radio waves through the ionosphere and the consequent effect of diurnal and other variations on the received observations. Much empirical information has been collected together in this chapter, and this will probably repay further study in connexion with the future application of this system of navigation. Chapter 6 deals with methods of computing the tables and charts which form such an essential part of a practical system of navigation, where the operation of converting the radio observation into a charted position must be accomplished as quickly and as simply as possible. It is stated in the preface that, up to the end of the War, the U.S. Hydrographic Office had prepared and issued two and a quarter million of the special hyperbolic charts required by the agencies operating the various chains of Loran stations.

The second half of the book, comprising the last six chapters, deals in some detail with the various items of equipment and technique forming the complete system. These chapters, like the remainder of the book, are profusely illustrated with diagrams and photographs, and give clear descriptions of the transmitting and receiving equipment, the antenna systems, and particularly of the special techniques and apparatus used for regulating and timing the pulse-modulated waves. Appendixes devote further space to discussion of the geometry of the Loran system and to the determination of errors in the positions of the transmitting stations. A classified bibliography occupying twelve pages is given at the end of the book: a very small proportion of the references are to normal technical publications, the great majority being to the special reports and instruction manuals which were produced during the war years by those responsible for the development of the various phases of this new and successful means of long-range navigation.

Altogether, these three volumes form a noteworthy and most welcome addition to radio literature and will ensure that much of the specialized knowledge and experience gained at the Massachusetts Institute of Technology during the war years is readily available to future workers in this subject. The preface to two of the books and of others in the same series concludes with this sentence: "The publishers have agreed that ten years after the date on which each volume of this series is issued, the copyright thereon shall be relinquished, and the work shall become part of the public domain". Sixty-five contributors to these three volumes have achieved, in the words of a previous reviewer, "a brilliant and amazingly successful piece of co-operative authorship", and the radio, scientific and engineering world is indebted to them for their efforts. R. L. SMITH-ROSE

POPULATION POLICY IN GREAT BRITAIN

Population Policy in Great Britain

A Report by P.E.P. Pp. viii + 228. (London: Political and Economic Planning, 1948.) 15s. net.

ARE the British people able and willing to maintain their numbers, and is it desirable that they should? If, as anticipated, the reply is affirmative, how can we ensure that our children shall be naturally well endowed and properly equipped as members of society to face the difficult years ahead? P.E.P., in answer to these basic questions, assumes that British society will remain democratic in its devotion to individual freedom and that the principles and practice of a future population policy—unfortunately, not yet even dimly discernible!—will be in harmony with our traditions.

In the decade that preceded the Second World War, British opinion was roused by contemporary prophets to the dangers of depopulation, then forecast as ultimately certain if not imminent. In these immediate post-war years, however, the prediction has been at least temporarily disturbed by a buoyant birth-rate, notably that of 1947, which was higher than for any previous year for a quarter of a century. The report depends on the assumption—to P.E.P. the only prudent one in the light of all the available evidence over a prolonged period—that, notwithstanding temporary spurts of fertility, the total number of people in Great Britain by 1970 will have become stationary or will be on the decline. (In such predictions the non-intervention of unforeseen, cataclysmic events is, of course, assumed.) The report, in eloquent appreciation of the danger to the nation and patriotically inspired, hopes to stimulate Britain to a reversal of the expected calamitous decline in both numbers and national vigour.

In the light of racial and cultural affinities, it comes, with no surprise to learn that population trends in Britain closely resemble those of our nearest continental neighbours. Britain's problem is that of all Western Europe, as nowadays the region is politically and ideologically conceived, and our international colleagues seem no more prepared than we are to meet the challenge of a falling birth-rate. The position in Eastern, Slavonic, Europe is notably different and likely within relatively few years to alter the balance of man-power in the Old World. From the Office of Population Research of Princeton University comes the estimate that, whereas in 1940 in Europe (without the U.S.S.R.) the percentage of total man-power made up of men of fifteen to thirty-four years was little more than 50, in the Soviet Union it was 61; and the forecast that in 1970 the advantage of the great eastern Power will be even more. As the report under notice tersely remarks, the political and economic implications of these estimates require no emphasis.

For Western Europe alone, the report fails to underline the important differences in geographical fortune between the various countries: it deserves emphasis that Britain, apart from Belgium, is easily the most densely populated of the occidental Powers, its economic and social prosperity more vulnerable than that of any to the threat from an ageing population. The assumption that Britain is not overcrowded, but rather the victim of a geographically unbalanced distribution of its inhabitants which can and will be corrected, would seem to be too readily accepted; as also the likelihood of our being able to disperse the almost unparalleled congestion of our towns, preserving at the same time both the agricultural soils—our richest material possession—and the scenically attractive zones of Britain on which the physical and mental health of the nation increasingly depends. The suggested alternative to the establishment of new urban centres at Crawley, Stevenage, etc., of their transference to the under-populated Dominions, shows the authors to be aware of the possible danger which some observers consider inevitable in the present official policy of 'new towns for old'.

There is much valuable discussion of an 'optimum' population, without, however, an approximation to the most advantageous total for the British Isles. That it should be larger than the present and continue to expand—with an average of 2·5 children per family—is regarded as axiomatic; indeed, on that basis the entire argument and consequent proposals rest. Yet there is neither criticism nor discussion of the recent assertion of an official Australian spokesman (here quoted) that "the best population for Britain would be 30 millions". There is commendable insistence, however, that the attainment of a numerical target is not so vital as the removal of existing obstacles to parenthood and an improvement in the quality of the population.

In these critical years the youth of Britain, whose welfare is the *sine qua non* of the nation's vigorous survival, seems likely to be tempted away on a scale of emigration unknown since the trans-Atlantic migrations of the late years of the nineteenth century. Largely in consequence of the two World Wars, the new countries which exert a powerful 'pull' on British youth have passed from being debtor to being creditor nations, able to provide capital for the opening-up of their undeveloped territories and for large-scale settlement. But Britain, after two generations of declining fertility, can no longer be complacent at the prospect of losing by emigration the youngest and most enterprising of its citizens. The Dominions should be prepared for the proposal that large-scale migration from our shores should represent a cross-section of the British population, both by age and occupation. How this could be effected without recourse to compulsion would inevitably be one of the more urgent topics for the consideration of the research institute for Commonwealth population questions, the establishment of which is one of the many wise proposals of the report.

Although the mortality-rate and the expectation of life in Britain leave scope for improvement—as New Zealand's superior figures under both headings show—they are satisfactory when compared with those of the great majority of Western nations, and it is not in these directions that anxiety exists. Both popular impression and investigation of the causes of the decline in the natural increase of our population leave no doubt that easily the most potent of these causes is the voluntary limitation of families by parents whose motives, however accurately guessed, cannot be certainly known without the thorough investigation now demanded. It is certain, however, that the practice of family limitation has spread from the class of highest social status to the lowest, and that with it has gone a narrowing of the gap between both their respective birth-rates and their respective cultural standards.

That parenthood is increasingly a matter of choice must be positively welcomed; but only so long as it is inspired by confidence in the destiny of both the nation and the civilization it represents. Without this sense of destiny on the part of the community, the work of the social reformer inevitably meets frustration; which certainly is an aspect of the population problem requiring the most earnest attention.

WALTER FITZGERALD

HERBS AND DRUGS

Drugs from Plants

By Dr. Trevor Illtyd Williams. (Sigma Introductions to Science, 10.) Pp. 119 + 12 plates. (London: Sigma Books, Ltd., 1947.) 6*s.* net.

THE popular appetite for information about the healing virtues of plants has been abundantly catered for by books written from the angle of herbalism. It is a long and honourable tradition, and few incidents in the history of science can be better known to the layman than the original stimulus that came to the study of plants from the appreciation, however imperfect, of their value to medicine. Unfortunately, the outlook of these modern near-herbals remains medieval, and little popular attention has been directed to the large number of important vegetable drugs in the modern pharmacopœias and to the fact that their number, as witness curare and penicillin, is still increasing. There is undoubtedly room for a book that will do something towards making clear to the layman the distinction between herbs and plant drugs.

In a series of introductions to science this title is an excellent, indeed almost an inevitable, choice; and the main problem confronting the author has been that of selection from the riches offering themselves. Plant drugs are of all degrees of significance, from morphia, without which, it has been said, few would be willing to practise medicine, to valerian, about the usefulness of which practitioners still fiercely argue. With only 119 pages at his disposal, the author has followed the sensible plan of selecting a few pre-eminent examples for discussion, and his choice has fallen upon quinine, followed by digitalis, penicillin, ergot, opium and cocaine. The last two raise the problem of drugs of addiction, and the author has added hashish (marihuana) for good measure. Other important plant drugs are briefly catalogued in a single chapter.

The author states his opinion that works of popular science should be entertaining; and it is also evident that he believes a dreadful example should live up to its name. The subject in hand lends itself so readily to sensationalism that in an account addressed to non-technical readers it is hard to know where an objective statement of fact ends and a desire to horrify begins. Suffice it to say that neither the author nor this reviewer has flinched.

On its technical side the subject straddles chemistry, botany, pharmacology and half a dozen other related arts and sciences. This is a formidable list for any publicist to tackle. His apprenticeship to chemistry has enabled the author to do what may be done towards explaining to laymen the structural chemistry of the very complex substances involved. He has not always been so happy in other branches. References to 'female flowers' have got many a botany student into trouble; *Atropa belladonna* is not a tree, and its leaves contain about a twentieth of one per cent of total alkaloids, not "½ per cent of pure hyoscyamine". Other statements calculated to cause a similar degree of discomfort to botanists occur here and there. Pharmacologists in Britain rarely use cats to standardize digitalis preparations; frogs are generally used. More important, since it involves an analytical principle, it is no longer correct to say that the unit of potency is defined as the quantity of digitalis necessary to stop the heartbeat of an anæsthetized cat or to kill a frog. It is defined as the potency of unit weight of an arbitrarily selected and carefully maintained standard preparation.

This little volume is not a technical handbook, and such inaccuracies are therefore of small account. What is valuable is its method of approach; and the layman who wishes to get a first appreciation of 'Nature's remedies' may do so here along sound lines.

W. O. James

DEVELOPMENT OF SYNTHETIC RUBBER IN THE UNITED STATES

Buna Rubber

The Birth of an Industry. By Frank A. Howard. Pp. xii + 307. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 21*s*. net.

THE author of this excellent book was, until his retirement in 1945, vice-president of the Standard Oil Co. (N.J.), of which he was principal executive for more than twenty-five years, directing and organising research, technical development and other related activities. He is probably the only man who is in a position to tell the story of the birth and development of the synthetic rubber industry in the United States, and he does so with a detachment which makes one almost forget that he was in the centre of the stage during the whole of the time and that, but for his faith and persistence, synthetic rubber might not have been produced in the United States in time to prevent a calamity.

The book falls naturally into two parts, the first dealing with the period from 1919 until 1939, and the second with the war years.

Co-operation between the Standard Oil Co. and its subsidiaries of America and the I.G. Farbenindustrie of Germany led to the formation in 1929 of a joint company, the Standard–I.G. Company, for he purpose, among other things, of enlarging co-operation in research and development on new products and processes. The final result of this co-operation brought to America the technique of he preparation of Buna *S*, an all-purpose synthetic rubber better known in Britain as *GR-S*, obtained by the copolymerization of butadiene and styrene.

The author tells how he instigated the original approach to the German company and of the liaison work which he afterwards carried out. He had realized in the early 'twenties the enormous potential value (to his country) of an all-purpose synthetic ubber, and his Company tried to interest rubber manufacturers in Buna *S*. Quite naturally, however, hey were apathetic, as there were ample supplies of he natural product, and the Government was not prepared to subsidize the necessary development work even after the start of the War in Europe. Howard tells with what sense of urgency he and his colleagues regarded the necessity for the setting up of a synthetic rubber industry and how, in the face of general apathy, his Company decided to erect the necessary plant for the manufacture of Buna *S* on a small scale.

Even after Pearl Harbour, all their efforts to get this vital material made on a large scale came to nothing time and time again, until the setting up of the Baruch Committee in August 1942; and the resulting appointment of a rubber director with absolute power cleared away all the difficulties, with the result that in a very short time the American synthetic rubber industry was among the largest in the country.

This book is so outstanding that it is unfortunate that, in Great Britain at least, the title may have the effect of limiting its readers to rubber scientists; but it is so well written and tells its thrilling story in such a clear and unprejudiced manner that it should command a much wider audience.

The printing and binding are first-rate and the only errors detected were "Briton" for "Britain" in what may be considered a controversial passage on page 110, and the spelling of the surname of Wallace H. Carothers with a 'u'. The appendix of 51 pages will be much appreciated by those readers who wish to delve more deeply into the history of Buna *S*.

C. W. Long

PROCESS HEATING IN INDUSTRY

Industrial Applications of Infrared

By James Doyle Hall. Pp. x + 201. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 21*s*.

IN 1938 publicity was first given to the use of radiant heat from electric lamps for the acceleration of paint drying. Since then the technique has been developed and extended, and now radiant heating is being used in many different industrial processes. Other sources of heat have been introduced. The present book, written by a lamp engineer, is concerned primarily with the use of electric lamps; and it describes in some detail the properties and design of lamps, reflectors, conveyors and other associated equipment for a very wide range of applications. A most notable feature is the inclusion of more than a hundred illustrations of working installations.

A few pages are devoted to 'radiant cup' gas burners; but no mention is made of the radiant plate type of oven which is quite common in Great Britain; nor is there any reference to the industrial use of electric heaters with nickel–chromium elements for giving higher intensities of radiation than are possible with lamps.

Within the limitations which the author has set, the book presents the case for radiant heating in a clear, attractive and readily usable manner, and it should be of considerable help to production engineers. It does, however, suffer to some extent from its own limitations. The case for lamp heating might have been stronger if the book had included a balanced comparison with other methods of process heating which are widely used in many of the fields discussed in the book.

M. R. Gavin

The Journal of the Institute of Metals

Vol. 72, 1946. Edited by N. B. Vaughan. Pp. lvii+732+80 plates. (London: Institute of Metals, 1946.) £3.

VOLUME 72 of the *Journal of the Institute of Metals* contains 721 pages of text together with an index occupying another ten pages, and fully maintains the high standard expected from this publication. Practically every aspect of non-ferrous metallurgy coming within the scope of the Institute is represented in the twenty-six papers, together with the discussions and correspondence upon them. To the metallurgist, the engineer, and the physicist concerned with the fundamentals of the metallic state alike, there is a direct appeal. The presidential address of Col. P. G. J. Gueterbock is of more than normal interest to those concerned with the health of the metallurgical industry as a whole, and the thirty-sixth May Lecture by Prof. N. F. Mott illuminates the relationship between atomic physics and the strength of metals. Of the remaining papers, the effects of residual stresses are considered in relationship to the fatigue of aluminium alloys; and Lunt and MacLellan give a detailed mathematical treatment of the wire-drawing process. H. W. L. Phillips deals at length with the alloys of aluminium containing magnesium, silicon and iron, and has an interesting account of the application of some thermodynamic principles to the liquidus surfaces of these materials. Corrosion problems, which have always interested the Institute, are dealt with in four papers, of which one may perhaps particularly mention that of Dr. Cuthbertson on the resistance to sea-water corrosion of some α-tin bronzes. The structure of ingots and castings is the theme of three papers; ageing effects of three more, and fatigue problems crop up repeatedly. There will, in fact, be few concerned with non-ferrous metallurgy to whom some of the contributions are not of direct appeal.

Considering present-day difficulties, the editor and his staff are to be congratulated on an admirably produced volume, and on the illustrations, which, as usual, attain a very high standard.

Swelling and Shrinking

A General Discussion by the Faraday Society held at the Royal Institution on 24th, 25th and 26th September, 1946. (Transactions of the Faraday Society, Vol. 42B.) Pp. 304. (London and Edinburgh: Gurney and Jackson, 1946.) 20*s*.

THIS publication brings together the series of thirty-four papers read at the Royal Institution meeting in 1946, together with summaries of the discussion which took place and some subsequent communications. An account of the discussion appeared in *Nature* shortly after the meeting (**158**, 571; 1946), and need not be duplicated here. It is only necessary to commend this volume as a most useful reference book for all who are interested in any aspect of the physical interaction of polymers with liquids. The field covered is extremely wide, ranging from aqueous systems possessing a well-defined structure which can be studied by X-ray methods to non-polar systems in which the components show a close approximation to random mixing.

As usual in the Faraday Society discussions, the subject is covered in an extensive rather than an intensive manner. This volume will therefore be found extremely useful as a first source of information, and it serves this purpose the more admirably in view of the fact that specialists from so many different fields have contributed, thus bringing together under a single cover papers which might otherwise have been scattered through a wide diversity of journals.

Visages de la mathématique

Essai de semi-vulgarisation de quelques aspects fondamentaux de la pensée mathématique. Par Dr. Pierre Defrise. Pp. 126. (Bruxelles: J. Lebègue et Cie., n.d.) 60 francs.

MATHEMATICAL research has two aspects. The more obvious is the solution of problems which arise in the branches of the subject already known. But there is also the logical and philosophical study of the foundations of mathematics, and of the relation between its different branches. Strangely enough, it is the second aspect as well as the first which is indispensable for a full understanding of modern physical theories, such as relativity and quantum mechanics. Dr. Defrise believes that a real understanding of science is impossible without at least a general idea of this second aspect. He has therefore tried to give a treatment of non-Euclidean geometry, the 'axiomatic method', the theory of groups, invariance and transformations, in a form requiring no knowledge of mathematics beyond the ordinary school course and suitable for the non-specialist reader. But this reader must possess a logical mind and a capacity for abstract thought which are not characteristic of 'the man in the street' in Great Britain, whatever is the case in Belgium and France. However, the reading of this little book would be very profitable, if not always very easy, to teachers of elementary mathematics in Britain, as Dr. Defrise's emphasis is on that aspect of geometry which is entirely omitted from our ordinary school course. H. T. H. PIAGGIO

A Picture Book of the Whole Coast of England and Wales

An Account of Variety in Scenery and its Causes. By J. A. Steers. Pp. vii+36+148 plates. (Cambridge: At the University Press, 1948.) 10*s*. 6*d*. net.

THE first Minister of Town and Country Planning commissioned Mr. J. A. Steers to carry out a personal survey of the whole coast-line of England and Wales and to present an assessment of its varied scenery which might serve as a guide should legislation to conserve the coast from further spoliation be regarded as necessary. The results of the survey were published as a large volume, "The Coastline of England and Wales", issued by the Cambridge University Press. In order to make the unique collection of 115 photographs available to a wider public, the publishers have reproduced them, together with thirty-one others and two colour-photographs, in this attractive picture book. A map shows the position of each picture, and there are brief notes on each; while in fifteen informative pages the author has dealt with the chief types of coast and the origin of each. The photographs are remarkable in that they avoid hackneyed subjects and often present well-known views from an unusual angle. The Royal Geographical Society has permitted the reproduction of the map assessing coastal scenery, and Dr. Fraser Darling contributes an introductory essay. The result is a book which can scarcely fail to whet the reader's appetite for a taste of the larger volume.

L. D. S.

COLOUR VISION

DURING the last few years, an air of dissatisfaction has become apparent in some quarters over the adequacy of the orthodox colour vision theories to explain the facts. There has even been some dispute about the facts themselves; but there is at least agreement that since one wave-length can be distinguished from another by its colour, some mechanism of colour discrimination must exist in the retina. All the theories have something in common, in that they all assume that there must be more than one type of receptor in the retina, the types differing, *inter alia*, in their spectral sensitivity. Given these different receptor types and assuming that they can send messages to the brain which give rise to distinctive colour sensations, then we evidently have the essential ingredients for a colour discrimination mechanism. Current argument is largely concerned with the probable number of these distinctive receptors, ranging from the two anatomically distinct types as suggested by Dr. E. N. Willmer on histological grounds to seven as postulated by Prof. H. Hartridge in his polychromatic theory. Three has previously been the most popular figure—a choice stemming from colour-mixture experiments.

This question was the subject for a full-day discussion in Section I (Physiology) of the British Association during the recent meeting at Brighton. The discussion was opened by the presidential address to the Section given by Prof. H. Hartridge, in which he elaborated the arguments in favour of at least seven different receptors. He referred to a number of phenomena which he felt were inadequately explained by existing theories, among them the suppression of the colour fringes which must be formed around the image of a point source of light according to reliable data on the chromatic aberration of the eye, and also the changes in colour which occur when the angular size of a test object is reduced, particularly the change from yellow to white and blue to black. The suggestion that this was due to the blue-blindness of the central fovea could not, he said, be upheld, since similar changes were observed all over the retina; moreover, the changes could be reversed by increasing the intensity of the stimulus.

Another piece of evidence which was difficult to reconcile with the trichromatic theory was the notch in the luminosity curve in the yellow part of the spectrum, as observed by Sloan and by Wright under certain conditions of reduced field-size and reduced illumination. The explanation, as he conceived it, was the existence of a yellow receptor which, when the stimulation was reduced, became inactive and consequently left a dent in the luminosity curve. He also felt that the colour-mixture curves—the dichromatic coefficient curves—obtained by Willmer and Wright under small field conditions were so different from the normal trichromatic coefficient curves that they could not be interpreted merely in terms of the inactivity of only one receptor out of three.

One difficulty faced by any theory postulating a number of different colour receptors was the close similarity in the value of the visual acuity obtained both for white light and for various monochromatic lights. It might be expected that stimulation with monochromatic light would leave a considerable proportion of the retinal receptors either inactive or with greatly reduced activity, so that there would in effect be considerable gaps between the receptors actually functioning. This might be expected to lead to a marked loss of resolving power, and Prof. Hartridge was not prepared to accept the idea that involuntary eye movements caused the image of an acuity test object such as a Landolt ring to be scanned by the retinal mosaic, in much the same way as a television picture is scanned. He considers that the evidence on eye movements at present available does not support the idea that any such scanning takes place.

Moreover, when he studied the question of the fixation areas of the retina used for different colours, he has found from experiments with his microstimulator that different areas appeared to be used for different colours, and he claimed to be able to map out such fixation areas on his own retina. Also, as had been suggested many years ago by Holmgren and by Fick, a small white point of light appeared in different colours according to the point on the retina used to view it.

For these and other reasons, Prof. Hartridge believes that the different colour receptors tend to be arranged in clusters and that while there are three main types of receptor—orange, green and violet receptors—there are in addition a smaller proportion of red, yellow, blue-green and blue receptors. He visualized them as having fairly narrow spectral sensitivity curves on the lines of the modulator curves reported by Prof. Granit, and although he conceded that foveal vision might be nearly trichromatic, he believes that the peripheral retina is certainly polychromatic.

Following the presidential address, shorter papers dealing with different facets of the same problem were given by Dr. K. Tansley, Dr. W. D. Wright and Dr. E. N. Willmer. Dr. Tansley reviewed the electrophysiological evidence provided by Prof. Granit's experiments. She emphasized that the existence of a receptor mechanism with a sensitivity which varied with wave-length was not in itself evidence for a colour perception mechanism, and she also pointed out that although the nerve impulse records obtained by Granit were single fibre records, the condition of stimulation in which a large area of the retina was illuminated made it virtually certain that the response was, in fact, the integrated and interacting resultant from a number of receptors. Studies on a variety of retinæ—snake, frog, cat, etc.—had revealed not only the scotopic sensitivity curve associated with the rods and the photopic sensitivity curve associated with the cones, but also much narrower curves described by Granit as modulator curves. These curves were sometimes recorded as humps on the broader sensitivity curves, sometimes as individual narrow curves; they had also been derived from a comparison between the sensitivity of the retina before and after light adaptation. Some seven modulator curves had been reported altogether, although only in the case of the cat had all seven been found in the same type of retina.

As a result, however, of the development of a polarizing technique in which records were obtained from a retina while a polarizing electric current was being passed across the retina in a given direction, Granit now appeared to be of the opinion that these seven modulator curves were in reality the result of interaction between three groups of receptors the maximal sensitivity of which occurred in the spectral regions of 450, 520 and 610 mμ.

Dr. Tansley acknowledged that these conclusions could only be extended to human vision, particularly human foveal vision, with some hesitancy; because whereas the cat's retina, for example, exhibits elaborate cross-connexions, the human fovea has much more direct connexions between receptors and optic nerve fibres. It was also true, as was mentioned in the discussion, that the animals investigated by Prof. Granit were not believed to possess colour vision; but Dr. Tansley explained that the micro-electrode technique had in practice proved much more difficult to apply to a retina such as that of the pigeon, which was capable of colour discrimination.

Dr. Wright dealt with the elements of colour-matching phenomena, and showed that, even if there were a yellow receptor, the sensation of yellowness could not be uniquely associated with its stimulation, since yellowness can also be produced by a mixture of monochromatic red and green radiations and therefore by the combined activity of the red and green receptors. It followed that any phenomenon observable with a yellow pigmented surface as test object must certainly involve the red and green receptors, since such a surface reflects light over a wide band of wave-lengths from the red to the green region of the spectrum, and the yellowness of the surface would arise primarily from the simultaneous activity of the red and green receptors. Thus the change from yellow to white with field-size could not be associated either with the presence or absence of a yellow receptor and could provide no evidence for or against such a receptor.

Again, the fact that the additive mixture of red, green and blue radiations produced colours which were too desaturated for an exact match of the colours in the spectrum was easily explained on the assumption that no physical stimulus, particularly no green stimulus, was capable of stimulating only one receptor and therefore of giving a physiologically pure response. This would naturally be the case if the sensitivity curves of the trichromatic theory were broad curves overlapping to some considerable extent. It was, in fact, quite easy to explain the calculations associated with colour-mixture experiments by analogy with an alloy having only three constituent metals.

Three processes were thus adequate to explain colour-matching phenomena and gave the simplest picture of a suitable mechanism, although trichromatic colour matching did not in itself prove conclusively that more than three types of receptor were impossible. The strongest positive argument for only three processes came from the stability of a colour match under a wide range of light and colour adaptations. If more than three processes were involved, then it would not be expected that as their relative sensitivities were changed in various ways by different adaptations, the same combination of only three stimuli would continue to provide a match of any given test colour.

Dr. Willmer approached the subject from the histological and anatomical point of view, and had been led to his hypothesis in an endeavour to explain colour perception in terms of the two types of receptor known to exist in the retina—the rod and the cone. He accepted the need for three mechanisms to satisfy the requirements of colour-matching data; but regarded the third process as arising from a distinction between the sensitivities of more centrally placed high-threshold rods and peripheral low-threshold rods, and from high-threshold rods working in combination with cones, as rod-cone units. He referred to the three chief types of bipolar cell as described by Polyak, namely, the midget, the flat and the mop bipolar, and suggested that these might be associated with the three processes. The absence of the mop bipolar in the central fovea would fit in with the dichromatism and tritanopic character of this area of the retina; but the validity of his theory hinged very much on the question of whether the fovea was populated purely by cones, or whether receptors that he has described as high-threshold rods were also present. On this point he considered the evidence was inconclusive. He also referred to Prof. W. E. Le Gros Clark's work on the lateral geniculate body where, from studies of the degeneration following lesions or damage to the optic nerve, three distinct cell groups had been observed. From considerations of their anatomical association with particular areas of the retina, Willmer suggested that group *a* of larger cells might be linked with the blue receptors (low-threshold rods) outside the central fovea, while groups *b* and *c* of smaller cells were linked with the green (rod-cone units) and red (cones) receptors both in the fovea and extra-fovea.

In the general discussion which followed, the merits of these arguments were considered at length, and it was apparent time and again that the impossibility of linking a given subjective phenomenon with a specific physiological process left the door wide open for speculation. This was illustrated, for example, by a reference to the Stiles–Crawford effect of the directional sensitivity of the retina. Until the origin of the directional sensitivity is known, the variation of the effect with wave-length can scarcely be used as very strong evidence for either this or that theory.

Prof. R. A. Morton brought the discussion to earth when he described the possible photochemical substances which might exist in the retina; and while he suggested, for example, that it was possible that retinene could exist in different ionic states in the retina, yet it was hard to believe that more than three, or at most four, light-sensitive substances could co-exist there at the same time. He pointed out that since these three or four substances might fade at different rates, the different combinations that might occur at different times could give the illusion of more than three or four primary substances. In reply to a specific question from Prof. Morton, Prof Hartridge hesitated to claim that there were sever distinct light-sensitive substances in the retina; yet if the polychromatic theory were correct, there would presumably have to be some distinctive chemica characteristics which differentiated one receptor from another.

Prof. Morton admitted that the photo-chemists had been given a clear challenge to discover what light-sensitive substances were to be found in the retina, and we have probably to become reconciled to the idea that until the more objective methods of histology, chemistry and electro-physiology have unravelled more of the secrets of the retina, theories of colour vision must remain more or less speculative. So many odd phenomena have to be explained, some quite trivial, some of fundamental importance, that the protagonist of any theory would have a hard task to convince the sceptics that his theory was complete in every respect, and he would probably be unwise to attempt it.

MARINE FISHERIES OF GREAT BRITAIN

ON September 13 a symposium on fisheries was held by Section D (Zoology) of the British Association, under the chairmanship of Prof. H. Graham Cannon.

Mr. Michael Graham opened with a paper on the theory of fishing, as it had developed since T. H. Huxley's common-sense dictum of 1883. This was that if natural mortality took more fish than the fishermen did, it was useless to regulate fishermen, whose efforts had no appreciable effect on the number of fish in the sea. In the meantime, history has shown that, in the demersal fish stocks near the British Isles, there is a persistent downward trend in catch per unit of effort, culminating in a chronic state of no profit in the 1930's. Marking experiments gave returns of 36 rising to 40 and 55 per cent of plaice returned within one year of marking. In order to put the facts in their places, it has been necessary to develop a theory of fishing. Now that eleven nations have signed the agreement of 1947, by which they will take a variety of useful measures as a start, it is necessary to state the theory in the universal language of mathematics, so that all parties can assess precisely what is advocated. The theory, as developed by the Ministry of Agriculture's Fisheries Laboratory at Lowestoft, began with Huxley's dictum about natural mortality and mortality by fishing; and added the factor of growth, because it is a fall in weight rather than in numbers that hurts the fishermen. The latest form of the theory is an equation by Beverton and Holt, which enables conservative measures, such as mesh regulation and control of fishing power, to be measured against each other in terms of the steady yield that would be obtained under different conditions. Attention was directed to Huxley's attack on any regulations that were not supported by strong evidence, and it was emphasized that the onus for showing the need for regulation should always lie on those who advocate it.

It was, therefore, quite in keeping that Mr. E. Ford should follow with a paper directing attention to the strong individualism of fishermen, as perhaps their most marked common trait. He has found the same individualism in fishery research workers, and said he suspects that it is also characteristic of fish! Mr. Ford made it clear that he regards these manifestations as important, and pleaded against their submergence in team-work. The chairman supported him in this; the present writer had not the opportunity of pointing out that strong individualism is characteristic of the members of all good teams, as may be checked by observations in any cricket pavilion. Probably Mr. Ford and also the chairman meant to attack petty hierarchies. It was clear that, as Mr. Ford sees it, the main problem of organisation of research, or of any other activity, is the use and encouragement of individuality, not its smoothing or repression. As it was put to 'Alice', "What does 1 + 1 + 1 . . . make?"; and Mr. Ford sees each 1 different from the others. It is respectfully suggested that the answer to this problem is the team, as properly understood.

In refreshing contrast to the preceding two papers, Mr. G. A. Steven gave a straightforward account of a piece of descriptive fishery research, namely, the elucidation of the seasonal cycle in the mackerel of the Celtic Sea. Contrary to general belief, the main spawning ground of the mackerel is in an area as big as Cornwall, lying over the edge of the continental shelf south of Ireland. Spawning takes place in summer, shifting to the eastward from April to June; but the movement of fish successively joining it is westerly. During the winter, the mackerel is a demersal fish, lying near slopes in the depth contours, for some reason as yet unexplained. Turning to races of mackerel in other parts of the world, Mr. Steven has found evidence of a similar behaviour pattern, correlated with depth, but naturally producing superficially different appearances where the depth contours are differently orientated. Thus, spawning in the Skagerak is crowded in to the coast, and so on. Prof. W. Garstang expressed the pleasure of the meeting at listening to Mr. Steven's vivid account of this work, and referred to his own interest in the subject more years ago than he claimed to remember. As a fishery naturalist at Plymouth, he had found that while all the European mackerel populations resemble each other closely, the North American mackerels are distinguished clearly, in samples of as few as a dozen, by having more spots in their pattern, and in other meristic characters.

Prof. J. E. G. Raymont gave an account of the now famous experiments on fertilization of Loch Sween, especially of the effects in increase of fauna of the loch bed—Chironomids, *Cardium*, etc. Bar the possibility of the effects being by ill-chance due to natural fluctuations—a point raised later by Dr. Cole in discussion—the results showed very clearly how fertilization with nitrate and phosphate had led to notable increases in benthos, time-lagged compared with the increases in plankton, and persisting for a year or so after fertilization had ceased. Increased growth of flounders and plaice followed, achieving values equal to the best natural areas. Prof. Raymont called for extension of the work to an inshore area of the more open sea; but in the discussion that followed, doubt was expressed whether a suitably self-contained area could be found.

For Mr. A. R. Margetts and himself, Mr. S. J. Holt read a paper on the effect of the War on the stock of plaice. Using Beverton and Holt's equation, already given by Mr. Graham, they had worked out what the density of plaice at the end of five years rest from fishing should be, on the basis of data of growth and mortality from the inter-war period. The estimate agreed fairly well with the actual density in 1945, obtained by back extrapolation from 1946, in which year the series of observations was renewed. However, not all the plaice in the North Sea enjoyed a respite from fishing. The younger fish on the eastern side of the North Sea suffered increased fishing from an augmented Danish fleet. The resulting thinning probably accounted for the increased growth-rate found in the younger fish, and it was only after the necessary allowance had been made that the theory gave precisely the same result as the actual, namely, five-fold. In order to take account of changes in growth-rate with changed density of stock, resulting from changed fishing-rates, the authors had used conclusions from Dr. Ben Dawes' experiments on growth of plaice in relation to food supply, supported by Margaret Brown's work on trout. With these they again applied the equation for the yield of a fishery, but with the plaice in the position of the fisherman, and the food of the plaice as its 'fish'.

In the symposium as a whole, the present writer got the impression that many zoologists preferred the more robust factual papers, and regretted the necessity for mathematical theory—useful as it has been in the more delicate and abstract sciences of physics and chemistry. MICHAEL GRAHAM

INBREEDING AND HYBRID VIGOUR IN CROPS AND LIVESTOCK

AT the British Association meeting in Brighton, Sections M (Agriculture), K (Botany) and D (Zoology) held a joint discussion on September 10 to discuss "Inbreeding and Hybrid Vigour in Livestock and Crop Improvement". The chair was taken by Sir John Russell.

The symposium was opened by Dr. J. M. Rasmusson, director of the Swedish Sugar Company's Breeding Institute, at Hilleshög, Sweden, with an account of his extensive work on the improvement of Swedish sugar beet. The chief effects of inbreeding sugar beet are to increase genetical homogeneity and to decrease productivity. At the same time, the adaptability of the plants to varying environmental conditions is lowered while the effects of environmental differences are increased: the plants are, in fact, less able to tolerate and adjust themselves to changes in external circumstances. The chemical constitution of the root, an important consideration in sugar beet, is scarcely affected by inbreeding.

The chief value of inbreeding is therefore to produce lines with specific and reliable features. It may also be of use in isolating lines in which troublesome associations between desirable and undesirable characters have been broken by changing the linkage relations of the genes. No practically useful types have been produced by continued self-pollination in Sweden; but a less-rigorous type of inbreeding, based on the use of maternal progenies between which selection is exercised, has given valuable lines. It has been observed, too, that rigorous mass selection, especially where the number of parent plants is kept small in each generation, produces the practically useful results of loose inbreeding.

When these various partially inbred lines have been raised, suitable mixtures of them can be used in bulk crosses. When this is done, nearly all the seed is from crossing though, of course, all the $\frac{n(n-1)}{2}$ crosses possible between the n lines are present more or less equally in the bulk. The bulk crosses are of commercial value because of their high yields and adaptability to environmental circumstances. The more different in origin were the parent lines, the greater the improvement on crossing; and crosses between lines produced by mass selection under different conditions generally excel those between lines raised by selection between maternal progenies. The effect of crossing, like that of inbreeding, on the chemical constitution is small. Sugar percentage may be slightly reduced though not to an extent sufficient to offset the increase in root yield.

Dr. Rasmusson concluded by mentioning a special case of crossing. Tetraploids, produced by colchicine treatment, yield 5–10 per cent less sugar than the comparable diploids. But the triploids from crossing diploid and tetraploid exceed the diploids by some 5 per cent. The triploid lines cannot, of course, be maintained from seed; but bulk crossing of diploids and tetraploids yields a mixture of the three chromosome types the average productivity of which sufficiently exceeds that of the diploid to make it commercially valuable.

Prof. R. A. Fisher next dealt with the genetical theory of inbreeding, which, as he pointed out, is essentially a means of manipulating the genetic materials so as to control their structure and composition. Inbreeding produces lines of predictable behaviour, particularly in their properties in subsequent crosses, even in respect of the numerous genes the effects of which are so small as to preclude their being followed by the mendelian method. Inbreeding is a tool the success of which has been so great in plant improvement that it can scarcely fail to achieve wide use in both plant and animal improvement in the future. Yet a theoretical understanding of its operation seems largely to be lacking, and very diverse opinions are held at present as to the reason for its success.

It is clear that the effect of inbreeding, particularly the production of an inbreeding depression which can be wiped out by one generation's crossing, must imply dominance of the genes concerned, and the genetical theory of the origin of dominance throws some light on how this could come about. The lines isolated by inbreeding differ greatly in their genetical qualities, and selection can be exercised among them at three stages in their production, namely, in the choice of individuals with which to start the inbreeding, in the choice of individuals for continuing the lines during the inbreeding, and in the choice of lines, once established as true-breeding, for use, especially in subsequent crosses. Of these, selection among the established lines is the most valuable, because the true-breeding nature of these lines permits selection based on extensive testing of a wide variety of them. Indeed, this facility offered for increasingly accurate selection is the essential advantage conferred by inbreeding. The rapid improvement in the accuracy of variety trials, made possible by replicated and randomized field designs, has played an important part in refining the selection which has been so successfully practised in the production of hybrid maize.

Mr. G. M. L. Haskell, who followed Prof. Fisher, gave an account of the theory and practice of hybrid maize production. Hybrid maize represents so great an advance over the open-bred varieties which preceded it that it has now replaced the latter virtually completely in the corn belt of the United States. Maize is naturally a cross-pollinator, and genetically the plants are mostly heterozygous. Ordinary methods of selection had shown themselves incapable of materially improving the open-bred varieties of maize before the new methods were introduced. The introduction of the inbreeding technique has led to the production of a great variety of lines which, though all showing inbreeding depression in greater or lesser degree, are uniform and virtually true-breeding and have satisfactory plant characters. Hybridization of inbreds, which is made easy by the monœcious habit of the plants, produces offspring the hybrid vigour of which is often such that they surpass in yield not merely the inbreds themselves but also the open-bred varieties from which these inbreds were produced. Every one of the hybrid plants is a potential yielder, and the hybrid families are uniform in appearance, time of maturity and disease resistance. The more diverse the parentage of the inbreds, the more likely they are to combine well in giving high-yielding hybrids. Combining properties vary from inbred to inbred and represent a character for which breeding can deliberately be practised.

Mr. Haskell described the commercial methods used in the United States for inbreeding and hybridizing maize, both in sweet corn where first crosses are used for commercial production, and in field corn where double crosses, made between two first crosses, are preferred. The special problems of breeding maize suitable for Great Britain in regard to photoperiodism and cold-hardiness were mentioned in conclusion. A feature of Mr. Haskell's paper was the wealth of lantern slides with which all its points were illustrated.

In the fourth contribution to the discussion Dr. H. P. Donald dealt with the use of inbreeding and crossbreeding in livestock production. Breed crossing is not an uncommon practice in animal husbandry. Sometimes it is indiscriminate, particularly where, as in Britain, many breeds are kept. Such crossing is not intrinsically undesirable though it must always indicate a lack of purpose in the breeding aims. Other crosses are made deliberately for purposes such as that of distinguishing the sexes at hatching in poultry. Crossbred animals may also be better fitted to particular environments. For example, the Zebu-cattle crosses in northern Australia combine good heat tolerance and quick growth; but have lost some popularity because of their intractability in handling. In the extreme case breeds might be kept as inbreds solely for the purpose of producing crossbreds. A further type is cyclical crossbreeding, where successive generations are mated to two, three or four breeds in turn. This should conserve the greatest part of any heterosis that the crossbreeding could give without the necessity of always going back to the pure breeds for crossing; but it has yet to be shown that the heterosis so obtained is worth while.

Inbreeding has not so far been widely tested as a preliminary to crossbreeding in livestock, because of the great experimental expense. It is known, however, to result in depression of such characters as viability, fertility and milk production. Many defects like scrotal hernia and cleft palate also appear. Slow inbreeding under selection might help to overcome these troubles, but many of the lines must in any event be discarded. The exploitation of inbreeding followed by crossbreeding is too expensive for the ordinary farmer and must require a new breeding organisation. This has been developed for the 'Hyline' poultry in the United States. These birds resemble double-cross maize in their method of production and they cannot be successfully bred on by the farmer. They show hybrid vigour more in the rate of survival than in the egg production of surviving hens.

The complementary use of inbreeding and crossbreeding in animals has potentialities in three ways: to exploit hybrid vigour, to fit the requirements of new territories, and to improve breeds within their own limits when simple selection ceases to be effective. It remains to be demonstrated, however, in each case whether the gain in production will pay for the labour and expense of the method.

The final paper of the meeting was given by Dr. K. Mather, who discussed the genetical principles and problems of inbreeding and crossbreeding as a method of plant and animal improvement. In inbreeding plants, such as wheat, peas and tomatoes, homozygous lines of uniform excellence can be maintained by the natural breeding system of the crop. This is not possible with crossbreeders, in which varieties and breeds, though in equilibrium from generation to generation, must always consist of a heterogeneous collection of heterozygous individuals. Genetical variation is inevitable and the average of the variety must in consequence always be below the best. The homozygotes produced by inbreeding are always poor in such species. Uniform and predictable groups of heterozygotes can, however, be obtained by artificially crossing these homozygous lines. Thus it is the aim of the method of inbreeding and crossbreeding deliberately to produce heterozygotes uniformly approaching the best individuals of the open-bred varieties and so, as groups, excelling the average of the varieties; and further to produce these heterozygotes consistently generation after generation.

Five problems arise with this method of breeding. First, there is the great multiplicity of inbred lines which can be raised and must be tested. In the past the desirable inbreds have been discovered by trial and error. Those which give the best hybrids are not, in fact, always themselves the most productive inbreds. Combining ability is the critical character of the inbreds, and it is on this character that they must mainly be selected. Quicker methods are needed for sorting out the lines with valuable combining properties from the mass of their less useful fellows.

The second problem is raised by the poverty of the inbreds themselves. They are expensive to keep, and their immediate yield of hybrid offspring when crossed is low, so that hybrid production is costly. Various methods, such as double-crossing and top-crossing, are used to overcome this latter difficulty without sacrificing the chief benefits of the system of breeding.

The method of convergent improvement has also shown itself capable of raising the vigour and productivity of the inbreds themselves.

Thirdly, there is the problem of making the necessary controlled crosses. This is easy in diœcious animals and in monœcious maize; but plants with hermaphrodite flowers require special methods. Cytoplasmically controlled male-sterility has been used for this purpose in onions, and bulk crossing is being exploited in sugar beet.

The fourth problem is raised by the very uniformity of the inbreds and their hybrids. Where only inbreds are maintained there is a risk of loss of the valuable reservoir of genetical variation which is to be found in the open-bred varieties, and in maize special collections of the old types have become necessary to provide sources of future breeding material. In the hybrids the danger of complete genetical uniformity is that it may result in total loss of the crop through a short period of adverse weather, the effect of which on a more variable stand would be much less serious. The production of double-cross hybrids goes some way to overcome this difficulty.

Finally, there is the question of whether the raising and crossing of inbreds pays for itself. In maize and sugar beet it certainly does; but elsewhere the answer is less clear. It seems, in fact, that the answer will not be the same for all species in all circumstances, and any investigation of the practical possibilities of inbreeding and crossbreeding must therefore pay due attention to the economic aspect.

K. MATHER

THE WORLD FEDERATION OF SCIENTIFIC WORKERS

THE first General Assembly of the World Federation of Scientific Workers was held in Czechoslovakia during September 21–25, as guests of the Czechoslovak Association of Scientific Workers. It was attended by thirty-three delegates and observers from thirteen countries (Austria, Britain, Bulgaria, Canada, China, Czechoslovakia, Denmark, France, Greece, Hungary, Poland, South Africa and the United States). Observers on behalf of Unesco and the World Federation of Trade Unions were present.

The business sessions were held in the Castle Dobřiš, the magnificent country palace belonging to the Czechoslovak Syndicate of Writers, which is about forty kilometres from Prague.

The Assembly was opened by the president of the World Federation of Scientific Workers, Prof. F. Joliot-Curie. Messages of welcome and greeting were received from the Czechoslovak Ministers of Foreign Affairs, Education and Information, Unesco, the World Federation of Trade Unions, the Czechoslovak Trade Unions, the Czechoslovak Academy of Sciences, and other personalities and institutions.

The chief business of the second session was the presentation and discussion of the secretary-general's report. The secretary-general, Mr. J. G. Crowther, reviewed the activities of the World Federation of Scientific Workers during the two years of its existence. He described how, at the end of the Second World War, associations of scientific workers had spontaneously come into existence in various countries. The formation of a Federation was desirable for the exchange of views, and the formation, so far as possible, of agreed opinions on all questions affecting scientific workers as such.

The World Federation now contains eighteen affiliated organisations, in fifteen countries drawn from all the five continents. The total membership of individual scientific workers is more than twenty-four thousand.

The World Federation has been recognized by Unesco as one of the non-governmental international bodies interested in its work. Accordingly, it was invited to send representatives to the Second General Conference at Mexico City, and to Unesco Commissions on the Popularization of Science and its Social Relations. These representatives proposed that Unesco should found fellowships for research on the social relations of science, an innovation that has been accepted.

The World Federation has initiated a new kind of international ceremony. These are celebrations of great men of science not in the country of their origin. The first was the London celebration of Langevin, the second was the Paris celebration of Rutherford. The third will be in 1949, on the centenary of the birth of Pavlov. The Langevin proceedings have been published, and those of the Rutherford ceremony are in the press.

The resolutions and proposals submitted to the first Assembly were analysed and discussed by four working commissions, dealing respectively with: (*a*) The Organisation and Social Responsibility of Scientists; (*b*) Atomic Energy, Secrecy and Peace; (*c*) Reconstruction, Colonial Countries, and Natural Resources; (*d*) A World Federation Journal, and Finance.

The reports of the four commissions, after amendment and verbal improvement, were accepted by the Assembly in plenary session. The resolutions dealt with the persecution of scientific workers, the unity of men of science against war, the co-ordination and improvement of abstracting services, international holiday camps for scientific workers, the control of atomic energy, secrecy in science, distribution of radioactive isotopes, scientific development in colonial countries, utilization of world resources, the foundation of a Federation journal, and other topics.

A special resolution was passed welcoming the formation of the Permanent International Committee for Peace by the Wroclaw Cultural Congress, and wishing it all success in its struggle for a peaceful world.

The decision to launch a World Federation journal was one of the most important. It is hoped that publication will begin soon, and that the first number will be devoted mainly to a report of the proceedings of the Assembly.

The draft "Charter for Scientific Workers" was discussed in plenary session, and emendations from affiliated associations were incorporated. The Charter was then adopted. The Czechoslovak Minister of Education, M. Z. Nejedlý, who is also president of the Czechoslovak Academy of Sciences, was present at this session. The chairman, Prof. J. Bělehrádek, remarked after the vote that the occasion was historical, for it was the first time in the history of science that scientific delegates from all quarters of the globe had agreed on a definition of their duties and rights as scientific workers.

On the night of September 22 a public meeting on "Science in the Modern World" was held in the Lucerna Hall in Prague. Two thousand persons bought tickets for this meeting. Speeches were delivered by Prof. F. Joliot-Curie (France), Mr. C. M. Liu (China), Prof. S. Maximos (Greece), Dr. K. Z. Bratanoff (Bulgaria), Prof. J. D. Bernal (Britain) and Prof. A. Kolman (Czechoslovakia). Several brilliant speeches were made; but one of the most remarkable was by Prof. Z. Nejedlý, in moving the vote of thanks to the speakers. He revealed an equal understanding in addressing the men of science on one hand, and wit and humour in speaking to the general audience on the other. After the meeting he gave a reception in honour of the Assembly, which was attended by Czechoslovak personalities, the British Ambassador and other members of the Diplomatic Corps.

The Czechoslovak Association of Scientific Workers entertained the members of the Assembly to a two day tour of their country, in which no less than six hundred kilometres were covered by bus. The main visits were to the Bata works at Zlín, and to Hradec Králové. The famous boot and shoe factory, now nationalized, is at the base of high wooded hills. The architecture is in the most modern functionalis style. Extensions are being built at a great speed floors being added to buildings at the rate of one a fortnight. The roof of the newest factory is to be a helicopter landing stage. Bata has its own twelve-story hotel. Many of its workers are housed in cubic villas on garden-city lines, and in flats. More than one thousand new flats are under construction. It was stated that Bata employs thirty-two thousand workers, and has a daily output of a hundred thousand pairs of boots and shoes—ninety per cen for export. There is a considerable research organisation, including consumer research. New styles ar tried out on a large scale by employees, who are given the footwear free, and are then asked to report on attractiveness, comfort, wear, etc.

Members of the Assembly also visited the new Medical Faculty, created at Hradec Králové in 1945. The building, which had been a military school, and had been occupied by the Red Army, was vacated by the Soviet Commander in order to provide accommodation for the new school, with the comment that it was fitting that Mars should make way for Athene.

After visiting the Medical Faculty, the members were received at the Institute of Glass Technology, a research and consulting centre for one of Czechoslovakia's chief industries. J. G. CROWTHER

NEWS and VIEWS

Experimental Zoology at Manchester :

Dr. Ralph Dennell

THE science of zoology underwent a profound change at the end of the First World War. The orthodox approach to the subject through a study of comparative anatomy was largely abandoned, and all energies were devoted to the new outlook afforded by experimental zoology. Despite this complete change-over, no new academic posts were created to cater for this new method of approach. For a short time, there was a readership at Cambridge, but that was all. Now, to fill this obvious want, the University of Manchester has established a full chair in experimental zoology, to which Dr. Ralph Dennell has been appointed. Dr. Dennell has the advantage of having made his name first of all as a functional morphologist. He commenced work on the feeding mechanism of various Crustacea, and later turned his attention to the luminous organs of certain deep-sea prawns. During the Second World War, he undertook a study of the feeding mechanism of the grain weevil, and this led him to an experimental investigation of the process of hardening of the insect cuticle, a problem which he is extending to the whole of the Arthropoda. At present, he is in Bermuda, with a Leverhulme fellowship, studying deep-sea luminous forms.

Assyriology at the British Museum :

Dr. Sidney Smith, F.B.A.

IT has been announced that Dr. Sidney Smith has retired from the post of keeper of the Department of Egyptian and Assyrian Antiquities at the British Museum, and has been succeeded by Mr. C. J. Gadd, formerly deputy keeper of the Department. Dr. Sidney Smith entered the British Museum in 1914 and has been keeper since 1930. There are probably few living Assyriologists who can speak with authority, as he does, not only on textual and philological matters, but also on every subject connected with Near Eastern and Egyptian archæology. He was one of the first to correlate the complicated stratigraphical and epigraphical data yielded by recent excavations in Syria and the Hatay, and his new scheme of chronology published in 1940 is being accepted by an increasing number of scholars. He is a controversialist who does not tolerate loose thinking; but serious students have always had reason to be grateful to him for his constant readiness to place the fruits of his learning at their disposal. It is understood that as professor of ancient Semitic languages and civilizations at the School of Oriental and African Studies, University of London, he hopes to have more time in future for his own researches.

Mr. C. J. Gadd, F.B.A.

MR. C. J. GADD, who in terms of service in the British Museum is only five years junior to Dr. Smith, is an Assyriologist of no less eminence than his predecessor, and is a profound and erudite scholar, whose deep understanding of the ways of thought of the Babylonians and Sumerians is exemplified in his Schweich Lectures, recently published under the title "Ideas of Divine Rule in the Ancient Near East". With his generous and self-effacing personality, he brings to his new appointment the goodwill of his staff and of all who know him.

Festival of Britain, 1951

GENERAL LORD ISMAY, chairman of the Council of the Festival of Britain, 1951, presided at a meeting on October 14 to announce progress in the plans for the Festival. Mr. Gerald Barry, director-general, emphasized that it is hoped to mark 1951 in three ways: by events centrally organised and financed by the Festival organisation itself; by events organised by other interests, which may be associated with and assisted by the Festival authorities; and by unofficial events throughout Great Britain. There is to be a central exhibition in London on the south bank of the Thames between the County Hall and Waterloo Bridge; the river front is to be cleared and a concert hall built on the site. The exhibition itself will be in temporary fabric structures of a new type; it will be on a small scale and an attempt will be made to tell the story of British life and achievement. It was emphasized that it will not be a trade fair. The Council of Industrial Design will be responsible for selecting contemporary industrial exhibits. A Council of Science and Technology, specially created for the Festival, will ensure that scientific achievement will be adequately represented both in the central exhibition and in other ways. An Architectural Exhibition, elsewhere in London, will take the form of a full-scale cross-section of a residential area in various stages of building, which can be completed and handed over for actual use after the Festival closes. There will also be one or more travelling exhibitions visiting the principal cities of the country; and it is hoped to co-operate with bodies holding annual meetings, such as the British Association. Finally, the Vice-Chancellors of the Universities of Oxford, Cambridge and London have been invited to arrange special vacation courses in the summer of 1951 in subjects relevant to the main theme of the Festival. In this way, it is hoped to demonstrate the contribution of British thought in philosophy, literature, religion and science to the progress of civilization.

Research and Recovery

MR. HERBERT MORRISON, Lord President of the Council, addressed the chairmen of councils and directors of the industrial co-operative research associations at a conference in London on October 15. The express purpose of this conference was that the delegates should acquaint the Government of their progress and difficulties in research so that the findings could be integrated into Great Britain's overall economic programme. Mr. Morrison believes that the first problem of economic recovery is one of increased productivity, and the key to this is to be found in more knowledge—knowledge both of technical processes and also of human relationships. The Government is fully aware of the importance of the issue and is prepared to support State and private research with every financial help; thus the trend of increase in cost—£470,000 in 1938, £2 millions last year and an estimated £2½ millions next year—is not a matter for concern but a sign of the ever-growing importance of research and a pointer to bigger things to come. Recent material results have convinced Mr. Morrison that the money is well spent, and he referred, for example, to the technical advances made in pottery firing operations, infra-red drying of paints, fitting of shoes, adjusting of peak electrical loads, production of linen, improvement of iron foundries and development of 'nodular cast-iron', design of more efficient domestic grates, scientific research into better houses, and the improvement of road surfaces. It is important that manufacturers should bear in mind the improvement of quality and lowering of costs in addition to increased productivity. All these problems can be solved by more scientific investigation, and Mr. Morrison considers that research is the spearhead of the advance of industry by which we will determine whether we are going to hold our place in competitive world industry or degenerate into a third-rate Power. Not only must the value of research be recognized, but also the conditions of scientific workers must be improved and their status acknowledged. Responsible people do realize these points, but are they fully understood by the general public? The research associations must publicize their activities and see that the world knows of the excellent results being obtained by British research effort.

Operational Research Club

About a year ago, a number of men of science interested in operational research began meeting together in the rooms of the Royal Society to discuss the development of methods and the application of this field of science. Papers were read and discussed in connexion with road traffic, productivity in the cotton industry, use of fertilizers by farmers, the organisation of inspection in the steel industry, etc. An "Operational Research Club" has now grown out of these meetings, and a healthy programme of papers for this session has been planned. In order to maintain the informal nature of the meetings, it has been necessary to limit the membership; but it is intended to include representatives from most of the operational research teams working in industrial and other civil fields, together with some from the defence services. The honorary secretary of the Club is Mr. D. Neville-Jones, 24 Rutland Gate, London, S.W.7.

Motor Industry in Britain

A clear picture of the British motor industry is presented in a broadsheet prepared by Political and Economic Planning (No. 284). The broadsheet traces first the development of the industry before the War, examining factors such as taxation which influenced demand in the United Kingdom and the growth of the Nuffield Organisation, the Ford Motor Co., the Austin Motor Co., Vauxhall Motors, the Rootes Group, and the Standard Motor Co. The effect of conversion to war demands and subsequent reconversion is then described, and, after a review of the post-war structure and home demand, the labour force of the industry is analysed, and its trade organisations and export markets are considered. The broadsheet makes no recommendations as to future policy, but indicates that if the shortage of foreign exchange could be left out of account, there is sufficient shortage of vehicles in the world to give both Britain and the United States ample scope for some time to come. Such comparison with pre-war figures as is practicable suggests that the industry's labour force is about 25 per cent greater than before the War.

The Original Wright Aeroplane

The original Wright aeroplane of 1903—the first power-driven man-carrying aeroplane to make a free, controlled and sustained flight—was lent by Mr. Orville Wright in 1928 for exhibition in the Science Museum, London, for an initial period of five years. On October 18 it was taken down for packing in crates in readiness for its return to the United States. This machine was designed and built by the brothers Wilbur and Orville Wright at Dayton, Ohio, in 1903, and was flown at Kitty Hawk, North Carolina, on December 17. The first flight lasted 12 sec. and was made in a wind of about twenty miles per hour, the machine being piloted by Mr. Orville Wright; altogether four flights were made on the morning of that day. The last flight was one of 59 sec., when the distance covered was 852 ft.; the machine was then overturned by a gust of wind while left unattended, and the damage caused prevented further experiments at that time. After these first flights, the aeroplane was preserved in the Wright Laboratory at Dayton. Certain parts which were damaged were replaced by Mr. Orville Wright himself, and the machine was restored to its original condition. An exact replica of the aeroplane has now been made and will be exhibited in its place at the Science Museum. Dr. H. Shaw, director of the Museum, is to accompany the machine to the United States, where it will be preserved in the National Air Museum, Smithsonian Institution, Washington, D.C. It should arrive there in good time for the forty-fifth anniversary of its first flight on December 17, 1903.

Economics and State Control

Prof. G. C. Allen's inaugural lecture at University College, London, on March 4, 1948, which has now been published (London: H. K. Lewis and Co., Ltd. Pp. ii+18. 2*s.* 6*d.* net), emphasizes that while the trend of economic opinion in pre-war days was in favour of a more active intervention by the State in economic affairs, such intervention was not inconsistent with the preservation of the system of private enterprise; it was deemed necessary for improving the operation of the system. Present policy, however of State intervention goes much further than the achievement of 'full employment', an acceptable distribution of the national income, and the promotion of structural adjustments in industry by fiscal or financial measures. Prof. Allen devotes mos of his lecture to an examination of the economic implications of the policy at present being pursued both in the nationalization of industry and in the guidance of private industry by substitutes for the compulsion of the market. He points out the importance in industries that depend to any extent upon innovation of being able to attract the outstanding personalities with initiative and organising capacity the administration and efficiency of such industrie will suffer under nationalization if such men are no longer attracted by the conditions of service. Similarly, he discusses the difficult question of effective Parliamentary control over the operation of public monopolies, and suggests that the safeguard of publicity can and should be made fully effective.

Prof. Allen offers no answer to the fundamental question whether it is possible for the State to formulate far-reaching plans for the disposition of economic resources intended to promote objectives of which men in their political capacity approve, and at the same time to afford adequate opportunities in the industrial sphere for the free movements of the mind and will, without which progress is in jeopardy. Certain dangers and problems, such as those of economic discipline, of the transfer of important categories of decision from the individual to the bureaucracy, and the establishment of an administrative machine capable of reaching speedy and wise economic decisions in those fields, and the danger of perpetuating the *status quo* in circumstances inherent in 'gentlemen's agreements' between the Government and organised bodies in industry, are indicated. Prof. Allen, while indicating the limits and dangers of such methods, believes that we are likely to be so hard put to it to find help in pursuing the middle way that we should not reject any method which offers even moderate prospects of success.

Permanence of Residence as a Social Factor

A PAPER by Dr. H. M. C. Luykx, "Family Studies in the Eastern Health District: IV. Permanence of Residence with Respect to Various Family Characteristics", reprinted from *Human Biology*, is one of several studies in a district of the city of Baltimore. Its findings are summed up in a table showing the family characteristics associated with the highest and lowest proportions of families remaining in the district between the triennial censuses of 1933, 1936 and 1939. The highest proportion of permanence was found among whites, owning their houses or paying the highest rent, with children and several wage-earners in family, where the family head was a skilled worker or foreman, middle-aged, foreign born, and not highly educated. With the present concern over labour mobility between industries, this study has considerable 'social significance'. Education, and renting rather than owning houses, seem indicated as favourable factors that social policy can control.

Directory of Natural History Societies

IN December 1943 the Committee of the Amateur Entomologists' Society agreed to compile a Directory of Natural History Societies. Quite independently, Miss R. S. Shove suggested in *School Nature Study* of January 1944 that a list should be prepared of school natural history societies and field clubs. As a result it was decided to trust the entire work to the Amateur Entomologists' Society, the School Nature Study Union agreeing to assist in the preparation of a schools section. In its early stages the compilation was directed by W. G. Rawlings; he was later succeeded by H. K. Airy Shaw. The Directory has now been completed and contains a list of all organisations with any biological interests, excluding bodies of an economic or professional nature. All societies, past and present, of which the Society could find any record in the British Isles, have been included. These have been arranged first to give information about national societies and then local societies, arranged in order of counties. The material arranged under each entry in the Directory is sufficient to guide naturalists in a distant county to a group of like-minded individuals. Not the least important parts of the Directory are the particulars of so many school natural history societies. The Directory can be obtained from the Secretary, Amateur Entomologists' Society, 1 West Ham Lane, London, E.15.

Nairobi Scientific and Philosophical Society

IN spite of the speed of modern communications, the sense of isolation arising among scientific men working in the Colonies and elsewhere overseas is still very real; one way of mitigating the difficulty is the formation of local scientific societies. The Nairobi Scientific and Philosophical Society is such a body, which arose from the need for co-operation between various scientific and technical officers working in Kenya. A meeting was held at Nairobi on April 9, 1947, at which the chairman, Mr. A. Walter, stressed the need for a central meeting place for scientific men, and the first formal meeting took place a month later. Now the Society has been able to issue vol. 1, part 1, of its *Proceedings*, and to claim a membership of fifty within six months of formation; this shows a very creditable interest among the necessarily small number of scientific and technical workers within reach of Nairobi. The *Proceedings* includes accounts of five meetings held by the Society; the subjects dealt with include *radio-sonde* in meteorology, the sociologist in industry, primitive agriculture in the modern world, development planning for the African and hormone weed-killers. The sociological bias shown is accounted for by the facts that advantage had to be taken of the availability of visiting guest speakers, and that the Society itself has arisen in a country where the development of a primitive people is taking place at an unprecedented pace. The Society is to be congratulated on the progress it has made as a centre for the discussion of problems of broad scientific and technical interest in Kenya. The officers of the Society are: *President*, A. Walters; *Vice-Presidents*, Dr. E. B. Worthington and V. A. Beckley; *Joint Honorary Secretaries*, W. A. Grinstead, P.O. Box 931, Nairobi, and H. E. Watson, P.O. Box 560, Nairobi; *Honorary Treasurer*, Dr. D. Harvey; *Honorary Librarian*, Dr. H. C. Pereira.

Earthquake in Iran

ON October 5, a great earthquake shook large areas in the province of Khurasan in north-eastern Iran, together with parts of Russian Turkestan. The large area of destruction appears to indicate either that the depth of focus of the shock was greater than normal, or that there was more than one shock. Two hundred people are reported killed and thousands injured at Meshed, with two hundred killed at Dereges. Askhabad, a Russian town with 150,000 inhabitants, suffered severely, four hundred people being reported killed. Six thousand injured people have been evacuated by air, and a temporary water supply has had to be organised to replace the town's water supply disrupted by the earthquake.

The area is a particularly seismic one, 140 earthquakes of varying intensity having been experienced during the last seventy years, and large earthquakes having occurred, according to Sir Arnold Wilson, at Kuchan in 1852, 1871, 1872, 1893 and 1895, at Meshed in 1673 and 1895, and in the whole area in 1929. This latter shock was also reported in *Nature* of May 11, 1929. On May 1, 1929, twelve distinct shocks were felt within twenty-four hours at widely separated points, running from Bandargaz to Kalat. The towns of Shirvan, Bujnurd and Jajarm were severely damaged, and a thousand people were killed in Askhabad. A cleft three yards wide is reported to have been opened between the towns of Khaki and Bagham, to a distance of eighteen miles. The total Persian casualties were 3,253 killed, 1,121 injured, 88 villages destroyed and 6,542 cattle injured. Further news is awaited concerning the present earthquake.

International Council of Scientific Unions

THE annual meeting of the Executive Committee of the International Council of Scientific Unions was held at Brussels in September, Prof. E. Borel presiding in the absence of the president, Dr. J. A. Fleming. A resolution from the Royal Society was adopted, that all adhering bodies, national academies and scientific unions be consulted before the Executive Committee accepts any new union. A resolution from the United States asking the Council to consider its constitution and the distribution of subjects covered by the Unions was referred to a committee in the hopes that a report might be available for discussion at the next General Assembly of the Council at Copenhagen during September 14–15, 1949. New joint commissions between the unions were agreed upon to deal with standards and units of radioactivity, spectroscopy, and high-altitude research stations. The adhesion of one new country, Pakistan, was reported. The recommendation from the Committee of Science and Social Relations that a journal should be started by the Committee was referred to the General Assembly. Dr. Establier was reappointed liaison officer with Unesco; representatives of Unesco present at the meeting were Prof. P. Auger and Dr. Wang-hsi-chin.

International Commission on Glass

THE International Commission on Glass held its first post-war meetings at Sheffield and Buxton during September 30–October 2 under the presidency of Prof. W. E. S. Turner. Decisions were taken to revise the constitution of the Commission, and arrangements were made for the preparation of scientific and technical reports on subjects of fundamental importance in glass technology. Until the adoption of the new constitution, the following comprise the International Commission: Prof. A. H. M. Andreasen (Denmark); Prof. J. A. de Artigas (Spain); Dr. B. P. Dudding (Great Britain, *honorary secretary*); Dr. M. Fanderlik (Czechoslovakia); Prof. P. Gilard (Belgium); Dr. J. C. Hostetter (United States); Dr. B. Long (France); Dr. H. Maurach (Germany); Dr. Atma Ram (India); B. Simmingsköld (Sweden); Dr. J. A. Stevels (Holland); Prof. W. E. S. Turner (Great Britain, *president*).

American Physical Society: Division of Fluid Dynamics

THE Division of Fluid Dynamics of the American Physical Society, which was established by the Council of the American Physical Society in June 1947, has been organised, and the following have been elected members of the Executive Committee: Jesse W. Beams, Howard W. Emmons (*secretary-treasurer*), Theodor von Kármán, Hugh L. Dryden (*vice-chairman*), Paul S. Epstein, Raymond J. Seeger (*chairman*), and John G. Kirkwood. The first meeting of the new Division took the form of a one-day symposium on June 23, when the Division joined with the University of California at Los Angeles, the University of Southern California, and the California Institute of Technology as part of a three-day meeting to discuss heat transfer and fluid dynamics.

British Museum (Natural History)

THE southern half of the Invertebrate Gallery (which used to be known as the Starfish Gallery) in the Zoological Department of the British Museum (Natural History) has now been re-opened. The Gallery was dismantled during the War, and an entirely new arrangement of starfishes and other Echinoderms has been prepared, showing many species in their vivid natural colours. Their usefulness to man and their methods of feeding and breeding are among the subjects illustrated in the new exhibit. In addition to Echinoderms the Gallery is being used temporarily to house a full-sized model of a giant squid, and a small selection of shells. These have been chosen mainly for some interesting peculiarity; there is, for example, a display of venomous cone shells. A series of common British shells is also exhibited. Certain groups of small invertebrates are also on view here, notably the great group of worms, including earthworms, leeches, many marine forms and parasites. Another new feature is a large-scale relief map coloured to indicate the main movements of the oceans, and the zoo-geographic regions into which the land masses are usually grouped for purposes of biological study.

National Certificates in Textiles

THE Textile Institute, which is jointly responsible with the Ministry of Education for the award of national certificates in textiles, announces that this year there were 131 entrants for the ordinary certificate, of whom 109 passed, and 85 for the higher certificate, of whom 82 were successful. Fifteen distinctions were obtained in the Higher National Certificate examination. Of the 191 successful candidates, 125 studied cotton subjects, 46 woollen and worsted, and 20 studied general textile subjects.

University of Sheffield: Appointments

THE following appointments have been made in the University of Sheffield: Dr. William Hobson, senior lecturer in preventive medicine in the University of Bristol, to the newly instituted chair of social and industrial medicine; Miss Ellinor I. Black, senior lecturer in the Department of Social Science, University of Liverpool, to be director of the newly instituted Department of Social Studies; S. Armstrong, lecturer in civil engineering; Dr. A. E. Beet, at present demonstrator in fuel technology, to be lecturer in fuel technology; A. W. Nicholls, assistant lecturer in glass technology; P. H. Price, research assistant to the professor of fuel technology; James S. Hough, research demonstrator in botany; P. Wright, Glass Delegacy research fellow.

Announcements

SIR WALTER MOBERLY, chairman of the University Grants Committee, will deliver the Rede Lecture in the University of Cambridge on November 18. He will speak on "Universities and the State".

FOR the future, the Universities Bureau of the British Empire will be known as "The Association of Universities of the British Commonwealth". Its new address is 32 Woburn Square, London, W.C.1 (Telephone No.: Museum 4578/9).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Multiplication of Bacteriophage

As part of a study of how viruses grow, we have been making series of electron micrographs which demonstrate essential steps in the multiplication of the virus-like bacteriophages.

This multiplication has been most easily seen in certain experiments with the *T*(2) bacteriophage against *E. coli.* Frequently transferred bacterial cultures less than two hours old were mixed with filtered bacteriophage suspensions of high titre and incubated for periods ranging from 0 to 30 minutes. At the end of the desired interval, interaction was arrested by chilling the mixture in ice water. The sediment obtained from it by centrifugation was formalinized and washed by repeated sedimentation. In final aqueous suspension it was mounted on collodion-covered grids and shadowed[1] with chromium or palladium.

Electron microscopic observation showed that young bacteria are lysed very soon after coming in contact with the particles of bacteriophage. All studies were carried out with an RCA Type EMU 2 microscope. Ruptured bacteria are common from cultures chilled immediately after mixing. In photographs such as that of Fig. 1, their protoplasm can be seen flowing out and engulfing the infecting particles. Foci of bacteriophage multiplication are apparent as dark clumps in similar cellular residues if incubation has proceeded for a few minutes before chilling. These foci, seemingly developed from the infecting particles, are at first few in number (Fig. 2). They are more numerous after longer incubation and after about 15 min. separate, presumably; newly formed particles are also seen distributed throughout the remains of the bacterial protoplasm. Both clumps and single particles increase still further with incubation, and eventually the regions of lysed protoplasm are more or less completely covered by the bacteriophage particles that have, through their growth, used up most of the protoplasm. As Fig. 2 suggests, detail cannot usually be discerned in the opaque clumps. Where, however, protoplasm has been washed or eaten away, they can be seen to consist of groups of particles (Fig. 3). These particles are commonly smaller than the average and are associated together in ways that suggest developing forms. Many of the free particles seen after short periods of incubation resemble the particles of these groups and, like them, are small.

Information from such electron micrographs, of which several hundred have now been obtained, indicates that these bacteriophage particles increase in number at the expense of bacterial protoplasm by a process that in many ways resembles the multiplication[2] of coccoid bacteria. Apparently most of this growth and multiplication takes place in the protoplasmic masses liberated by lysis rather than in bacteria which are still intact. In these respects bacteriophage can be thought of as a parasite living on bacterial protoplasm. It has been, and will continue to be, difficult to observe many details of this multiplication, because it necessarily occurs within masses of bacterial protoplasm the molecular texture[3] of which is not much finer than that of the developing bacteriophage.

Particles of bacteriophage resemble micro-organisms in other ways. Thus they have a complex organisation that includes a flagellar appendage and a head consisting of particles enclosed in a well-defined membrane. The amino-acid composition of bacteriophage protein is significantly different from that of its host[4]. Additional evidence about the 'living' nature of bacteriophage can be obtained from studies of its rate of diffusion. A number of years ago Northrop[5] found that a sufficiently dilute staphylococcus bacteriophage suspension seemed to diffuse faster than would be expected from its particle size. Recent measurements by Polson and Shepard[6] in this Laboratory, by a different method, have indicated that dilute coli bacteriophages also diffuse abnormally rapidly. The new data, however, are not entirely satisfied by Northrop's assumption of dissociation into small active fragments, and it is conceivable that they point to an independence of particle movement

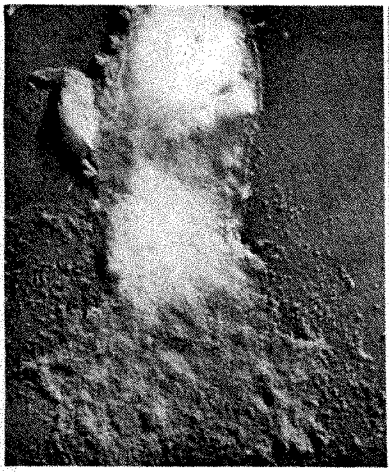

Fig. 1

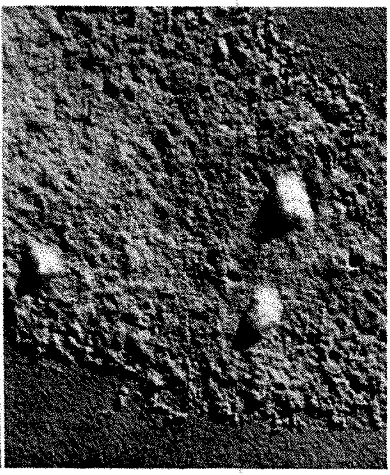

Fig. 2

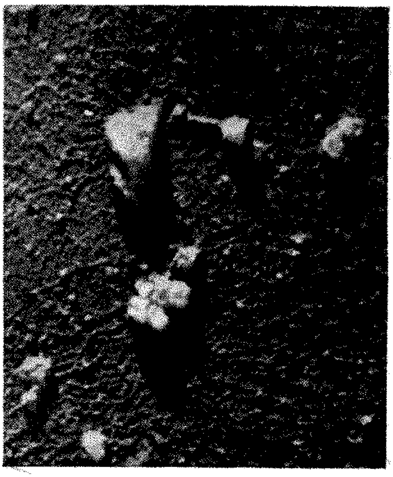

Fig. 3

Fig. 1. A colon bacillus being lysed under the action of *T* (2) bacteriophage. Granular protoplasm flowing from the lower part of the organism has partly engulfed a bacteriophage particle at the left. (× *c.* 17,000)

Fig. 2. Protoplasm from part of a lysed colon bacillus showing three opaque centres of multiplication. (× *c.* 17,000)

Fig. 3. Two clumps of developing bacteriophage particles free of enveloping protoplasm. The several developing particles in the lower clump and the single mature particle to the right of the upper clump are essentially clear. (× *c.* 40,000)

that presumably would be sustained by some kind of metabolic activity.

Bacteriophages are known which have diameters as small as *c.* 100 A. If they multiply in the autonomous fashion observed for the $T(2)$ bacteriophage, then 'living' self-reproducing objects exist which are considerably smaller than the molecules of such well-defined proteins as the hæmocyanins and erythrocruorins.

These studies are being described in more detail in papers appearing in the *Biochimica et Biophysica Acta.*

RALPH W. G. WYCKOFF

Laboratory of Physical Biology,
National Institute of Health,
U.S. Public Health Service,
Bethesda 14, Maryland.

July 27.

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Ultra-Violet Microscopy of Living Malignant Cells

PREVIOUS work on the ultra-violet microscopy of living cells has led to conflicting conclusions as to the value of this technique in cytological research. Thus, Wyckoff, Ebeling and Ter Louw[1] reported that Feulgen staining, which demonstrates desoxyribose-nucleic acid in fixed cells, duplicates the results obtained by the ultra-violet microscopy of living cells. "Ultra-violet microscopy can be considered as the equivalent of a vital staining specific for formed chromatin" was their conclusion. More recently, in *Nature*, Brumberg and Larionow[2] maintained that desoxyribose-nucleic acid is present in the nucleus of living cells in a form which does not absorb irradiation in the 2600 A. region, and that absorption only occurs in injured and dead cells.

We have explored the possibility of investigating living cells by ultra-violet microscopy and have utilized for the purpose several strains of rapidly growing malignant cells which have been maintained for some years by serial transplantation in inbred strains of mice at the laboratories of the Imperial Cancer Research Fund (Ludford and Barlow[3,4]). Fibroblasts from subcutaneous connective tissue and mesothelial cells have also been included in the study. The apparatus used was that designed by Barnard, and the technique employed the same as described by him and Welch[5,6]. It has the considerable advantage in that dark-ground illumination with visual light is employed for selecting objects for ultra-violet micrography. By this procedure cells receive the minimum exposure to ultra-violet irradiation—only the few seconds during exposure of the photographic plate. A preliminary study of the cells was made by phase-contrast photomicrography so as to establish a standard for comparison with ultra-violet micrographs, in order to be able to detect any indication of cellular injury that might be revealed in the latter. It was found possible to obtain pictures of living cells by employing objectives computed for working with wave-lengths of 2570 A. and 2750 A., without any appreciable injury to cell structure. Microspectrographic analysis of living cells as carried out by Caspersson[7] with fixed tissues was not possible. Living cells would not tolerate the necessary series of exposures to irradiations of different wave-lengths. For reasons adduced by Caspersson, we have therefore assumed, without unequivocal evidence, that structures exhibiting strong absorption in micrographs taken with wave-lengths of 2570 A. and 2750 A. are of a nucleotide nature.

Numerous observations in cytopathology point to the mitochondria as sensitive indicators of cell injury. They react rapidly to ultra-violet irradiation. They first become distorted and then disintegrate, leaving vacuoles in the cytoplasm. In the sarcoma cell shown in Fig. 1 (2750 A.) are seen well-defined filamentous mitochondria characteristic of actively growing cells. The nucleus of this cell contains several large nucleolar masses with the "nucleolar associated chromatin" of Caspersson[8]. The cytoplasm contains a considerable amount of absorbing substance, which has been a conspicuous feature of all our rapidly growing malignant cells. A very pronounced change in the distribution of nucleotides takes place during cell division. About the time the nuclear membrane breaks down at prophase the mitochondria become rounded and are seen to bear peripheral deposits of nucleotides. Much smaller granules, most of which are below the limits of resolution (probably the microsomes of Claude[9]), are distinguishable among the much larger rounded mitochondria. The 'ground cytoplasm' is almost completely depleted of absorbing substance; but the chromosomes exhibit strong absorption throughout mitosis. These features are apparent in the sarcoma cell at telophase seen in Fig. 2 (2570 A.). Towards the end of the cleavage process the mitochondria become filamentous again,

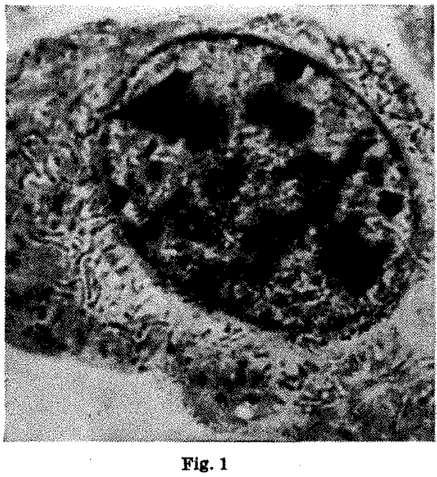

Fig. 1

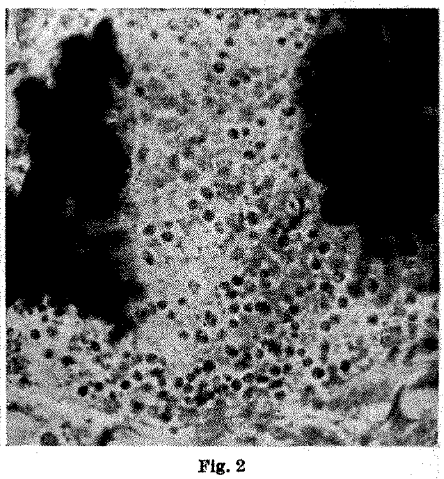

Fig. 2

Fig. 1. Living sarcoma cell with numerous filamentous mitochondria characteristic of active growth. From tumour *Rb* of the Imperial Cancer Research Fund. 2750 A.

Fig. 2. Dividing sarcoma cell from the same tumour as Fig. 1, showing the changed form of the mitochondria and altered distribution of nucleotides during mitosis. 2570 A.

and at the same time nucleotides reappear in the cytoplasm even though the chromosomes are still clearly distinguishable in the reconstituting nuclei, and no nucleoli have been reformed. In none of our micrographs of recently divided cells is there any suggestion of a greater concentration of absorbing substance directly surrounding the nuclear membrane which might imply a nuclear origin of cytoplasmic nucleoproteins. On the contrary, the nucleus is often surrounded by a relatively clear area. Our observations implicate the mitochondria rather than the nucleolus in cytoplasmic nucleoprotein synthesis.

Ultra-violet microscopy affords unique opportunities for studying the internal structure of the living nucleus. Some micrographs of dividing cells at late anaphase show the chromosomes already divided longitudinally, and this double thread-like structure persists in the 'resting' nucleus. Under appropriate conditions, nuclei can be seen to be composed of attenuated double threads upon which are disposed parallel pairs of minute granules that are not properly resolved with a wave-length of 2570 A. These would seem to be chromomeres or possibly gene loci.

Comparison of micrographs of fibroblasts from connective tissue with malignant fibroblasts (sarcoma cells) reveals a definite correlation between the amount of nucleotides and the rate of cell-growth. Particularly striking is the intense cytoplasmic absorption of rapidly growing sarcoma cells in comparison with the relatively clear cytoplasm of 'resting' fibroblasts.

Additional ultra-violet micrographs illustrating the various observations reported here will be published in subsequent communications.

R. J. LUDFORD*
J. SMILES
F. V. WELCH

National Institute for Medical Research,
London, N.W.3. June 4.

* Director of Cancer Research, Mount Vernon Hospital and Radium Institute, temporarily working at the National Institute for Medical Research.

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Cytochemistry of the Gonadotropic Hormones

DESCRIBING the histological demonstration of mucin after periodic acid, McManus[1] states that a positive reaction is given, *inter alia*, by "certain pituitary cells" and "the colloid of the pituitary stalk". According to Chow[2], the follicle-stimulating and luteinizing fractions of the anterior pituitary secretion are glycoproteins, and Evans *et al.*[3] confirm that the former contains 10·3–13·1 per cent carbohydrate and 8 per cent glucosamine. According to K. Meyer's classification, it is thus a mucoprotein, that is, it contains more than 4 per cent hexosamine. Furthermore, Gurin[4] has shown that chorionic gonadotropin is also a mucoprotein, containing galactose (10–12 per cent) and hexosamine (5–6 per cent) as an integral part of its molecule, and Gey *et al.*[5] have demonstrated the production of this hormone by cytotrophoblast cells in tissue culture. On the contrary, Fraenkel-Conrat *et al.*[6] have shown that the growth-hormone fraction of the pituitary contains only 0·25 per cent sugar and less than 0·9 per cent glucosamine.

The technique I have used is that described by Hotchkiss[7], which is essentially like McManus' and gives positive results with a wide variety of carbohydrate substances; but of these, after ordinary aqueous fixatives, only mucopolysaccharides, mucoproteins, glycoproteins and traces of glycogen remain. If it is true that the gonadotropic hormones are produced by the basiphil cells of the pituitary, these should be stained by the McManus–Feulgen technique, with the acidophils remaining colourless.

This has been found to be the case. The colloid of the stalk, the colloid of the acini and the granules of the basiphils are stained positively. In addition, a variable proportion of the chromophobes contain vesicles and granules which are stained bright red, and these are occasionally present in mature basiphils. It is concluded (*a*) that the secretion of the basiphils is the gonadotropic hormone, and (*b*) that some chromophobes are, as Severinghaus[8] has postulated, predestined basiphils.

Similar granules are found in the Langhans' cells of the chorionic villi and of chorion epithelioma. It is suggested that these granules may be the chorionic gonadotropin.

ANTHONY G. EVERSON PEARSE

Postgraduate Medical School,
(University of London),
Ducane Road, London, W.12.
May 29.

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Relative X-Ray Sensitivity of Metaphase and Interphase Chromosomes

MANY investigators have studied the problem of radio-sensitivity of cells in different stages of mitosis and meiosis in a wide range of plants and animals. Much disagreement still exists, however, as to which stages of the nuclear cycle are stages of high sensitivity to chromosome breakage and which stages are relatively resistant.

It is generally acknowledged that radio-sensitivity varies inversely with the degree of tissue differentiation, and that the change in sensitivity during differentiation is relatively high. However, it is not generally realized that the extent of sensitivity changes which may occur within a single cell-generation is also very high. A preliminary report is given here of the range of sensitivity of chromosomes to X-ray breakage during microsporogenesis in *Trillium erectum*.

Rhizomes of *Trillium erectum* were stored at 4–6° C. for several weeks before irradiation. Shortly before treatment a test slide was made from one or more anthers from each flower bud to determine the stage of division. Due to the high degree of synchronization of meiotic divisions, it may be assumed that the remaining anthers contained mostly microsporocytes in a similar stage. After exposure to 160 kV. X-rays, the plants were again placed in cold storage until microspore division, and then smears were taken.

Sensitivity was determined by counting the number of fragments present at microspore metaphase following irradiation with 50 r. at either first meiotic metaphase or early post-meiotic interphase. Examination of first or second anaphases after irradiation at first metaphase revealed very few fragments or bridges. However, after such cells had passed through post-meiotic interphase, a high degree of fragmentation was evident. (In *Trillium erectum* there is no regular interphase between first and second meiotic divisions. The chromosomes go from first anaphase directly into second metaphase without the usual resting period.)

Average number of fragments scored at microspore metaphase after a dose of 50 r. at first metaphase and at early post-meiotic interphase in *Trillium erectum*

Number of plants irradiated	Stage irradiated	Number of microspores scored	Average number of fragments per 100 pollen mother-cells
7	Metaphase I	2300	556
4	Early post-meiotic interphase	735	11·2

The average number of fragments per 100 microsporocytes (or per 400 microspores) is given in the accompanying table. The data show first metaphase to be a stage of high sensitivity to X-ray breakage, and early interphase a stage of very low sensitivity. Treatment at metaphase produced approximately fifty times as many fragments as the same dosage at early interphase. Since these two stages do not necessarily represent the stages of highest and lowest sensitivity, it is considered that a fifty-fold increase is a conservative estimate of the actual sensitivity change which occurs during the nuclear cycle. This range is considerably higher than that previously reported[1,2] for *Trillium*, mainly because the interphase had not been sufficiently studied to establish the point of lowest sensitivity. A comparable order of change has been reported by Conger[3], who found metaphase to be approximately thirty-seven times as sensitive as resting nuclei in onion root-tip cells. Failure to examine for aberrations in the succeeding divisions may be responsible for previous claims[4-6] that metaphase chromosomes are not damaged by X-rays. It should also be pointed out that measurements of sensitivity based on the percentage of rejoining of broken ends do not agree with a sensitivity value based on fragmentation only[7]. This also may have contributed to conflicting claims[8] as to stages of high *versus* low radio-sensitivity.

This investigation was begun in the Biological Laboratories of Harvard University. Financial assistance was received from the American Cancer Society and from the Cancer Research Division of the Donnor Foundation.

ARNOLD H. SPARROW

Biology Department,
Brookhaven National Laboratory,
Upton, Long Island, New York.

May 27.

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Production of *i*-Erythritol by *Aspergillus niger*

CERTAIN strains of *A. niger*, as is well known, ferment sugar to citric acid to the virtual exclusion of any other acid. Strong citric acid fermentations, however, are often accompanied by the production of mould starch[1] and a dextrin-like substance[2]. The present communication directs attention to the formation also of *i*-erythritol. Though this tetrahydric alcohol has already been found in two species of *Penicillium*, namely, *P. brevi-compactum* Dierckx and *P. cyclopium* Westling[3], and in one species of *Aspergillus*, *A. terreus*[4], rather surprisingly no one has hitherto reported its occurrence in cultures of *A. niger*.

The citric acid of the fermented solution and washings from the mould mycelium is first precipitated as the calcium salt and removed by filtration. The filtrate, which may contain some residual reducing sugar in addition to the starch and dextrin, is concentrated by evaporation. During this operation, most of the calcium citrate still in solution is thrown out and is filtered off. The filtrate is treated with two or three volumes of alcohol and the precipitate which forms is removed. The alcohol is evaporated off and the syrup remaining crystallizes on standing. The crude crystals are separated and purified by treatment with decolorizing carbon and recrystallization.

The aqueous solution of these crystals is neutral, shows no optical activity and does not reduce Fehling's solution. It has a sweet taste. Solubility in water rises rapidly with increasing temperature.

The crystalline substance gave m.p. 119·5–120·5° C.; mixed with a sample of authentic *i*-erythritol, m.p. was 119–120° C. Analysis:— found (Weiler); C, 39·57; H, 8·24 per cent; calculated for $C_4H_{10}O_4$: C, 39·34; H, 8·25 per cent. The acetyl derivative had m.p. 85–86° C.

I desire to acknowledge the assistance of two colleagues, Mr. G. H. Gossop and Mr. L. G. Manchester, in the work here reported.

JOHN L. YUILL

John and E. Sturge (Citric), Ltd.,
1 Wheeleys Road,
Birmingham.

May 27.

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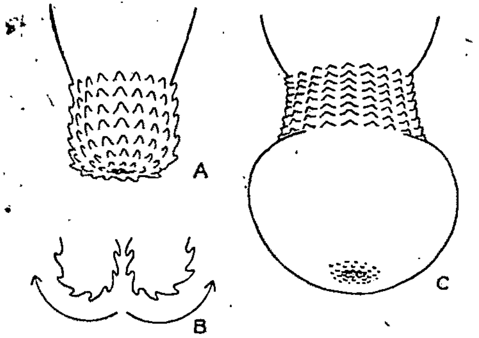
Thixotropy, and the Mechanics of Burrowing in the Lugworm (*Arenicola marina* L.)

Chapman and Newell[1] have recently published the following argument:

(1) Lugworms can burrow into a particular beach whether covered by sea-water or not. The total downward thrust which a worm can exert is limited by its weight. If one divides the immersed weight of a worm by the area of its front end, one finds "that the maximum pressure which can theoretically be exerted cannot exceed 16 g./sq. cm.". (2) A man can walk across the same beach without sinking in, though his feet exert a pressure of about 150 gm./sq. cm. (3) "The explanation of this apparent anomaly must be sought in the physical properties of the wet sand." The authors demonstrate that the sand is thixotropic by "stepping five times with the weight of the body on the foot"; this causes the

sand to liquefy, after which it fairly rapidly sets again. They suggest that "when a worm begins to burrow in the sand, its resistance is first reduced by alternating extrusion and withdrawal of the proboscis and then the anterior end of the worm is thrust into the softened sand".

It will be noted that the demonstration of thixotropy was made by using pressures considerably greater than those the lugworm can produce. But, in any event, I am unable to see any real contradiction between the first two observations, and do not believe that it is necessary to invoke thixotropy at all.



Action of the proboscis. *A*, Incomplete extrusion of the buccal mass. *B*, Section through the advancing buccal mass. *C*, Extrusion of the pharynx

As the worm burrows, it repeatedly extrudes and withdraws its proboscis. This proboscis consists of two main parts. The first part to emerge is the buccal mass, which is set with strong, conical teeth, directed as shown in the diagram (*A*). As it comes out, the thrust on the sand will first be sideways to the line of advance, then backwards towards the animal's tail, as shown by the arrows in (*B*). The latter (backwards) thrust is assisted by 'flanging' movements of the more anterior chætigerous annuli[2], which occur during burrowing. If one causes a worm to burrow into an artificial sand consisting of very small glass spheres (Messrs. Chance Bros.' 'Ballotini') —which it can and sometimes will do—then these movements of the chætigerous annuli may be seen.

After its extrusion, the buccal mass shortens considerably as the second part of the proboscis, the pharynx, is violently thrown out (*C*). The pharynx is a soft balloon, with numerous very small papillæ. Its ejection rather suggests the sudden blowing of a bubble by the worm. It may serve to drive out the sand from the hole rasped by the buccal mass, and perhaps to shape it.

The front end of the worm narrows and lengthens as the buccal mass is extruded, as if to drive it further into the sand. In the second stage, when the buccal mass shortens and widens, the front end of the worm does so too; so the pharynx is thrust out more or less into the area already worked upon by the buccal mass.

These facts show that the lugworm is not at all comparable to a body sinking into the sand under its own weight. It is more like a digging rabbit, which scratches and shovels the earth away. The actual disruption of the structure of the sand must be done by the teeth of the emerging buccal mass. Unhappily, it is not easy to assess the force with which the worm could make them diverge from each other. Chapman and Newell[1] give a number of valuable data on the hydrostatic pressure in the body cavity under various conditions; they recorded pressures up to 27 cm. of sea-water in worms "actually engaged in burrowing". But other factors play a part; if one transects a worm immediately behind the first chætigerous annulus, the very small front end so isolated can still extrude and withdraw its buccal mass, though it seems unable to throw out its pharynx.

G. P. WELLS

Department of Zoology,
University College,
London, W.C.1.
June 18.

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Some Geometrical Considerations Regarding Imbricate Æstivation

IN connexion with some anatomical investigations now in progress, an occasion has arisen for reviewing the evidence for a possible affinity between the Ranales and the monocotyledons. A critical consideration of certain floral features reveals that a number of phenomena on which considerable stress has been placed are not, in fact, independent results, but may be deduced as geometrically inevitable consequences of the nature of imbricate æstivation.

Imbricate æstivation may be defined as the arrangement of flattened organs in a ring so that each edge of each member of the ring overlaps with one of the edges of an adjacent member. It will be convenient to distinguish three types of member: external, with both edges outside those with which they overlap; internal, with both edges inside; and oblique, with one edge inside and one edge outside. Let the numbers of members in each category be denoted by e, i and o respectively. Then the total number of outside edges is $2e + o$ and the total number of inside edges is $2i + o$. But, from the nature of imbricate æstivation, there are as many outside edges in a ring as inside ones, so that $2e + o = 2i + o$ and $e = i$. There follow two important corollaries: first, the number of oblique members is odd or even according as the total number of members in the ring is odd or even; secondly, a ring with an odd number of members must have at least one oblique member.

Now suppose that a ring is being built up by placing members in position one at a time. If the first member is to be external, the one next to it cannot be external. It can be either internal or oblique. If it is oblique its free edge (that is, the one farthest from the first member) will be an outside edge. The third member can then be either internal or oblique, but not external. Obviously, it is impossible, moving round the ring from an external member, to reach another external member without first passing an internal one. A similar train of argument can be used to prove the converse. We have therefore established the proposition that: the internal and external members of any ring of imbricating organs will occur in equal numbers and will alternate regularly all round the circumference.

In other words, any ring of imbricating organs may be regarded as consisting of two equal alternating whorls, with the addition of a varying number of oblique members which do not belong definitely to either whorl, and which may be distributed in various ways. The appearance of two independent alternating whorls can be regarded as the special case arising when o is zero; and contort æstivation as that arising when e and i are zero.

Consider a ring of organs in which the position of any edge (that is, whether inside or outside) is independent of the position of the other edge of the same member. Clearly, it is to be expected that, of the total number of members present, one quarter will be external, half oblique and the remaining quarter internal.

It is interesting to reconsider some of the observed facts in the light of these theoretical results. The commonest number of petals in *Ficaria verna* is eight, as stated by Salisbury[1]. In most cases this number is made up of three internal petals, three external and two oblique. Obviously the position of one edge of a petal markedly influences that of the other edge; conditions are unfavourable for the production of oblique members. Salisbury concluded that the corolla was derived from one with two alternating trimerous whorls, the oblique members having arisen by division of the members of these whorls. But it is not difficult to find flowers in which the 'whorls' are dimerous, while in flowers with more than eight petals there are often four external and four internal petals.

Hitherto, it has not been sufficiently appreciated that any condition unfavourable to the production of oblique members automatically brings about the appearance of alternating whorls. In *Ficaria* the elimination of oblique members is incomplete, but has gone far enough to give, in most flowers, an appearance of alternating trimerous whorls.

It has been shown that complete elimination of oblique members is not possible when the total number of organs is odd. The pentamerous plan does not permit elimination of oblique members beyond the condition seen in the familiar quincuncial arrangement. The observation (ref. 1, p. 54) that, in plants with variable numbers a hexamerous calyx or corolla may consist of two trimerous whorls while a pentamerous one is quincuncial, is therefore only to be expected, and does not justify the conclusion that the oblique member in the quincuncial arrangement is the result of the fusion of one external member with one of the internal ones.

It is not my purpose to belittle the significance of evidences of trimery in the Ranalean flower, or to deny the conclusions reached by Salisbury and others as to increase or decrease in the number of floral parts, but merely to point out that peculiarities of æstivation are often only expressions of geometrical necessity, and are therefore not available as evidence for determining the course of floral evolution.

K. J. DORMER

University College,
Nottingham.
May 19.

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Initiation of Explosions by Grit Particles

EARLIER work[1,2] has shown that the initiation of liquid and solid explosives by impact or friction is due to the formation of localized hot spots. These hot spots may be generated by adiabatic compression of small entrapped bubbles, by friction and shear at solid surfaces, and, in extreme cases, by the viscous heating of rapidly flowing explosive. It was found that for nitroglycerine the minimum temperature of the momentary hot spot necessary for initiation by friction was *c.* 400–500° C.

It is known that explosives are made more sensitive both to impact[3] and to friction[1] if small particles of grit are mixed with them. The early work showed that the rise in the surface temperature of a solid under friction is usually limited by its melting point. If initiation is due to the development of hot spots on the grit particles, we should therefore expect that the effectiveness of a particle would depend on its melting point. Some experiments have been carried out to investigate this.

A few small solid particles of known melting point were added to the solid explosive, which was spread as a thin layer between flat steel surfaces. In one series of experiments the explosive was then subjected to rapid shear, while in another series it was subjected to an impact just strong enough to give very occasional explosions (*c.* 2 per cent) in the absence of any grit. Over the range used the hardness of the particle was relatively unimportant, but its effectiveness in initiating an explosion depended on its melting point.

Initiation of P.E.T.N. in the presence of foreign particles

'Grit' added	Hardness (Moh scale)	Melting point (° C.)	Explosion efficiency % (friction)	Explosion efficiency % (impact)
No grit	—	—	0	2
Ammonium nitrate	2–3	169·6	0	~2·5
Potassium hydrogen sulphate	3	210	0	~2·5
Silver nitrate	2–3	212	0	2
Sodium dichromate	2–3	320	0	0
Sodium acetate	1·5	324	0	0
Potassium nitrate	2–3	334	0	0
Potassium dichromate	2–3	398	0	0
Silver bromide	2–3	434	50	6
Lead chloride	2–3	501	60	27
Silver iodide	2–3	550	100	—
Borax	3–4	560	100	30
Bismuthinite	2–2·5	685	100	42
Glass	7	800	100	100
Chalcocite	3–3·5	1100	100	50
Galena	2·5–2·7	1114	100	60
Calcite	3	1339	100	43

The hardness of P.E.T.N. is *c.* 1·8 and its melting point 141° C.

The friction experiments gave the results with P.E.T.N. shown in the fourth column of the accompanying table. All the substances melting above 430° C. were effective in initiating this explosive, while all those melting below 400° C. had no effect. Similar results were obtained for the frictional initiation of lead azide, but in this case the limiting temperature was somewhat higher. Silver iodide melting at 550° C. and all substances of higher melting point were effective, but lead chloride, melting point 501° C., and lower melting solids were not.

The last column of the table shows the impact sensitivity of P.E.T.N. under similar conditions, and again it will be seen that only substances melting above 430° C. were effective. Impact experiments on lead styphnate and mercury fulminate gave similar results, but the limiting melting point was about 500° C.

High-speed camera studies confirm that initiation occurs at the grit particle, and that the first stage of propagation is usually a slow burning[4]. These simple experiments indicate that the initiation of explosives containing grit is due to the formation of hot spots on the grit particle. Under the conditions of these experiments, the minimum effective hot-spot temperature for the explosives studied was again about 400–500° C.

We thank the Ministry of Supply (Air) and the Royal Society for grants for equipment, and Imperial Chemical Industries, Ltd. (Explosives Division), for the research maintenance of one of us (O. A. G.).

Note added in proof (*October* 8). Recently, Ubbelohde *et al.*[5] have published results on the effect of grit. Under the conditions of their experiments they did not observe an increase in sensitivity unless the hardness of the grit exceeded 4 on the Moh scale. They find supporting evidence for hot spot initiation in that the sensitivity with hard grit particles is influenced by the melting point of the anvil.

F. P. Bowden
O. A. Gurton
Research Group on the Physics and
Chemistry of Rubbing Solids,
Department of Physical Chemistry,
Cambridge.
May 27.

[1] Bowden, F. P., Stone, M. A., and Tudor, G. K., *Proc. Roy. Soc.*, A, **188**, 329 (1947).

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Dielectric Properties of Mixed Barium and Strontium Titanates at 10,000 Mc./s.

Measurements have been made of the complex permittivity ($\kappa' - j\kappa''$) of a series of mixed barium and strontium titanates at 9,450 Mc./s. and 20° C. by a technique, already described[1,2], which employs a wave-guide containing a multilayer dielectric slab.

The variation of κ' and $\tan\delta$ ($= \kappa''/\kappa'$) at 9,450 Mc./s. is shown in Fig. 1, and also that of κ' at 1·5 Mc./s., for purposes of comparison. The value of $\tan\delta$ at 1·5 Mc./s. is of the order 0·01 throughout.

It is well known that the addition of strontium titanate to barium titanate lowers the temperature of the Curie point by an amount proportional to the percentage of strontium[3]. The Curie point occurs at 20° C. for the composition 72 per cent $BaTiO_3$, 28 per cent $SrTiO_3$. The marked variation in permittivity which occurs at 1·5 Mc./s. for 72 per cent $BaTiO_3$ is considerably modified at 9,450 Mc./s. and results for the compositions 66 and 75 per cent $BaTiO_3$, lying closely on either side of this point, suggest that there is no great perturbation in the dielectric properties, although this has not been closely investigated. The dispersion in permittivity suddenly becomes appreciable, and the loss tangent rises rapidly for concentrations of barium titanate well below that at which the material becomes permanently polarized.

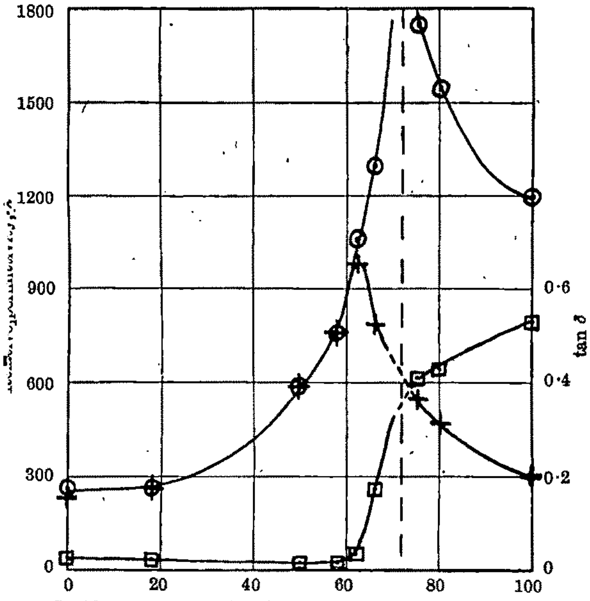

Fig. 1. Barium-strontium titanate mixtures at 20° C. ⊙, κ' at 1·5 Mc./sec.; +, κ' at 9,450 Mc./sec.; □, $\tan\delta$ at 9,450 Mc./sec.

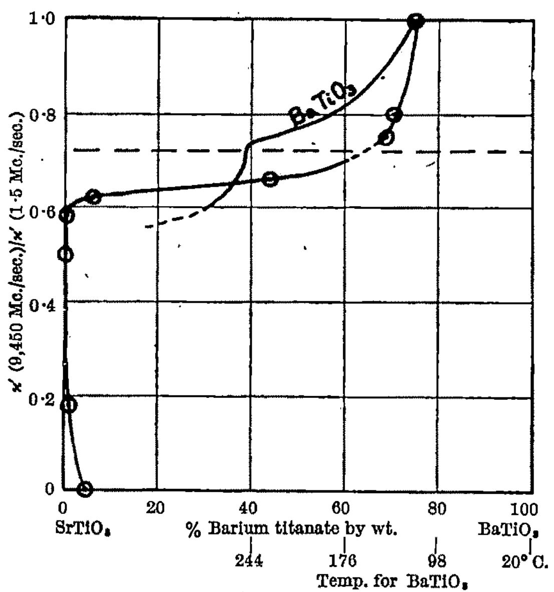

Fig. 2

An alternative way of showing the dispersion is to plot $\frac{\kappa' \text{ (at 9,450 Mc./s.)}}{\kappa' \text{(at 1·5 Mc./s.)}}$ versus composition as in Fig. 2.

On the same figure is plotted the result for barium titanate alone, at variable temperature[2], where the temperature scale is related to the composition of the mixed titanate by the shift in the Curie point mentioned above. The essential similarity of the two curves may be noted, and also the fact that in both cases the dispersion is closely associated with the permanently polarized condition.

Incidentally, the material with composition 56 per cent $BaTiO_3$ 44 per cent $SrTiO_3$ having $\kappa' = 760$ and $\tan\delta = 0·02$ at 9,450 Mc./s. and 20° C. should be of considerable technical importance in microwave work. The maximum permittivity value observed was 990 with $\tan\delta = 0·04$ at a composition of 62 per cent $BaTiO_3$ 38 per cent $SrTiO_3$.

I wish to thank Mr. Popper, of Philips Electrical, Ltd., for providing suitable ceramic materials.

J. G. Powles
Electrical Engineering Department,
Imperial College of Science and Technology,
London, S.W.7.
Sept. 9.

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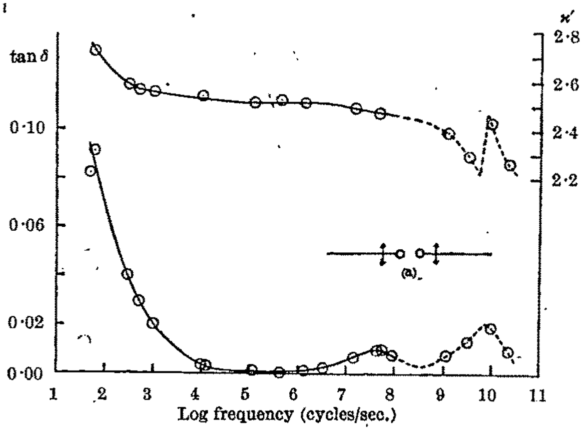
Dielectric Behaviour of Methyl Palmitate: Evidence of Resonance Absorption

THE complex permittivity $\varkappa = \varkappa' - j\varkappa''$ of methyl palmitate, $C_{15}H_{31}COO.CH_3$ (melting point (sharp) 29·7° C.), has been determined at room temperature (17–20° C.) over the frequency-range 50–3 × 10^{10} cycles/sec., with the results shown in the diagram, in which $\varkappa''$ is presented in terms of the tangent of the dielectric loss angle, $\tan \delta = \varkappa''/\varkappa'$. The 50–$10^4$ c./s. measurements were made on a Schering bridge; the 10^4–10^8 c./s. ones by a reactance variation resonance method[1], and the higher-frequency measurements by use of a number of cavity resonators[2].



The results reveal three absorption regions in the spectrum investigated, and in seeking an explanation of the mechanism of these the following possibilities must be considered: normal (D.C.) conduction; anomalous conduction arising from the presence of aggregations of conducting impurity; dipole relaxation; and the occurrence in this frequency-range of a natural vibration frequency of the dipolar molecules or of parts of these molecules. The measured D.C. conductivity was found to account for no more than 1 per cent of the low-frequency value of $\tan \delta$, and the material tested was of such purity as to exclude the second possibility. In connexion with the third, if there exist two positions of equilibrium corresponding to opposite dipole directions with a transition probability of p per sec., then energy absorption will occur around the frequency $p/2\pi$ c./s. With methyl palmitate there appear to be two such possibilities, involving rotation of the molecule about its axis and about an axis perpendicular to this. Since the probability of the latter type of rotation would seem to be small, the absorption between 50 and 10^3 c./s. may perhaps be accounted for on this basis. Unfortunately, in the absence of measurements at still lower frequency, the peak of this absorption is undetermined; but there is reasonable correlation between the observed changes of $\varkappa'$ and $\tan \delta$ in this region, and they indicate an effective resolved component of dipole moment of the order of 1·3 Debye units.

On this basis the second absorption is presumably due to a rotation of the molecule about its axis, though, since it has been concluded by Malkin[3] from X-ray studies that methyl esters crystallize as double (end-on) molecules, the moving unit may be the double molecule. It can be estimated from the variation of $\tan \delta$ in the region of this second absorption that $\varkappa'$ should decrease by 0·06, which is consistent with the observed variation of $\varkappa'$, and suggests an effective resolved part of the dipole moment, in this case, of about 0·4 Debye units.

The variation of $\varkappa'$ associated with the third, ultra high-frequency, absorption region would seem to identify this as a resonance phenomenon; although, if a curve be drawn through the four available experimental points, this variation appears as the inverse with respect to frequency of what is to be expected. This suggests that the four points at which measurements have thus far been made are inadequate to afford full resolution of the dispersion and absorption, and measurements at additional frequencies and at low temperatures are essential for clarification.

A resonance absorption in solids in the electrical spectrum has not previously been reported; but the prospect of this occurrence with compounds of the type under consideration within the 1/10 to 1/100 cm. wave-length band (3 × 10^{11} – 3 × 10^{12} c./s.) has been predicted by Fröhlich[4]. The evidence that methyl esters crystallize in double molecules suggests, as one possibility, that the resonance may be due to oscillation of the component single molecules about an axis perpendicular to their length, in the manner indicated at (*a*) in the diagram. If this be so, the frequency of vibration would presumably be lower than for the type of oscillation discussed by Fröhlich.

It is desired to emphasize the tentative nature of the explanations suggested above pending the completion of further work now in progress.

Our thanks are due to Dr. L. Hartshorn, of the National Physical Laboratory, for help in connexion with the low-frequency measurements, and of one of us for a studentship provided by the Australian Council for Scientific and Industrial Research.

J. S. DRYDEN
WILLIS JACKSON

Electrical Engineering Department,
Imperial College of Science and Technology,
London, S.W.7. Sept. 1.

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Velocity of Sound in Free Air

A PREVIOUS communication[1] described an oscillographic method for measuring the velocity of sound in air. Further experiments have been made during the past four years, with the aid of a grant from the Research Committee of King's College, Newcastle-upon-Tyne, and during 1947 a series of 940 determinations was made in the Bute Hall of the University of Glasgow.

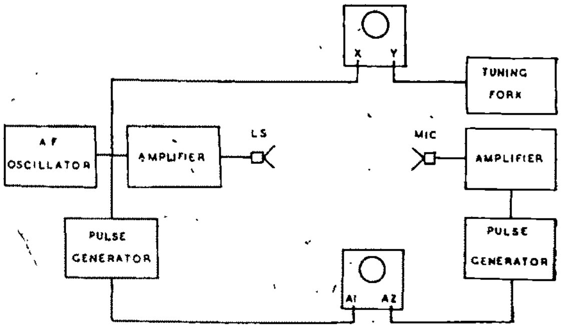

Fig. 1. General arrangement of apparatus

The object of these experiments was to measure the velocity of sound in free air with an accuracy of the same order as that which has been achieved in the best supersonic measurements. The general arrangement of the apparatus is shown in Fig. 1. Sound, at 13,500 c./s., was emitted by a small moving-coil loud speaker connected through an amplifier to an audio-frequency oscillator, and was detected by a receiver, consisting of another loud speaker, identical with the first, mounted on a screw mechanism, permitting it to be moved relative to the source, along the line joining their centres. The output from the receiver was amplified and passed to a pulse-generating circuit, which delivered a train of pulses, each about a microsecond in duration. These pulses were used to deflect one beam of a double-beam oscillograph, which had an internal time-base, synchronized by the audio-frequency oscillator output.

If the microphone was moved relative to the source, the pulses travelled across the screen, and the distance between two successive positions of the microphone at which a pulse coincided with an arbitrary reference mark on the screen was equal to the wave-length of the sound. The reference mark was obtained by connecting the audio-frequency oscillator to a pulse-generating circuit, and applying the resulting pulses to the other beam of the oscillograph.

At a frequency of 13,500 c./s., the wave-length of sound at normal temperatures is about one inch. The screw was six feet long and was fitted with a scale calibrated in thousandths of an inch. By moving the microphone, simultaneously observing the oscillograph screen through a telescope, and counting the transits of the receiver pulses, a length equal to 40 wave-lengths was measured 940 times, under varying atmospheric conditions. The frequency of the oscillator was checked continuously against that of a 1,000 c./s. valve-maintained tuning fork (which had an accuracy of a few parts in a million), using a Lissajous figure on the screen of a subsidiary oscillograph; after the apparatus had been operating continuously for a fortnight, the frequency drift was very small and could easily be corrected. The temperature was found by observation (through a telescope several yards away) of two mercury thermometers suspended between the source and the receiver. The humidity of the air was found from readings with a whirling hygrometer, and the carbon dioxide content was measured with a Haldane carbon dioxide apparatus. The room in which the experiments were conducted was 115 ft. long, 69 ft. wide and 67 ft. high; it was empty of furniture and was free from serious draughts. The apparatus was placed in the centre of the room, well clear of the floor, and no reflexions from walls or ceiling were detected.

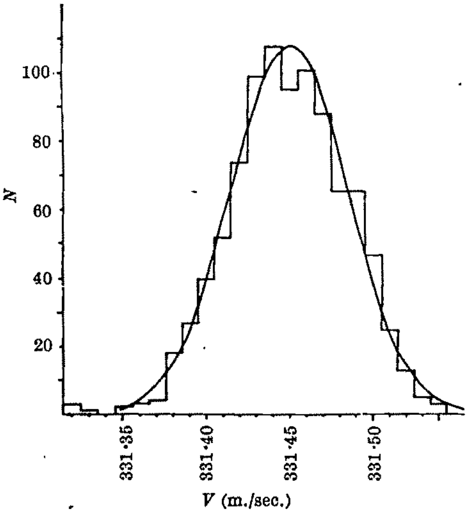

Fig. 2. Distribution of the 940 results, with normal error curve superimposed

Corrections were applied to the results for the influence of the following factors: (1) temperature, which affects (*a*) the density, (*b*) the specific heat C_v, and (*c*) the imperfection of the air; (2) presence of water vapour, which affects (*a*) the density and (*b*) the specific heat C_v of the air; (3) the known error of the screw and the thermometer.

The mean value found for the velocity of sound at a frequency of 13,500 c./s. in dry air at temperature 273·16° K. and pressure 1013·2 mb., containing 0·03 per cent of carbon dioxide, was 331·45 ± 0·04 metres per second. The distribution of the 940 results is shown in Fig. 2, with the normal error curve for the same number of results and the same standard deviation superimposed for comparison.

A fuller account of this work is being prepared for publication elsewhere.

J. M. A. LENIHAN

Natural Philosophy Department,
University, Glasgow, W.2.
June 9.

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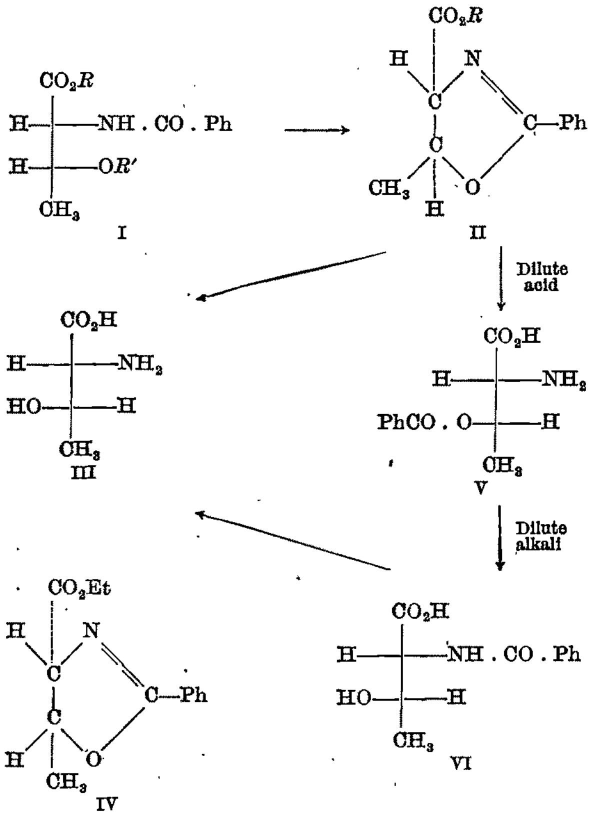
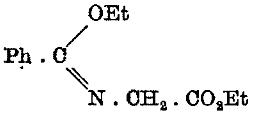
Studies in the Synthesis and Isolation of Threonine

IN a communication to the editor of the *Journal of the American Chemical Society*[1] which has just been received are described the conversion of DL-N-benzoyl*allo*threonine methyl ester (I, R = Me; R' = H) into the corresponding oxazoline (II, R=Me) by the action of thionyl chloride and hydrolysis of the oxazoline with acid to give DL-threonine (III). This discovery was anticipated by Attenburrow, Elliott and Penny[2], who described not only the thionyl chloride method of inverting the configuration of DL-N-benzoyl*allo*threonine ethyl ester (I, R=Et; R'=H), but also a second and closely related method consisting of the treatment of the *p*-toluenesulphonyl derivative (I, R=Et; R'=Ts) with potassium acetate in boiling alcohol, followed by acid hydrolysis. The same oxazoline (II, R=Et) was produced in both cases, and the view was advanced that inversion of configuration took place simultaneously with ring closure. The *trans* structure was therefore assigned to the oxazoline on the basis of the known configuration of threonine[3].

It has now been found that the reaction of DL-threonine ethyl ester hydrochloride with benzimido-ethyl ether constitutes a third method of preparing the oxazoline (II, R=Et). In this type of reaction, which was first applied by Barber *et al.*[4] to ethanolamine, the configuration of the threonine molecule is retained. In a similar way the *cis*-oxazoline (IV), which yielded pure DL-*allo*threonine on acid hydrolysis, was prepared from DL-*allo*threonine ethyl ester hydrochloride. The *cis*-oxazoline, when boiled with aqueous alkali, was rapidly converted into the *trans* form with simultaneous hydrolysis of the ester group. The resulting *trans*-2-phenyl-5-methyl-Δ^2-oxazoline-carboxylic acid (II, R=H) was also obtained by hydrolysis of the *trans*-oxazoline ester (II, R=Et) in the same way. This interconversion, which must be the result of an equilibrium reaction favourable to the *trans* form, probably occurs via the anion of the oxazoline ester. The *trans* structure was assigned to the carboxylic acid because it was converted successively into DL-O-benzoylthreonine (V) and DL-N-benzoylthreonine (VI) by the action of dilute acid and alkali respectively. It seemed scarcely possible that any configurational changes could occur in these reactions.





VII

As a result of these discoveries, the separation of stereoisomers described in an earlier synthesis of DL-threonine[2] has been rendered unnecessary. Crude DL-ethyl-α-benzamido-β-hydroxybutyrate, an intermediate product in the synthesis, was converted into a mixture of the oxazolines II and IV by the action of thionyl chloride and then into pure DL-N-benzoylthreonine by the series of changes already described. The overall yield was about 60 per cent. Details of this work have already been submitted for publication in the *Journal of the Chemical Society*. It follows from these experiments that the interconversion of D- and L-threonine should be readily achieved, and this is being investigated.

The reaction of benzimidoethyl ether with threonine ethyl ester hydrochloride has been used for the isolation of threonine from casein. Commercial casein was hydrolysed with hydrochloric acid, and after removal of the glutamic acid and the basic amino-acids the remaining mixture was esterified and subjected to the action of benzimidoethyl ether. It was known that glycine ethyl ester hydrochloride would be converted into the derivative (VII) by this reaction[5] and also that compounds of this type, when treated with alkali, would be converted into the corresponding acylamino-acids[6]. It was assumed that other monoamino-acids would behave similarly.

The product was hydrolysed with alkali and acidified to *p*H 1. The acid-insoluble N-benzoyl compounds were removed by extraction, leaving in solution only the acid-soluble O-benzoyl derivatives of serine and threonine. These were converted into the N-benzoyl derivatives when the solution was again made alkaline. As was expected from stereochemical considerations, the N-benzoylserine was racemic. It was separated from the L-N-benzoylthreonine in a pure condition as the sparingly soluble β-phenylethylamine salt. The L-N-benzoylthreonine remaining in the mother liquors as a soluble salt was purified as the free acid by counter-current distribution between ether and water. The yield of L-N-benzoylthreonine was about 10 per cent of that to be expected from the threonine content of the casein hydrolysate.

Experiments are being continued and will be published in full at a later date.

D. F. Elliott

National Institute for Medical Research,
London, N.W.3.

Aug. 24.

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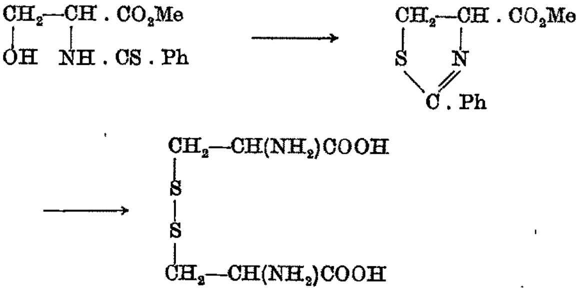
Conversion of DL-Serine into Inactive Cystine

In a previous paper[1] it was shown that DL-N-benzoyl*allo*threonine ethyl ester was converted into the corresponding oxazoline ester with inversion of configuration at the β-carbon atom by the action of thionyl chloride.

This reaction has now been used for the replacement of the hydroxyl group in serine by a thiol group. DL-Serine methyl ester hydrochloride was converted into DL-N-thiobenzoylserine methyl ester by the method of Holmberg[2]. The latter substance, on treatment with thionyl chloride, afforded the corresponding thiazoline in almost quantitative yield. Hydrolysis of the thiazoline and oxidation of the product gave inactive cystine in good yield. Similar reactions have



been carried out on DL-*allo*threonine ethyl ester hydrochloride.

These investigations are being continued.

D. F. ELLIOTT

National Institute for Medical Research,
London, N.W.3. Aug. 24.

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[1] Attenburrow, J., Elliott, D. F., and Penny, G. F., *J. Chem. Soc.*, 310 (1948).

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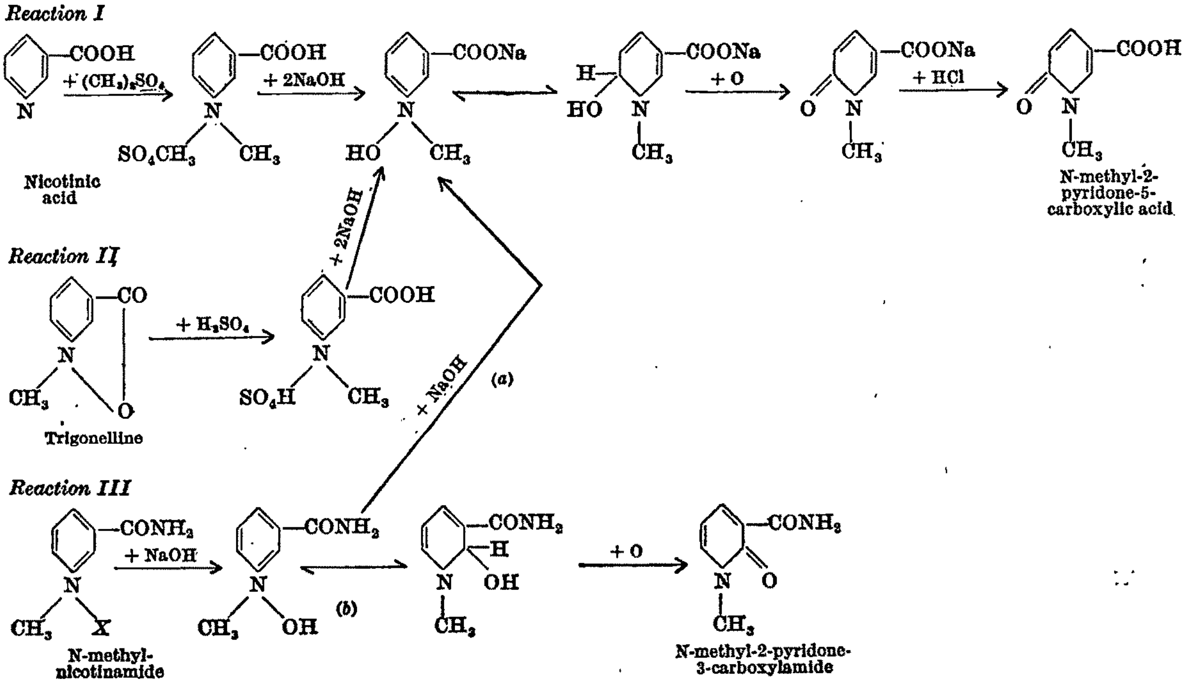
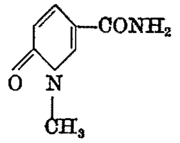
Synthesis of Derivatives of N-Methyl-2-Pyridone from Nicotinic Acid and Nicotinamide

IT is well known that N-methylnicotinamide is formed from nicotinamide by methylation in the human body, and Knox and Grossman[1,2] have shown that N-methylnicotinamide is itself capable of being metabolized. These workers not only demonstrated that N-methylnicotinamide could be oxidized to N-methyl-2-pyridone-5-carboxylamide by an enzyme present in rabbit liver; but they also succeeded in isolating the latter compound from human urine after the ingestion of doses of 0·6–0·9 gm. of nicotinamide per day.

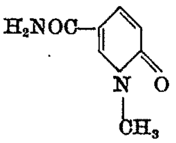
Knox and Grossman described the compound as 1-methyl-3-carboxylamide-6-pyridone, and the corresponding acid as 1-methyl-3-carboxy-6-pyridone. Their nomenclature is similar to that adopted by Beilstein (1-methyl-6-pyridone-3-carboxylic acid), but differs from that used by the earlier workers in this field[3-6], who invariably used the name N-methyl-2-pyridone-5-carboxylic acid.



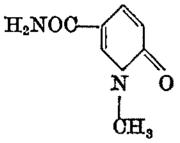
Both names are acceptable, but we prefer to regard the compound as N-methyl-2-pyridone-5-carboxylamide, not only because the earlier workers used this nomenclature, but also because it seems to us to show more clearly the relationship of the compound, from the point of view of chemical structure, to the isomeric N-methyl-2-pyridone-3-carboxylamide (see later). No confusion exists in the literature as to the nomenclature of the latter compound.



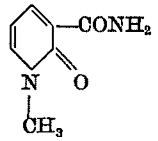
1-methyl-3-carboxylamide-6-pyridone



N-methyl-2-pyridone-5-carboxylamide



N-methyl-2-pyridone-5-carboxylamide



N-methyl-2-pyridone-3-carboxylamide

We have studied[7] the reactions which occur *in vitro* when nicotinamide or nicotinic acid is methylated and is then oxidized by the method of Decker[8,9]. It was found that nicotinic acid gave N-methyl-2-pyridone-5-carboxylic acid after methylation and oxidation, but that nicotinamide gave the amide of the isomeric acid, namely, N-methyl-2-pyridone-3-carboxylic acid. These results provided the first evidence that the course of the Decker conversion may be influenced by the nature of the substituent in the 3-position. They also indicated either that the methylation and oxidation of nicotinamide follows a different course *in vitro* from that *in vivo*, or that nicotinamide is converted to nicotinic acid before being methylated and oxidized in the animal body.

After this work was completed, a recent paper of Huff[10] came to our notice, in which he described the preparation of N-methyl-2-pyridone-5-carboxylic acid by the oxidation of either trigonelline acid sulphate or N-methylnicotinamide. Since Huff provided no explanation for the reactions which occurred, and since his results might appear to conflict with our findings, it seemed desirable that the position should be clarified. His findings and our own have therefore been combined in the accompanying diagram.

The methylation of nicotinic acid with dimethyl sulphate and the oxidation of the methylation product with alkaline ferricyanide by our method proceeds according to reaction I. The preparation of trigonelline acid sulphate from trigonelline and its oxidation with alkaline ferricyanide, as described by Huff, is shown in reaction II. It is clear that these reactions are very similar. In both cases there is a free carboxylic acid group in the 3-position before oxidation occurs.

The oxidation of N-methylnicotinamide is shown in reaction III. Since the amide group in the 3-position can be easily removed by saponification, the reaction can follow two courses (*a* and *b*). If N-methylnicotinamide is oxidized by our method, saponification does not occur, since a low temperature is maintained and the alkali and ferricyanide are added simultaneously. Only N-methyl-2-pyridone-3-carboxylamide is formed (reaction III *b*), which may be isolated by repeated extractions with chloroform. In the method of Huff, however, the alkali is added at room temperature, and before the ferricyanide. In this case reaction III *a* also occurs. Huff isolated only N-methyl-2-pyridone-5-carboxylic acid from the reaction mixture, and did not attempt to isolate N-methyl-2-pyridone-3-carboxylamide.

The following experiment confirms our previous results and clarifies those of Huff. Two 10-gm. portions of N-methylnicotinamide iodide were oxidized side by side, one according to our procedure and the other by a method similar to that of Huff. In the latter case the alkali was added to the solution of N-methylnicotinamide at room temperature, and the ferricyanide was added half an hour later. In both cases N-methyl-2-pyridone-3-carboxylamide was isolated from the reaction mixture; but the yield was greater by our method. No trace of N-methyl-2-pyridone-5-carboxylic acid could be found in the mother liquor when the oxidation was arranged to take place as described by us; but, when Huff's method was used, 0·5 gm. of crude N-methyl-2-pyridone-5-carboxylic acid was obtained. After further purification, by crystallization from water, the melting point was 238°, which agrees well with the value of 237–238° reported by von Pechmann and Welsh[5].

It is clear that only in method III *b* is the amide group present in the 3-position before oxidation, and that only in this case is the 2,3-isomer formed. It is also apparent that the method of Huff for the preparation of N-methyl-2-pyridone-5-carboxylic acid from N-methylnicotinamide represents a side-reaction, and does not indicate the true course of the oxidation of N-methylnicotinamide *in vitro*.

CHR. WIEGAND
Farbenfabriken Bayer,
Wuppertal-Elberfeld.

W. I. M. HOLMAN
Medical Research Council,
Department of Experimental Medicine,
University of Cambridge.

June 8.

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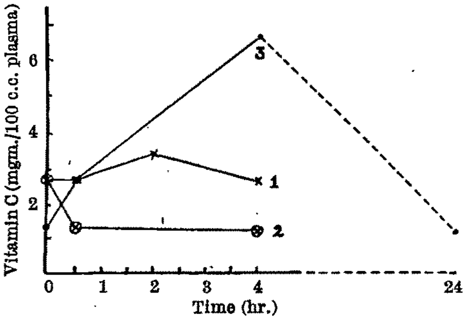
Species Difference in the Biosynthesis of Vitamin C and Response to Diabetogenic Substances

Tidwell and Axelrod[1] have recently confirmed the views of Nath and Brahmachari[2] regarding the initial stimulation of islet cells and excess production of internal insulin in the experimental animals by injection of intermediary fat metabolites, especially sodium aceto-acetate. Their findings that the condition of hyperglycæmia cannot be developed in rats even after the injection of sodium aceto-acetate for 28 days (daily dose 18 mgm. per 100 gm. body-weight) also confirm the recent findings of Nath and Brahmachari[3], who observed a 50 per cent increase in the potency of the pancreatic insulin of the treated guinea pigs in about twenty-five days, and a marked decrease in the activity of internal insulin only on prolonged injection for about seventy days.

In their three-day injection experiments, however, Tidwell and Axelrod observed that rats are far less susceptible to the action of aceto-acetate, especially towards the degree of increase in blood sugar, than the rabbits used by Nath and Brahmachari[2], and they (Tidwell and Axelrod) have pointed out that species difference might play an important part in the response to diabetogenic substances. Thus, though alloxan is known to cause marked diabetogenic effect on rats, Scott *et al.*[4] find little evidence of injury produced by it in islet cells in various species of birds, while Ruben and Yardumian[5] have shown that mere enteric absorption of alloxan is quite sufficient to injure the β-cells of the islets of rabbits.

Attempts were therefore made to see if such difference in behaviour could be accounted for through differences in the capacity for immediate biosynthesis of vitamin C, which is known to be highly beneficial in improving carbohydrate tolerance of diabetics[6]. Mosonyi[7] has shown that animals which produce ascorbic acid react to the administration of chemicals, especially of some ketones, by increasing the ascorbic acid excretion; though chloroform was ineffective in causing increase in the biosynthesis of vitamin C in rats, chloreton, a condensation product of acetone and chloroform, has been found by Ghosh[8] to exert great influence in the process.

In order to investigate the degree of biosynthesis in different animals (rats and rabbits) by means of a sudden shock caused through the injection of some intermediary fat metabolites, the following experiment was undertaken. Sodium aceto-acetate in the dose of 18 mgm. per 100 gm. body-weight was injected intramuscularly into some groups of animals



Curve 1 : rabbits, 6 mgm. sodium aceto-acetate per 100 gm. body wt.
,, 2 : ,, 18 ,, ,, ,, ,,
,, 3 : rats, ,, ,, ,, ,,

of each kind, and the quantity of vitamin C in 100 c.c. of plasma was estimated colorimetrically (by means of a photo-electric colorimeter) according to the usual method with the indophenol dye. The results of the preliminary observation are represented graphically.

This figure shows that the rabbits are unable to adjust themselves with the biosynthesis of their high requirements of vitamin C in order to cope with the situation, but that rats can go on synthesizing it even with such a high dose of the keto compound. 6 mgm. of the keto acid per 100 gm. of the body-weight (that is, one-third of the previous dose) can, however, excite the mechanism of biosynthesis of vitamin C to some extent in rabbits.

Work has also been undertaken to study the influence of vitamin C in accelerating the process of ketolysis, as well as in checking the process of glycogenolysis by perfusion experiments with kidney and liver slice respectively in the Ringer's solution modified by Krebs[9]. 5 mgm. of vitamin C per c.c. of the reaction mixture is found to accelerate ketolysis by 70 per cent in thirty minutes in a solution containing 200 mgm. of sodium aceto-acetate per c.c.; and 2 and 5 mgm. of vitamin C have been found to inhibit the degree of glycogenolysis by 37 per cent and 60 per cent respectively in one hour.

Further work is in progress.

M. C. NATH
C. H. CHAKRABORTY
V. G. HATWALNE
KUSUM S. LAUL

Department of Biochemistry,
University, Nagpur.
June 24.

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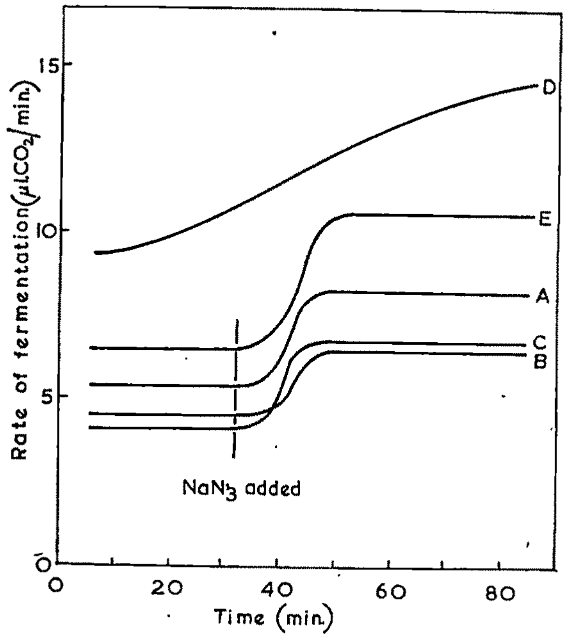
Use of Certain Growth-Inhibitors as Tools in Metabolic Investigations

CULTURES of *Saccharomyces carlsbergensis* grown in the presence of sub-optimal amounts of vitamin B6, biotin, or pantothenic acid, and containing in each case less than one tenth of the normal quantity per mgm. of the growth-factor, possessed reduced rates of fermentation, which could be increased within a few minutes at most by addition of the latter. A rapid and marked stimulation was produced also by the addition of sodium azide in suitable concentrations; typical results are shown in the accompanying figure.

Sodium azide did not increase the rate of fermentation of the normal yeast in the medium containing ammonium sulphate (*D*). Growth of each yeast, in contrast, was strongly inhibited by the same concentration of azide.



Influence of vitamin deficiencies and sodium azide upon rate of fermentation by *S. carlsbergensis*. *A*, B6-deficient; *B*, pantothenic acid-deficient; *C*, biotin-deficient; *D*, and *E*, grown in medium containing all essential growth-factors. The liquid in the manometers contained glucose (3 per cent), KH_2PO_4 (*M*/30), $(NH_4)_2SO_4$ (2·5 mgm./ml.), and usual amounts of other mineral salts; $(NH_4)_2SO_4$ was omitted in *E*. Sodium azide was added at the points indicated; effective concentrations were 5×10^{-5} *M* for *A* and *E*, and 10^{-5} *M* for *B* and *C*. All fermentations were run at 30° C. in an atmosphere of nitrogen. 1 mgm. (dry weight) of yeast was used in each experiment

Sodium azide, 2 : 4-dinitrophenol, and possibly certain other cell-poisons appear to release fermentation and respiration from the controlling influence of endergonic processes, exercised through the transphosphorylation mechanisms[1,2]. In view of this, the above results appear to indicate that vitamin B6, biotin, and pantothenic acid do not participate directly in the reactions involved in alcoholic fermentation; but influence the latter only indirectly by probable functions in the anabolic activities of the cell.

R. J. PENNINGTON

Department of Industrial Fermentation,
University, Edgbaston,
Birmingham 15.

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Retinene₁ and Indicator Yellow

Ball, Collins, Morton and Stubbs[1] have found that retinene$_1$ may combine with various proteins and amino-acids to give compounds with the properties of Lythgoe's indicator yellow. This is an interesting advance in the chemistry of vision; but, as stated by Dartnall[2], does not prove that indicator yellow is a "fortuitous artefact having no direct relevance to visual chemistry".

However, Lythgoe's statement[3] that he was unable to extract retinene from bleached visual purple solutions, using petroleum ether alone as a solvent, has recently been shown by me to be erroneous[4]. Lythgoe failed probably because he did not shake his extract with enough vigour to compensate for the slow diffusion of the liberated retinene through the aqueous phase to the petroleum ether. Furthermore, even in the presence of an 'active agent' such as alcohol, retinene is not released to petroleum ether during a period of 2–10 min. after the solution is bleached[4]. This supports Dartnall's view that retinene itself is not split off the visual purple molecule by light. The actual photo-product is probably Lythgoe's transient orange[5].

Dartnall states "that when one quantum of light is absorbed one chromophore is altered, but there is no evidence for the statement, often occurring in the literature, that the secondary process following activation of the chromophore is a loosening, that is, a dissociation of the chromophore-protein bond". A similar conclusion[6] was reached on the basis of a comparative study of the squid visual purple, cephalopsin[7]. This substance is a retinene$_1$ compound which is chemically almost identical with vertebrate visual purple, but is not normally dissociated by light, either in solution or in the most sensitive preparations of living retinas[8]. An increase in retinene release from illuminated squid retinas has been reported[9], but has been shown to be an artefact[8].

Ball, Collins and Morton[10], in their answer to Dartnall, state that there are three materials in bleached solutions of rhodopsin: retinene, and the acid and alkaline forms of indicator yellow. However, according to Lythgoe[3] there are two forms of acid indicator yellow: a stable form with adsorption maximum at 450 mμ below *p*H 4 and an unstable form with absorption maximum near 445 mμ between *p*H 4 and 6. The unstable form of acid indicator yellow readily releases retinene when its solutions are shaken with petroleum ether[4], and thus probably corresponds to the "loosely bound retinene" mentioned by Ball, Collins and Morton.

ALFRED F. BLISS

Department of Physiology,
Tufts College Medical School,
Boston, Mass.

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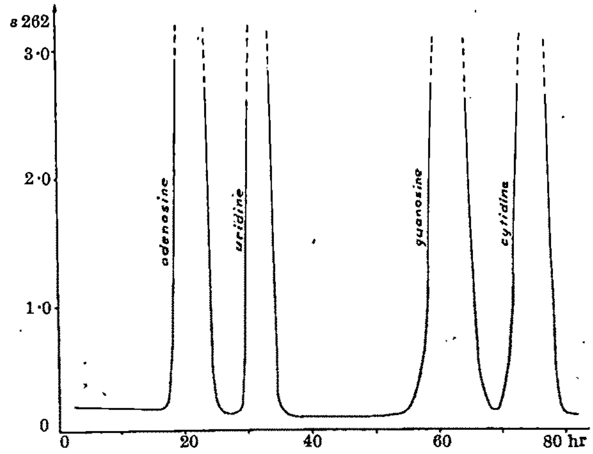
Partition Chromatography on Starch of Ribonucleosides

DURING work on ribonucleic acid turnover with nitrogen-15 in this Department, we found it necessary to isolate the different nitrogen-containing substances from small amounts of ribonucleic acid. It was thought that partition chromatography on starch as introduced by Elsden and Synge[1] might give a possible solution to our problem. Vischer and Chargaff[2] have applied partition chromatography on paper to the purine-bases; Edman, Hammarsten, Löw and Reichard[3] have worked out a method for separating guanine and adenine on a starch column. Tinker and Brown[4] have recently applied Craig's counter-current distribution technique to purines and pyrimidines and related compounds.

In regard to the pyrimidine bases, it seemed to be difficult to prepare them in a good yield from ribonucleic acid without destruction and conversion of cytosine to uracil during hydrolysis. The preparation of the ribonucleosides, however, was thought to be a simpler task, and a method for separating them from a mixture of the pure compounds on a starch column has been worked out.

The solvent chosen was butanol saturated with water. The starch was prepared by extracting ordinary commercial potato starch with methanol for 24 hours in a Soxhlet apparatus. The starch column was 200 mm. long and had an inner diameter of 23 mm. About 5 mgm. of each of the four pure ribonucleosides were dissolved in about 3 ml. of butanol–water and added to the top of the column. The butanol was run continuously for about three days; a sufficient head of liquid was kept in the column so that 5–7 ml. of fluid ran through the column per hour. The effluent was collected each hour by a simple apparatus constructed by Edman[5], and analysed in the Beckman spectrophotometer at 262 mμ. In this way the nucleosides may be easily localized (see graph). The different nucleosides have specific light absorption maxima around 262 mμ and may be characterized by comparing the light absorption at 262 mμ (maximum for uridine and adenosine), 248 mμ (guanosine) and 270 mμ (cytidine). Under these conditions, the values of *R*, according to Martin and Synge[6], for the different nucleosides were as follow: adenosine, 0·80; cytidine, 0·21; guanosine, 0·28; uridine, 0·52.



Separation of 4 mgm. of adenosine, uridine, guanosine and cytidine on a starch column 200 mm. long with butanol-water as the mobile phase

Samples containing the same nucleoside were combined, the solvent evaporated off and the residue dissolved in 0·1 *N* hydrochloric acid. The purity of the different compounds after chromatography was established by determining the ratio ε max./γ nitrogen per ml. These values obtained were: adenosine 0·196 (ε = 257 mμ); cytidine, 0·295 (ε = 280 mμ); guanosine, 0·164 (ε = 255 mμ); uridine, 0·332 (ε = 262 mμ).

The yield with about 5 mgm. of each nucleoside was 90–100 per cent. This method has been successfully applied in tracer experiments to hydrolysates of ribonucleic acid. The hydrolysis of ribonucleic acid to nucleosides was carried out with a pyridine–water mixture by a modification of Bredereck's method[7]. The results of these experiments will be published elsewhere.

PETER REICHARD

Chemical Department,
Karolinska Institute,
Stockholm.

May 27.

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EIGHTEENTH SESSION OF THE INTERNATIONAL GEOLOGICAL CONGRESS

An outline of plans for the eighteenth session of the International Geological Congress was given in *Nature*, August 7, p. 232. The proceedings lasted in all for a period of seven weeks during August and September. Much of the time was occupied by a series of thirty-seven long geological excursions, which visited important localities throughout Great Britain and eastern Ireland. Some 250 British geologists acted as organisers, directors and secretaries for these excursions and for an extensive series of additional short excursions centred on London. Despite indifferent weather, the excursion programme was extremely successful; it was clear that the excursion parties, which consisted predominantly of geologists from abroad, found interest and enjoyment in visiting the classic areas and type localities of the British Isles under the guidance of British specialists.

The formal and scientific meetings of the Congress, with an associated programme of receptions and entertainments, were held in South Kensington during August 25–September 1. The total membership of the session, including non-attending members, was more than 1,760; the total attendance of members and relatives was about sixteen hundred, including some nine hundred from overseas. Seventy-six different countries were represented; sixty-four Governments and 360 universities, societies and institutions sent official delegates.

This widely representative assembly provided the first full-scale opportunity for international geological discussion for eleven years—since the seventeenth session in Moscow; and throughout the Congress members made good use of the opportunity. The attendance at all the meetings and functions was very large. At times five sectional meetings, each with an attendance of some two hundred members, were simultaneously in progress. Audiences of nine hundred filled the lecture theatre of the Royal Geographical Society to hear special addresses by Prof. O. T. Jones and Sir Edward Bailey on "The Structural History of Britain". Colour films of the Mexican volcano Paricutin, presented by Dr. J. G. Reyna and Dr. F. H. Pough, and of the Virunga volcanoes of Africa, presented by Prof. T. W. Gevers, were shown twice because the same theatre could not hold at one time all who wished to see them. More than fourteen hundred members attended a reception by H.M. Government on the first day of the session, and a similar number were present at a reception by the Geological Society on August 31. Some six hundred official delegates and relatives were received by the Vice-Chancellor of the University of London on August 30, and many other receptions and entertainments were also successfully arranged. In addition to the formal items of the programme, members made full use for informal meeting and discussion of extensive lounge accommodation in the Geological Survey and Museum, which was the headquarters and registry of the Congress.

At the inaugural meeting in the Royal Albert Hall, Prof. H. H. Read, president of the Geological Society of London, was elected president of the Congress. Viscount Addison, Lord Privy Seal, welcomed the assembly on behalf of H.M. Government, and Sir John Anderson, honorary president of the General Organising Committee, explained how, under the ægis of the Geological Society and with active Government support through the Geological Survey and Museum, professional and amateur geologists throughout Britain had worked in face of considerable difficulties to make the Congress a success. From speeches by the heads of Government delegations at the final meeting of the general assembly on September 1, and from much informal comment, it can be judged that the delegates and members were, in fact, well pleased and satisfied with the arrangements which had been made.

During the session, the Council of the Congress arranged for the reconstitution of many of its international commissions, the work of which had been interrupted during the War. A full account of the proceedings of the Council, and of the sectional meetings, to which some 350 papers were offered, will be published in the report of the Session, but at least twelve months must necessarily elapse before this can be issued. Meanwhile, summaries of the more important decisions of the Council, and of the sectional proceedings, will appear in forthcoming numbers of the *Geological Magazine*. Further articles will also appear in *Nature*.

The Congress accepted with pleasure an invitation from the Government of France to hold the nineteenth session in Algiers in 1952. At the same time it expressed its gratitude for an invitation from the Government of India, and it is hoped that the invitation to meet in India may be renewed at the nineteenth session.

SCHOOL OF PHARMACY, UNIVERSITY OF LONDON

The Dean of the College of the Pharmaceutical Society announced at the 107th inaugural meeting on October 6 that the College is to be reconstituted on an independent basis and renamed the School of Pharmacy, University of London. It will be financed mainly from University funds.

This event marks the end of a phase of pharmaceutical education in Britain which was identified with the efforts of the members of the Pharmaceutical Society, who from their foundation in 1841 proceeded energetically to raise the status of their calling by promoting a modern system of professional education. Their aim was reaffirmed in the charter which the Society obtained in 1843, the objects of which included "the advancement of chemistry and pharmacy and the promotion of a uniform system of education". In pursuance of this policy the Society founded in 1842 what was at first known as the School of Pharmacy, the name being changed in 1926 to "The College of the Pharmaceutical Society".

The history of the School is a record of an attempt by a professional body to carry the burden of its own educational advancement, and all will join in paying tribute to the Society for success in that aim. The School from its inception has made outstanding contributions to our knowledge of pharmacy, chemistry, materia medica and medicine. The record of more than a century of endeavour is one which must redound to the credit of the Pharmaceutical Society. In 1842, with the prescience of enlightened educationists, the Society equipped and staffed a pioneer establishment on a scale which ultimately yielded rich dividends. A chemistry laboratory was established in that year which was one of the first of its type in Great Britain and which would at that time bear comparison with the best of its kind in Europe. It has housed a long list of distinguished professors, each of whom added an important quota to his science. Thus in chemistry we see the names Aufield, 1862; Tilden, 1865; Palmer Wynne, 1896; Collie, 1902; Crossley, 1904; and Dunstan, 1905; and in botany those of such figures as Robert Bentley, 1849, and Reynolds Green, 1887. In pharmacy and materia medica came Pereira, Redwood, Ince, Greenish and Wallis. The early days of the School saw the development of the use of the microscope by Greenish in the evaluation of powdered drugs. Its latter years saw the establishment, by Burn, of pharmacological laboratories for research work in methods of biological assays, and the years between had a record of steady achievement which was marked in 1926 by the recognition of the School by the University of London as a School of the University and by the establishment of a degree in pharmacy.

The reconstitution of the School brings to an end a fruitful regime of a hundred and six years, and inaugurates a new era which it is hoped to make even more productive of benefit to pharmacy than the old. Under its new title, the School will have an independent existence with a new governing body, a Council which will consist of the Dean (Prof. H. Berry), together with the following members: (*a*) nominated by the University of London: Dr. O. L. Brady, Sir Archibald Gray, Mr. John Hunter and Dr. G. B. Jeffery; (*b*) nominated by the Academic Board of the College: Prof. G. A. H. Buttle, Dr. Katharine Coward, Dr. J. W. Fairbairn and Prof. W. H. Linnell; (*c*) nominated by the Pharmaceutical Society: Mr. W. S. Howells, Mrs. J. C. Irvine, Mr. H. N. Linstead and Mr. C. W. Maplethorpe; together with three co-opted members: Sir Henry Dale, Mr. W. J. C. Quarrell and Sir Harry Jephcott, who becomes chairman of the new School Council. Mr. S. R. Curtis has been appointed secretary to the School.

BRITISH EMPIRE CANCER CAMPAIGN

THE twenty-fifth annual report of the British Empire Cancer Campaign covers the work done during the latter half of 1947. To those not acquainted with the ramifications of modern cancer research, much of the work in the report will occasion surprise, owing to its apparent lack of connexion with the subject. But the fact is that the problem of malignant growth is inextricably bound up with peculiarities of cellular respiration, nutritional requirements, hormone balance and interaction of enzyme systems; and its study demands contributions from almost every branch of science.

In the sphere of radiation physics, work has been mainly concerned with preparing the way for the future use of high-voltage radiation and of radioactive isotopes. To this end refinements of methods for accurate measurement of dosage, which becomes of increasing difficulty and importance under these conditions, have been developed. Measurements of extraneous radiations likely to harm personnel engaged in radiation therapy have also been carried out. During the year, further studies have been made on the biological effects of radiations. The extreme rapidity with which cellular changes occur is astonishing. Thus Prof. J. S. Mitchell has shown that within seven minutes of exposing cultures of chick embryo fibroblasts to X-irradiation, alterations occur in the amount of substances in the cells which cause absorption of ultra-violet light of wave-length 2537 A. Ribose nucleic acid is believed to be largely responsible for such absorption; but the possibility that other substances may be concerned is receiving attention. By standard histological methods pycnotic changes in the cell nuclei of the membrana granulosa of large ovarian follicles can be demonstrated within four hours of irradiating rats (L. Halberstaedter and M. Ickowicz). By the use of radioactive phosphorus (P^{32}) uptake as a measure of thymonucleic acid formation, Mrs. B. E. Holmes has adduced evidence that therapeutic doses of X-rays reduce the synthesis of this substance, and that this reduction may be an integral part of the damaging effects of radiations. On the clinical side, an important practical outcome of A. Glücksmann and L. G. Spear's histological method of assessing the progress of radiation therapy in cancer of the cervix uteri has been that, on the strength of it, several cases have been submitted to radical surgery, irradiation having been abandoned although in some cases the clinical response seemed favourable. In every case examination of the operation specimens showed the malignant process to be active.

Among the clinical reports is an analysis from Birmingham of survival-rates of 1,367 cases of cancer of the breast observed between 1936 and 1942. The accepted clinical opinion that the results of surgery combined with radiotherapy are superior to those of either form of treatment alone receives statistical confirmation. Owing to the small numbers, however, it is not possible to decide whether pre-operative or post-operative irradiation is the more effective method; though in the series quoted, post-operative treatment gave the better results. From St. Mark's Hospital come some important figures relating to cancer of the rectum. Of 716 cases treated between 1928 and 1941, just under half survived five years or more. But the five-year survival-rate of cases with disease confined to the rectum was more than 80 per cent, whereas those in which lymphatic metastases were present had a five-year survival-rate of just over 25 per cent. The correlation between the histological appearance of the growths and the extent of metastases was high in this series. Lymphatic spread was present in 80 per cent of cases in which 'high grade' malignancy was reported histologically; but in only 20 per cent of those reported as 'low grade'. In a very full report by the Clinical Cancer Research Committee on malignant disease of kidney, bladder and prostate, the figures concern cases treated before œstrogen therapy had been introduced for the last-named disease, and will therefore be useful for comparison with similar figures when the results of such treatment are available.

Sir Ernest Kennaway's study of the effect of circumcision on the subsequent development of cancer of the penis has already excited comment in the medical Press. He finds that the operation protects against cancer if performed at eight days but confers no protection when carried out after the fourteenth year. "The failure of the operation deferred until the 14th year to give the protection given by it when carried out on the 8th day suggests that the train of events leading to malignant growth is set going early in life, and that removal of the cause does not then avert the development of cancer at a much later age." In the experimental field the component processes which constitute "the train of events leading to malignant growth" have been characterized with greater clarity during the last fifteen years. Dr. I. Berenblum and Dr. P. Shubik have now placed such studies on a quantitative footing. Dr. Berenblum had earlier shown that croton oil, itself non-carcinogenic, would cause growths to appear when painted on the skin of mice previously treated with doses of known carcinogens insufficient to provoke neoplasia. The late Dr. J. C. Mottram showed that a single painting of carcinogen was effective when followed by croton oil applications. Using different carcinogens and varying the number and frequency of croton oil applications, Berenblum and Shubik have shown that two entirely distinct mechanisms enter into the carcinogenetic process in mouse skin. The initial painting with carcinogen produces some invisible, irreversible alteration in a few of the cells of the painted area—the 'initiating' process. The 'initiated' cells remain dormant until stimulated into activity by a 'promoting' agent—in these experiments croton oil. The recognition of these two stages explains certain discrepancies which have been encountered in assessing the carcinogenic potency of certain compounds. A compound may be a powerful initiator but a poor promoter. If its activity is measured in terms of minimal dose response it will be labelled a powerful carcinogen, since this measurement is essentially that of initiating action; whereas if average latent period for tumour production is the measurement chosen, its activity will be poor, average latent period indicating promoting action.

Of medical interest is the finding of workers in Oxford that liquor picis carb. B.P., a commonly used coal-tar preparation, sometimes prescribed for long periods, contains 0·02 per cent benzpyrene, and produced papillomas in ten weeks when painted twice weekly on mouse skin. After twenty-six weeks, 50 per cent of survivors had tumours, more than half of which became malignant.

Further work on recently discovered carcinogens has been done during the year. A curious property of 2-acetylaminofluorene, namely, the production of epitheliomas of the external auditory meatal wall, is shared by 4-dimethylaminostilbene. Taking advantage of the characteristic brilliant fluorescence of the latter compound in ultra-violet light, Glasgow workers have shown that it is excreted in the cerumen, which would account for the unusual site of tumour growth.

Work on growth inhibitors at the Royal Cancer Hospital has been considerably extended. 4-N : N-di-(2 chloroethyl)-aminostilbene, which possesses the chloroethyl groups characteristic of the nitrogen mustards, has a marked but short-lived inhibitory effect on the Walker rat carcinoma. The N : N-di-2-chloroethyl side-chain was introduced into many aromatic amines, and marked inhibitory activity has been demonstrated in the aniline, *o*-, *m*- and *p*-toluidines, *o*- and *p*-anisidine, β-naphthylamine, and *p*-aminobenzoic acid derivatives.

Much work is presented on tumour viruses. Prof. R. D. Passey and his colleagues at Leeds have examined extracts of tissues from breast tumours, and normal tissues from high- and low-cancer strain mice by means of electron microscopy. Extracts made from all tissues and from the milk of high-cancer strains consistently show numerous spherical particles of the order of 250 A. diameter. These particles are absent, or only present sporadically, in similar material from low-cancer strains. Ultra-centrifugation at 60,000–120,000 *g* removes the particles from the extracts. Even after the drastic process of extraction employed, the samples in which the particles are numerous incite mammary tumours when inoculated into susceptible mice. The particles are thus closely associated with milk-factor activity; but the authors stress the need for caution in interpreting the findings.

The *British Journal of Cancer*, which is sponsored by the Campaign, has now completed a year of publication, and gives an indication of the quality and breadth of cancer research in Britain. The present report includes work from new centres, such as the University of Bristol, the Hebrew University at Jerusalem and the University of Glasgow, which indicate how the activities of the Campaign are still growing twenty-five years after its foundation.

D. A. G. GALTON

AN ELECTRON MICROSCOPE STUDY OF CELLULOSE IN THE WALL OF *VALONIA VENTRICOSA*

By DR. R. D. PRESTON and DR. E. NICOLAI
Botany Department
AND
DR. R. REED and A. MILLARD
Department of Biomolecular Structure,
University of Leeds

DURING the past thirty years or so, intensive investigation of cellulose by various physical methods has directed attention repeatedly to the possible existence of supermolecular units of structure ranging from 'fibrils'[1] some 0·4 μ in diameter and of indefinite length to small spherical or ellipsoidal particles of diameter up to 1·5 μ [2].

While this has lent colour to speculations by earlier workers based largely on microscopical observations[3], it has never been clear that the newer physical methods yielded any more precise a picture of these units than did mere microscopical observation; nor, indeed, could it be claimed that proof had ever been given of the concrete existence of any such units in the intact, untreated walls of plant cells. With the advent of electron microscopy, however, and especially following the notable advance in manipulative technique using metal shadowing and surface replication, it became at last possible to make a direct attack on this particular aspect of cellulose structure.

Few of the many existing electron micrographs of cellulose have been very informative other than to show that, under suitable treatment, cellulose can be broken down into fibrous bodies. This has been due largely to the unfortunate choice for experimental material of either drastically treated celluloses such as filter paper or of mechanically disintegrated cellular tissues which are difficult to manipulate and the photographs of which are, by their very nature, almost uninterpretable[4].

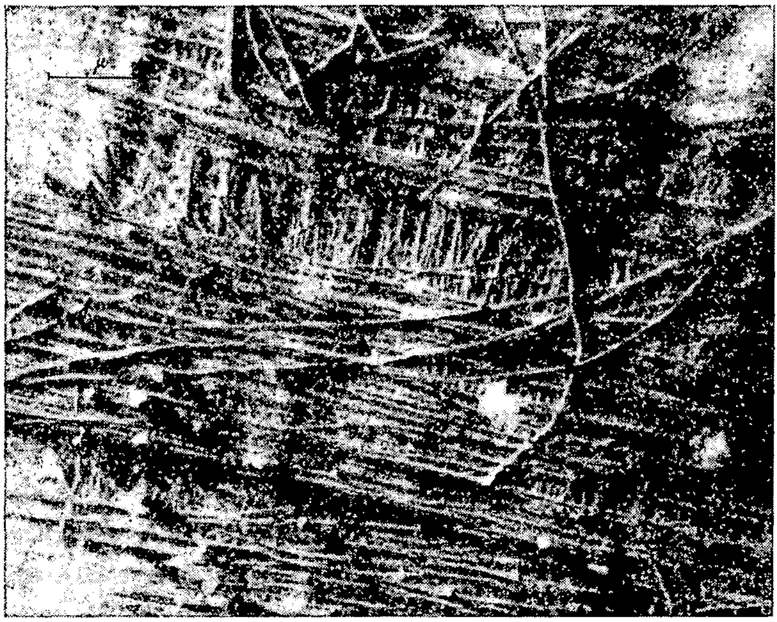

Fig. 1

The technique clearly demands a cell wall of large area, strong enough to be handled without material deformation, and the fine structure of which is already known in sufficient detail to make interpretation possible.

All these desiderata are fulfilled by the walls of the vesicles of *Valonia ventricosa*, and during the course of an intensive investigation of the cell walls of algæ initiated in the Botany Department at Leeds the organisation in this particular species, the fine structure of which is already well known[5,6], is being studied with the electron microscope. While the investigation is as yet only in the preliminary stages, the photographs obtained are already so striking that it has been thought desirable to direct attention to some of their more important features. It is not proposed to describe at this time the methods used in the preparation of the specimens examined in the microscope, except to say that all the photographs are of surface replicas, in 'Formvar' or collodion, of chromium-shadowed wall material cut from the vesicles without distortion.

Fig. 1 shows the appearance of the wall surface and Fig. 2 that of intermediate lamellæ in the wall laid bare by stripping and representing, if not the actual inner surface of the wall next to the cytoplasm, at least the condition very close to this surface.

Both photographs show a number of points of outstanding interest. First, and perhaps most unexpectedly, the wall appears to consist of fibres of indefinite length the diameters of which vary between surprisingly narrow limits around about 300 A. The uniformity alone of these fibres makes it rather certain that they are an intrinsic feature of the wall not artefacts due to intensive drying, etc., and can therefore be considered as fundamental building units of cellulose, at least as found in this particular alga. Certainly the particle hypothesis as proposed by Farr and Eckerson, upon which considerable doubt has already been cast[7], is once and for all shown invalid. The 'fibrils', on the other hand, already described for *Valonia*[8] are clearly aggregates of indefinite numbers of these fibres. At the same time, it is possibly significant to note that occasionally the clear impression is given of the presence in the wall of spherical particles, some 300 A. in diameter, linearly arranged and suggesting, therefore, a unit of smaller dimension.

Secondly, within any one lamella the fibres run closely parallel to one another, with the exception of occasional stray fibres which have probably been displaced during the preparation of the specimen. This is in harmony with the X-ray photographs[6].

Thirdly, in an adjacent lamella which can be observed through the interstices in the upper lamella, similar fibres are clearly visible which lie at an angle to the first set commonly rather less than a right angle (Fig. 1), but occasionally much less (Fig. 2), and sometimes a third orientation can be detected (Fig. 2). All this again is in harmony with the X-ray photographs, though at the moment it appears that

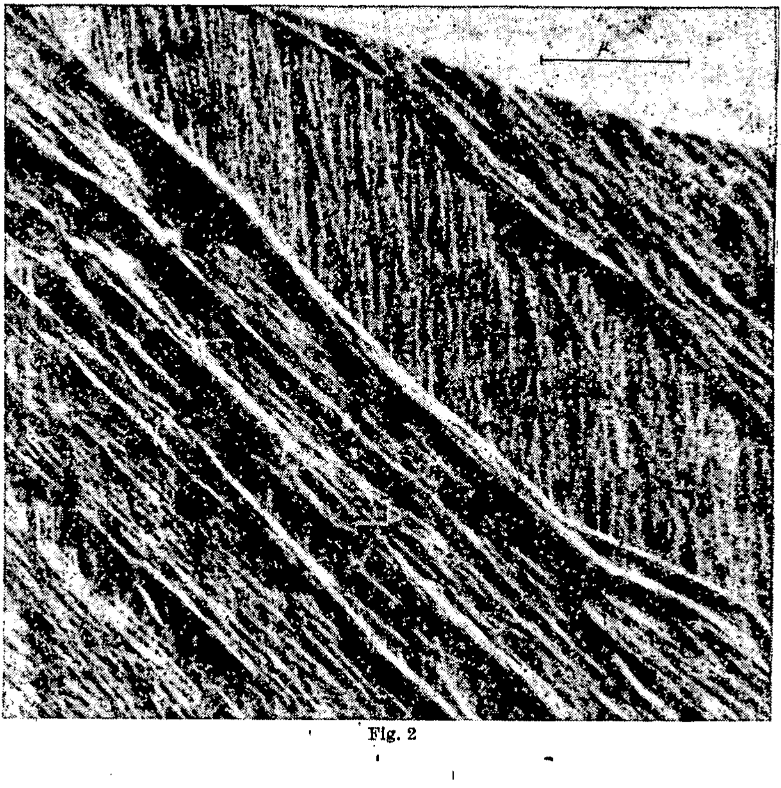

Fig. 2

the third orientation is more prevalent than these photographs gave reason to suspect.

It is clearly too early to speculate upon the precise nature of these fibres or to express any opinion as to the way in which they are produced by the plant. So far as the photographs go, however, they certainly give the impression that the fibres might be regarded as 'crystallites' of cellulose, and this would be in harmony with those properties of this particular wall which suggest a high degree of crystallinity. The density, for example, is the highest yet recorded[8] for cellulose (1·562) and suggests a crystalline/non-crystalline ratio of about 71 per cent. A determination of this ratio made for the senior author by P. H. Hermans of Utrecht (using his X-ray method), to whom our thanks are due, is on the other hand disappointingly low—lying between the values for native fibres and for wood pulp. This may, however, be due to impurities in the specimen sent to him. (A more recent determination on a purified sample is reported by Dr. Hermans to indicate a crystalline/non-crystalline ratio of 67–68 per cent.) The orientation of the fibres must be remarkably perfect, for it must be recalled that in this wall the molecular planes of 6·1 A. spacing tend to lie parallel to the wall surface. If the fibres are isodiametric in cross-section, such orientation could arise only through the prevalence of —OH groups in this plane, and would therefore presumably be initiated at the moment of deposition at the cytoplasm-wall interface, and not secondarily by changes within the mature wall. If, on the other hand, the fibres are flat ribbons (and the photographs as yet offer no evidence on this point), then the orientation could arise mechanically; though even then the orientation is not induced merely by drying, as it is in bacterial cellulose, for precisely the same condition has been demonstrated in undried algæ[9]. Finally, it should be noted that since the fibres run uninterruptedly with apparently smooth sides over distances much greater than 10 μ (width of the photographs taken), their appearance lends no support to the 'fringed micelle' hypothesis but tends rather to suggest the continuous, periodically distorted structure suggested by Meyer[10].

The senior author is indebted to Prof. W. T. Astbury, of the Department of Biomolecular Structure, for valued advice and for placing the facilities of the electron microscope at his disposal, and to the Department of Scientific and Industrial Research for a grant defraying in part the expenses of the algal research.

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THE YOUNG WORKER IN INDUSTRY

AT the discussion on "The Young Worker in Industry" arranged by Section L (Education) of the British Association on September 13, the two main contributions were from representatives of industry and of the Ministry of Education. In the first paper, which dealt with recent progress in industrial education and training, the authors pointed out that the increasing scale and complexity of British industry since the industrial revolution has been paralleled by a widening appreciation of the need for industrial workers to know something of the principles underlying the industrial arts. The establishment of the mechanics institutes and, later, technical colleges, works' schools and junior technical schools was part of the practical response to this need, as was, more recently, the setting up of the system of national certificates and the part-time day release by industry of young personnel for technical study.

War-time demands for skilled personnel stimulated realistic thinking and practical developments in the fields of selection and training. War and the post-war economic difficulties have also thrown into relief the social need for maximum economy in the use of man-power. To secure this, it is essential that all young people receive the type of education and training best suited to their interests and natural aptitudes. In this, industry has an important part to play, not only in providing information regarding the types of careers available, but also in establishing training schemes, a function of which should be the assessment under practical conditions of the trainees' suitability, not with the view of 'weeding out' failures so much as of providing training for a suitable alternative occupation where one course of training proves inappropriate.

The story of national education in Britain between the two World Wars is one of the failure in the practical application of the ideals of the Fisher Act, followed by renewed planning represented by the reports of the Consultative Committee between 1925 and 1938. The trade recessions of this period also checked progress in industrial and commercial training, which was largely in the hands of private enterprise. Some enlightened firms, however, endeavoured to repair the gaps with their works' schools, some of which have a long history. The experience gained in these schools should be of value in connexion with the proposed county colleges. The interest which young workers have in further education is, in most cases, best stimulated by basing it on their work and environment. It is suggested that the initiation courses run by many firms to help young people to bridge the gap between full-time schooling and wage earning could be paralleled by wider courses, designed with the same intent, in the county colleges to be established.

Apprenticeship is an aspect of training in which appreciable progress has been made in industry since the end of the First World War, particularly in the more technical industries such as engineering. Some of the largest concerns have comprehensive apprenticeship schemes with grades according to the educational levels of entrants—craft apprenticeship for boys from secondary modern and secondary technical schools, student apprenticeship for boys from secondary grammar and from public schools, and graduate apprenticeship for young men and women graduates. The difficulty of smaller firms in supporting schemes on such an ambitious scale is one reason for the modern tendency to discuss and plan apprenticeship schemes at a regional and national level.

Attention has also been given to practical training at the professional level, particularly in the engineering industry. For example, the Institution of Electrical Engineers has published no less than three booklets on training for the electrical industry between 1942 and 1947. The report published in 1947 makes recommendations based on the best in modern training practice in this field, and lays down practical training standards designed to secure for the young professional engineer the width of experience and consequent flexibility necessary for the continued progress of the industry. One specific recommendation is that graduate apprentices should be given leave of absence by their firms to widen their experience not only in Great Britain but also overseas. This recommendation is already being carried out by some firms, and an increasing number of overseas contacts is being made. Many foreign students are coming to Great Britain for engineering training both theoretical and practical. There is no reason why an interchange of craftsmen and technicians, as well as young professional engineers, could not be arranged to give human reality to political and economic union between countries. Already the merits of British methods of training professional engineers are widely recognized. If this reputation can be extended to other industries and vocations, Britain will have made a contribution to world prosperity equal to that made by its scientific men in the field of knowledge.

The second paper, by a representative of the Ministry of Education, indicated that it has always been traditional in Great Britain for our educational institutions to provide for the educational needs and interests of the young worker rather than for the needs of industry as such, and that likewise it is traditional for industry to take responsibility for the practical training of its young workers and to look to our educational institutions for the provision of technology and general education. The needs of industry and the interests of young people are not always identical, and it was to avoid indiscriminate recruitment regardless of aptitudes that the Juvenile Employment Service—now called the Youth Employment Service—was set up. To be fully effective, this Service must have the support of parents, teachers and employers, and be staffed with officers expertly trained in vocational guidance and having a wide knowledge of industrial conditions, so as to effect good 'placing' and to 'follow up' such placing. Much research is called for in this field.

The educational needs of young workers once they are in industry are very varied, depending on their educational level at entry and on their aspirations; but that further education must be available is now an accepted need for all. Only 30–40 per cent of 'school-leavers' at present receive any further formal education.

Of these, too high a proportion can only acquire their technology at night at the expense of their leisure, and a 40-hour week for the adult should not make us indifferent to the 60-hour week of many apprentices. The larger firms which provide systematic industrial training in works' schools usually have a close link with the technical colleges and appreciate the need for day-time release—200,000 young workers are now released for such training as compared with 40,000 in 1938. In the smaller works, many are too small to provide even good practical training facilities.

The provision of the 1944 Education Act for compulsory day-time release for young people up to the age of eighteen years tries to provide a partial answer to the problem of the youth who ends his formal education at the school-leaving age of fifteen—'partial' because industry must attempt to do its share and the work in the county colleges to be set up under the Act should be complementary to industrial training. Within the past few years, some hundreds of education officers and personnel managers have been appointed by industrial employers for the specific purpose of furthering educational activities, and their influence is already having a marked effect. But such developments are limited in general to the larger industrial firms, and the problem of the smaller firms still remains. There are a number of ways in which the educational system can help to make up for the deficiencies of education and training within industry. One is to send young apprentices to the local technical college for full-time training for one or more years, and another is to release apprentices for 'sandwich' courses in colleges for full-time periods of varying length followed by part-time day release.

Pressure from industry to augment facilities for further education of the young worker is causing the Ministry of Education some embarrassment. The county colleges cannot at present be introduced. The difficulties of interesting the bulk of adolescents, who by the very nature of the industrial structure of Britain must become unskilled workers, in further education are well recognized; but if successful, the education provided by the county college will solve many problems. It will lay a foundation for adult life; develop regular habits of study and work; a pride in a job well done; a healthy interest in recreational pursuits, and fit the young people to play their part in the struggle for industrial survival.

Although not yet ready to introduce the county colleges, the local education authorities in Britain have been asked to plan their provision as an integral part of the whole field of further education. In the large cities there will be one or more central colleges for advanced studies for those over eighteen, and satellite branch colleges to meet the varied needs of those under eighteen. Vocational training and general education will not be separated. In smaller cities and towns there will be small colleges to meet the needs of day and evening courses for youths and adults.

A vital problem in educating youth in industry is to secure permanent liaison between the colleges and industry, and it is hoped that this has been effected by the nation-wide system of Regional Advisory Councils, consisting of representatives of industry and the colleges, the local education authorities and the universities.

The system of further education and training in Britain is complex and untidy; but it has achieved success largely by its voluntary nature, for it is democratic and flexible and comparatively easy to develop in the ways best suited to our people. The technical colleges employ large numbers of expert technologists from industry as teachers, and it is hoped this will continue when the training is carried on in the day-time. The Ministry has been encouraging developments by setting up three training colleges for the training of technical teachers, by facilitating the release of teachers to industry and by encouraging research.

In the discussion which followed the main papers, reference was made to the valuable assistance being given by some industrial concerns to technical education by providing materials and teaching staff. One speaker stressed the need that the selection of vocations should not be made too early; another that small firms had the one great advantage of being able to keep in closer touch with their young workers than can the larger concerns. Listening to all the contributions to the session, one was particularly struck with the obviously growing interest of industry in the education and training of the young worker, and the growing co-operation between employers, organised labour, and the education authorities.

A. P. M. FLEMING

SOCIETY FOR APPLIED BACTERIOLOGY

THE annual general meeting and conference of the Society was held during July 27–30 in the Department of Agriculture, Queen's University, Belfast. Approximately a hundred members and visitors attended the conference.

Agriculture, and particularly dairying, being the principal industry of Ulster, papers on dairy bacteriology predominated among the seventeen contributions submitted to the conference. The first session, on July 27, was devoted to four papers from Northern Ireland workers.

Mr. P. L. Clerkin, of the Bacteriology Division, described the development of the dairy industry in Northern Ireland during the past two decades with particular reference to the methods of bacteriological control. A feature of the Northern Ireland procedure for raw milk is the classification of liquid supplies into three grades designated simply *A*, *B* and *C*. Grade *A* is the produce of tuberculin-tested herds, bottled on the farm and sold raw. It must conform to fairly high bacteriological standards. Grades *B* and *C* have lower bacteriological standards and the bulk of such supplies is pasteurized. To assist the ready identification of the milk by the consumer, coloured labels, bottle-caps, etc., were assigned for each grade. This procedure was of interest since the authorities in Great Britain have consistently masked the identity of graded milk supplies under names which convey little or no information to the consumer. Legislation controlling ice-cream quality was introduced in Northern Ireland in 1938 and the Bacteriology Division advised on suitable hygienic standards. In this field, the Ulster authorities have been in advance of England and Wales.

Drs. Lamont and Kerr and Mr. McGirr, of the Northern Ireland Veterinary Division, submitted a paper on the Stormont technique of tuberculin testing. This technique was based on observations indicating that, in the tuberculous bovine, intradermal tuberculin injections exhibited increased sensitivity to a second tuberculin injection given seven days after the primary inoculation. The diagnostic feature is the increase in skin thickness and *not* the nature of the reaction. Results are now available for 590 animals subjected to the new procedure and afterwards slaughtered for post-mortem examination. The results showed that the Stormont test had a total error of 3·4 per cent, of which 2 per cent were undetected infected animals.

Lamont and his co-workers have also studied the white blood cell changes in relation to tuberculin testing with particular reference to the new technique. The most striking finding is that the blood reaction with the Stormont technique is very marked, there being a pronounced rise in the polymorph-lymphocyte ratio. The maximum alteration in the ratio appears at varying periods, hence for diagnostic purposes multiple bleeding would be necessary. Using white blood cells, Lamont and his colleagues have succeeded in passively transferring tuberculin sensitivity from the bovine to guinea pigs. These findings offer fairly concrete proof of the presence of the antibody responsible for tuberculin sensitivity. In general, this work supports the thesis recently propounded in a number of American publications that white blood cells and particularly lymphocytes play a very important part in the genesis and manifestations of many immune phenomena.

Dr. Pearson, also of the Veterinary Division of the Ministry, presented a paper on the limitations of penicillin in the treatment and control of bovine mastitis. The North of Ireland experience indicates that clinical mastitis, as encountered by the veterinary surgeon, requires much more individual consideration than is usually given, before penicillin is prescribed. The symptoms of streptococcal and staphylococcal infections are becoming more and more difficult to differentiate, and in Ulster in recent years there has been a definite increase in staphylococcal infections of the udder. In many of these cases little or no response has been shown to penicillin therapy, the organisms being invariably penicillin-resistant. This resistance may possibly have developed during previous penicillin treatment of sporadic mastitis. Strains of resistant streptococci have not become such a problem although such strains undoubtedly exist. Treatment of *Corynebacterium pyogenes* mastitis with penicillin has been found to be a waste of time and money. During recent years there has been a marked increase in the number of samples from clinically positive cases of mastitis, where it has been impossible to detect any causal organisms either culturally or microscopically.

Mr. J. G. Murray, of the Bacteriology Division, contributed a paper on ropy contamination of pasteurized milk. In a recent outbreak the principal source of such organisms was found to be contaminated milk bottles, *Bacterium aerogenes* being the principal contaminant. These organisms were frequently missed when incubated in bile salt broth at 37° C.; but at 22° and 30° C. they were readily detectable. Mixed cultures of slime-producing organisms were also occasionally present.

The second paper-reading session, on July 28, opened with a paper on factors affecting the bacterial population of lake waters by Dr. C. B. Taylor, of the Freshwater Biological Association, Wray Castle, Ambleside. The bacteria present in lake water may be considered in three categories: (*a*) those washed in from outside sources, of which a large population will ultimately perish although others may find conditions suitable for growth; (*b*) indigenous bacteria capable of existence in a dilute nutrient solution, as represented by lake water, and able to use for growth low concentrations of available organic matter, such types being probably ubiquitous; (*c*) bacteria dependent on a solid surface for their proliferation and found in connexion with plankton cells. Group (*a*) reflect the amount of pollution in the watershed, and their numbers in the inflowing water are at the maximum for a few hours after heavy rain. Normally they only mix with the lake water to an appreciable extent in winter. Group (*b*) are types with very weak physiological activity and very low powers of resistance to unfavourable circumstances. An appreciable number are pigmented, yellow being the most common colour. This group is at its most numerous during the winter months. Group (*c*) are most common during periods when algal cells are present to afford sites for attachment.

Dr. Taylor, along with his colleague, Mr. C. H. Foot, also presented a paper on the most suitable medium for growth of bacteria from water. An interesting point in their findings was the fact that sufficient available nitrogenous organic matter is present in ordinary agar to satisfy the requirements of most water bacteria. Plain agar with the addition of salts, incubated at 20° C. for ten days, reproduced 80 per cent of the colonies found on a standard medium. Beef extract, a concentration of 0·5 per cent peptone and nitrate ($NaNO_3$) were found to be restrictive to bacterial growth.

Dr. Cunningham and Mr. McLeod, of the East of Scotland College of Agriculture, presented a short paper on the occurrence of *Bact. coli* Type I coliform organisms in the bovine udder. The evidence of the occurrence of persistent coliform infection of the udder in the absence of macroscopic symptoms is weak. In the case quoted by Cunningham and McLeod the numbers of organisms varied between 25 and more than 1,000 per ml. but usually were of the order of a few hundred. The numbers varied only slightly from day to day and also in the foremilk, mid-milk and strippings. During the course of the investigation the cow went dry, and after calving the same quarter was again found to be infected. The practical importance of the finding is the fact that the coliform test is still applicable in Scotland for designated milk and, in the case in question, the milk supply failed to satisfy the required standards when the milk from the infected animal was included in the bulk milk of the herd.

Mr. A. Rowlands and Mr. W. A. Hoy, of the National Institute for Research in Dairying, Reading, presented the results of experiments with the lye (or caustic soda) method of treating milking machine teat cup clusters and milk tubes. This method is almost universal in the United States; but so far has not been given official backing in Great Britain. The Reading results were entirely satisfactory even under known unsatisfactory conditions. Chlorination of the lye solution was found to be a useful additional safeguard.

In the final paper-reading session, on July 30, Miss M. E. Sharpe, of the National Institute for Research in Dairying, discussed some of the biochemical characteristics of Group *D* streptococci isolated from infants' fæces with special reference to their tyrosine decarboxylase activity. A definite association was found between tyrosine decarboxylase activity and the biochemical characteristics on which the subdivision into species has been made. *Str. fæcalis* and its varieties *zymogenes* and *liquefaciens* show a high tyrosine decarboxylase activity. *Str. durans* has an intermediate activity and *Str. bovis* and the unclassified strains have little or no activity. No strains of Group *D* streptococci which ferment raffinose produced tyrosine decarboxylase.

Miss E. R. Hiscox, of the National Institute for Research in Dairying, Reading, dealt with some of the factors affecting the ripening of pasteurized milk cheese. Since cheese-making is now largely a factory process, pasteurization of the milk prior to manufacture affords the advantages of standardization, uniformity and elimination of many faults. The cheese, however, as a rule is slower in ripening and lacks the typical flavour of the variety concerned. In Miss Hiscox's investigations raw milk cheese had twice the volatile acidity of the pasteurized milk cheese and few lipolytic organisms were found in the pasteurized milk cheese. Since flavour is probably the combined effect of fat lipolysis and volatile acids, the reason for poor flavour development in pasteurized milk cheese is apparent. The question has now arisen whether flavour can be restored by the use of suitable inoculants, and recent American work has been directed to this end.

Mr. J. Wolf, of the University of Leeds, submitted a short paper on the germicidal properties of tar acids present in producer gas tars. The germicidal properties of these tar acids are rather low as determined by the Rideal-Walker coefficient. A marked increase in the Rideal-Walker coefficient was attained when the tar acid emulsion was chlorinated by various methods. This work suggests that tar acids from producer gas tars might provide a useful source of germicides.

The subjects covered by other papers included a review of the microbiology of composting; the survival of the microflora of milk powders at different relative humidities; a modified acidity test for use on the milk reception platform of dairies, and studies of the thermoduric bacterial flora of raw milk.

Details of the papers will be published in due course in the *Proceedings of the Society for Applied Bacteriology*, the editor of which is Dr. T. Richards, Department of Agricultural Bacteriology, University of Reading.

FREE ENERGY OF PROTEIN SOLUTIONS

THE annual general meeting and conference of the Society of Leather Trades' Chemists was held on September 17 and 18 at the University of Leeds, Mr. G. Jessup Cutbush, vice-president of the Society, presiding. Included in the proceedings was the delivery of the third Procter Memorial Lecture, by Mr. G. S. Adair, reader in biophysics, University of Cambridge, who spoke on "Recent Work on Osmotic Pressures, Membrane Equilibrium and the Generalized Free Energy of Protein Solutions in the Light of the Work of Procter". Mr. Adair remarked that this year is the centenary of the birth of Henry Richardson Procter, and the occasion was also noteworthy since the commemoration lecture was being delivered in Leeds, where his work was carried out.

Procter's theory of the swelling of gelatin in hydrochloric acid was described by Loeb as one of the most original and ingenious contributions to modern science. The theory gives a remarkably clear and simple account of the large changes in the osmotic pressures of proteins caused by acids and alkalis. Much work remains to be done to elucidate the smaller effects caused by different salts. Recent experimental observations on hæmoglobin in phosphate buffers show an increase in osmotic pressure in-the more acid and the more alkaline solutions, in general agreement with the theory; but the point for minimum osmotic pressure is on the acid side of the pH for minimum combination with acid or base. The difference may be as much as 0·2 pH units for 0·01 molar phosphates and 0·7 units for 0·05 molar phosphates.

Measurements of the membrane equilibrium of ions, if allowance is made for hydration of the protein, indicate that hæmoglobin causes relatively small changes in the activities of cations like sodium, potassium or ammonium, and relatively large diminutions in the activity coefficients of phosphate and chloride ions[1].

A reaction of the following type might cause similar changes in ion distribution and osmotic pressure:

$$-\mathrm{Pr}^{+} + \mathrm{Na}^{+} + \mathrm{Cl}^{-} = [\mathrm{PrCl}]^{-} + \mathrm{Na}^{+},$$

where $-\mathrm{Pr}^{+}$ denotes a protein double ion, $[\mathrm{PrCl}]^{-}$ a protein ion with a combined or associated chloride ion neutralizing one positive charge. Although salts tend to diminish the osmotic pressure in the range of concentrations studied by Procter and Wilson, they usually increase the pressure in the range where most of the observed pressure is due to the protein itself.

This observation might be explained if groups on the surface of the protein molecule can attract either an inorganic ion or a second protein molecule. If many inorganic ions are present, the chance of attracting a second protein molecule is diminished, and the osmotic pressure should be increased. The effect may be compared with a diminution in the term a in van der Waals' equation for gas pressure. The net excess of salt associated with a protein can be correlated with its solubility and activity.

In studies of the effects of electrolytes on swelling and osmotic pressure of proteins, reproducible results are most readily obtained by the use of relatively large volumes and several changes of the external liquid or dialysate, preferably a buffer mixture with a well-defined pH value.

The chemical potentials of salts, acids and water must be the same on both sides of the membrane in a state of equilibrium[2]. Buffer mixtures can be used to control the potentials in a series of protein solutions in a manner comparable with the control of temperature by a thermostat. Thermodynamical formulæ applicable to dialysed protein solutions may be derived from a function A_G, a revised form of the first definition[3] of which is stated as follows: the function A_G, termed the generalized free energy, of any system is equal to the total energy of the system, minus the sum of all individual forms of energy that include an intensive factor controlled by an external system.

The factors here termed intensive are the temperature, T, the pressure with a negative sign, $-P$, $(-P = \delta U/\delta V)$, and the chemical potentials. The total energy of a fluid, U, is regarded as the sum of at least three individual forms of energy, the thermal energy TS, the mechanical energy $-PV$ and the chemical energy $\mu_i n_i$ for substance i; S is entropy of the fluid; V is volume; n_i is number of molecules of i; μ_i is chemical potential of i.

In fluids with a constant mass of each substance, there are two intensive factors to consider, T and $-P$, four combinations of intensive factors, and four possible values for A_G, equivalent to the well-known functions termed energy, heat content, free energy of Helmholtz and free energy of Gibbs. If any of the potentials be controlled, an unlimited number of functions of the same type can be obtained by deducting products like $\mu_i n_i$ from the energy. All the functions are special cases of one function A_G, so that methods used in deriving thermodynamical relationships from the well-known functions[4] may be applied to more complex systems, such as dialysed protein solutions, where potentials are controlled. The formula $\mu_p = \delta A_G/\delta n_p$, for example, is valid for all systems if μ_p represents the potential of a non-diffusible substance, for example, protein. It will be remembered that Henry Procter himself was not entirely satisfied with standard forms of the second law of thermodynamics expressed in terms of entropy. A revised form of the law may be suggested as follows: the generalized free energy of any system tends to reach a minimum.

[1] Adair, G. S., and Adair, M. E., *Biochem. J.*, **28**, 1230 (1934).

[2] Adair, G. S., *Trans. Farad. Soc.*, **31**, 98 (1935); **33**, 1106 (1937).

[3] Adair, G. S., Abstracts of Communications, International Physiological Congress, Oxford, 125 (1947).

[4] Lewis, G. N., and Randall, M., "Thermodynamics" (New York, 1923).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 25

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. Frank Debenham: "The Great Ross Barrier of the Antarctic".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Hill, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "A Western European Power Network?" (to be opened by Mr. T. Graeme N. Haldane).

KING'S COLLEGE (in the Department of Electrical Engineering, Strand, London, W.C.2), at 5.30 p.m.—Mr. W. J. Gibbs: "Tensor Analysis Applied to Electrical Machines".* (Further Lectures on November 1, 8, 15, 22 and 29.)

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. F. E. Simon, F.R.S.: "The Unattainability of Absolute Zero".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. E. R. Thornley and Mr. G. A. Pittman: "A Dynamic Compression Test for Rubber/Cord Fabric Adhesion".

Tuesday, October 26

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. B. Fry: "Visible Speech".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Miss P. M. Kaberry: "The Position of Women in a Bamenda Tribe, British Cameroons".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Mr. F. Hoyle: "Stellar Evolution and the Expanding Universe". (Further Lectures on Tuesdays, November 2 and November 9.)

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Cecil Binney: "Legal and Social Implications of Artificial Insemination".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. M. W. Thring: "The Construction of Models in which more than One Process is Similar to the Original".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Measurement of Phase Angle of Electric Circuits" (to be opened by Mr. Arvon Glynne).

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Prof. M. L. Oliphant, F.R.S.: "The Atomic Age—the Scientific Achievement".*

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Dr. H. J. Woods: "The Structure of Fibres".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the WELWYN GARDEN CITY SCIENTISTS' CLUB, at The Cherry Tree, Welwyn Garden City), at 8 p.m.—Dr. T. S. Jones: "Polypeptide Antibiotics—Biological Polymers".

Wednesday, October 27

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Dr. E. J. F. James: "Chemistry and Education".*

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. J. H. Paterson: Presidential Address.

Thursday, October 28

Chadwick Public Lecture (at University College, University Park, Nottingham), at 4 p.m.—Sir Arthur MacNalty, K.C.B.: "Advances in Preventive Medicine during the War of 1939–1945".*

Linnean Society (at Burlington House, Piccadilly, London, W.1), at 5.10 p.m.—Dr. Helga S. Hacker and Dr. P. H. Hacker: "Local Variations and Chances of Interbreeding in *Apodemus sylvaticus*, the Long-tailed Wood-Mouse".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Kenneth Clark: "Three 'Scientific' Painters", 1, Uccello. (Further Lectures on Thursdays, November 4 (Piero della Francesca), and 11 (Seurat).)

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. K. Linderstrøm-Lang: "Micromethods in Biology".*

University of London (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. K. de B. Codrington: "The Place of Archæology in Indian Studies".*

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—A member of the staff of Handley Page, Ltd.: "Aircraft Engineering and Production".

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (in Room B1, The University, St. George's Square, Sheffield), at 6.30 p.m.—Mr. E. C. Fieller: "The Activities of the Mathematics Division of the National Physical Laboratory".

Manchester Statistical Society, Industrial Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. P. Armitage: "Sequential Methods of Sampling Inspection".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7 p.m.—Sir Robert Robinson, F.R.S.: "Strychnine, Brucine and Vomicine".

Pharmaceutical Society (at 17, Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. C. H. Hampshire: "The British Pharmacopœia, 1948".

Friday, October 29

Society of Public Analysts and other Analytical Chemists, Polarographic Discussion Panel of the Physical Methods Group (in the Main Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Annual General Meeting; Discussion on "Polarography in Biochemistry".

Chemical Society, Glasgow Branch (joint meeting with the Andersonian Chemical Society and Glasgow University Alchemists' Club, at the Royal Technical College, Glasgow), at 3.45 p.m.—Prof. John Read, F.R.S.: "Chemical Personalities of a Century Ago".

Royal Astronomical Society (joint meeting with the Astronomical Society of Edinburgh, at the Royal Society of Edinburgh, 22–24 George Street, Edinburgh), at 4.45 p.m.—Scientific Papers.

Chemical Society, Newcastle and Durham Branch (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 5 p.m.—Prof. W. Baker, F.R.S.: "Recent Work on Systems of Aromatic Type" (Bedson Club Lecture).

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. K. Linderstrøm-Lang: "Enzymatic Breakdown of Proteins, I".*

North-East Coast Institution of Engineers and Shipbuilders (in the Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. S. S. Cook, F.R.S.: "Thermodynamics in the Making" (Andrew Laing Lecture).

Royal Statistical Society, Birmingham Group of the Industrial Applications Section (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. C. Wainwright: "Statistical Principles in Quality Specifications for Plastics".

Manchester Statistical Society, Industrial Group (in the Lecture Room of the Society of Architects, 16 St. Mary's Parsonage, Deansgate, Manchester), at 6.45 p.m.—Mr. P. Armitage: "Sequential Methods of Sampling Inspection".

Royal Institute of Chemistry (joint meeting with the Cambridge University Chemical and Metallurgical Societies, at the University Chemical Laboratory, Pembroke Street, Cambridge), at 8.30 p.m.—Sir Charles Goodeve, F.R.S.: "The Physical Chemistry in Iron and Steel Processes".

Saturday, October 30

Biochemical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "Partition Chromatography and its Application to Biochemical Problems".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mr. R. D. Barnett: "Digging up Past Civilisations".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Deputy Director—The Director, Museum and Art Gallery, Newport, Mon. (October 30).

Principal and a Head of the Agricultural Department at Essex Institute of Agriculture, Writtle, Chelmsford—The Chief Education Officer, County Offices, Chelmsford (October 31).

Lecturers (2) in Horticultural Science—The Principal, Kent Horticultural Institute, Swanley (November 6).

Research Lecturer in the Department of Colour Chemistry and Dyeing—The Registrar, The University, Leeds 2 (November 8).

Principal Scientific Officer to control research and development of radio and radar navigation devices and aircraft approach and landing aids, a Principal Scientific Officer to control research and development of radio communication systems, airborne and ground; electro-acoustic and sound recording equipment; special test equipment for such devices, a Principal Scientific Officer to control development of general radio test equipment for Service use and special radio and electronic test equipment for test purposes, and a Senior Scientific Officer for the development of components for new radio equipment—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2300 (November 11).

Lecturer in Applied Mathematics—The Registrar, University College, Southampton (November 13).

Farm Manager at the Council's Institute of Animal Physiology, near Cambridge—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (November 15).

Lecturer in Pharmacology in the Department of Materia Medica, Medical School, Dundee—The Secretary, University of St. Andrews (November 30).

Professor of Veterinary Science at Makerere College, Kampala, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (November 30).

Lecturer in the Department of Physics at Pietermaritzburg, and a Lecturer in the Department of Experimental Physics, at Durban—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 1).

Chair of Geology—The Registrar, The University, Nottingham (December 31).

Assistant Lecturer and Demonstrator in the Physiology Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Director of the Jeremiah Horrocks Observatory—The Chief Education Officer, Municipal Building, Preston.

Entomologist to the States of Jersey—Dr. T. Small, 14 Esplanade, St. Helier, Jersey, Channel Islands.

Laboratory Technician—The Secretary, University College Hospital, Gower Street, London, W.C.1.

Lecturer in Chemistry—The Principal, Derby Technical College, Normanton Road, Derby.

Lecturer in Chemistry and a Lecturer in Physics—The Principal, Acton Technical College, High Street, London, W.3.

Mathematician to assist in theoretical research on the deformation of metals—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Physical Chemist having some research experience in surface chemistry or in methods of examination of fine powders, and a Chemist with experience of inorganic analysis—Director of Research, British Whiting Federation, 26 Claremont Road, Surbiton, Surrey.

Research Biochemist in the Special Unit for the Study and Treatment of Juvenile Rheumatism—The Administrative Officer, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead, Berks.

Research Engineer, Physicist or Metallurgist to take charge of a Rolling Mill Research Team, and a Research Engineer, Physicist or Metallurgist to initiate work on Forging, at Sheffield—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Senior Geologist for Mines Department, Adelaide, to undertake and supervise geological investigations on mineral deposits in South Australia and to advise on geological aspects of exploitation—The Agent General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1.

Assistant Experimental Officer (Chemist, male) for the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, London, S.W.7.

Principal for Bury Technical College—The Director of Education, Education Offices, Bury.

Technicians (2) (Grade II) in the Department of Chemistry—The Secretary, University College, Gower Street, London, W.C.1, quoting Chemistry 5.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Other Countries

Bulletin of the Bingham Oceanographic Collection, Peabody Museum of Natural History. Vol. 11, No. 4: A Symposium on Fish Populations, held at the Royal Ontario Museum of Zoology, Toronto, Canada, January 10 and 11, 1947. Pp. iii+283. (New Haven, Conn.: Yale University, 1948.) 4.25 dollars. [267

Bernice P. Bishop Museum. Special Publication 38: Studies in Hawaiian Pollen Statistics, Part 2, The Pollens of the Hawaiian Phanerogams. By Olof H. Selling. Pp. 430+58 plates. (Honolulu: Bernice P. Bishop Museum, 1947.) [38

Annual Report of Ontario Research Foundation, 1947. Pp. 24. (Toronto: Ontario Research Foundation, 1948.) [38

Catalogues

Measuring the Future: Scientific Progress illustrated by the War time Experience of Messrs. Baird and Tatlock (London), Ltd. By John Langdon-Davies. Pp. 52. (London: Baird and Tatlock (London), Ltd., 1948.)

Book Bulletin, No. 5. Pp. 16. (Cambridge: Bowes and Bowes Ltd., 1948.)

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SCIENTIFIC RESEARCH AND MAN-POWER IN THE UNITED STATES

ALTHOUGH the two earlier reports on "Research—A National Resource", covering both the "Relation of the Federal Government to Research" and "Industrial Research", not to mention the more recent report from Dr. Vannevar Bush, "Science—the Endless Frontier", have to some extent prepared the British reader to appreciate the scale of the research effort in the United States—an effort in which it is estimated that 137,000 scientific workers were engaged in 1946–47, some 30,000 of them in government laboratories—it is not easy to convey a concise picture of the scope of the five reports which Mr. J. R. Steelman, chairman of the President's Scientific Research Board, has presented under the general title "Science and Public Policy"[*]. The White Paper on "Scientific Research and Development" issued in Britain is too slight to be comparable; possibly Sir John Anderson's descriptive survey of government organisation for research in his Messel Memorial Lecture last July is a more useful comparative outline of British activities. From the critical point of view, the penetrating analysis of expenditure on research and development contained in the third report of the Select Committee on Estimates for the session 1946–47 makes that report the appropriate British document to set beside the Steelman reports, although the latter also contain features in common with the White Paper on the Scientific Civil Service and with the report of the Barlow Committee on Scientific Man-power. However, nothing of quite the same scope and nothing comparable in scale has yet been published in Britain, although it is equally true that the whole subject has been discussed very thoroughly and fully as intensively, if not as quantitatively, in books and reports from both public and private sources as well as in Parliament.

The first of these volumes, entitled "A Program for the Nation", sketches the position of the United States in scientific research and development, comparing expenditure in 1930 and in 1945, and presents a budget for the future as well as discussing the limiting factor of man-power. After considering questions of personnel and the Federal organisation, it details recommendations for action by the Federal Government to meet the challenge of science and assure the maximum benefit to the nation. In the second volume, "The Federal Research Program", details of the Government's programme for research and development are analysed. The bulk of this volume consists of statements from the individual departments or agencies, indicating the range of work and its organisation; and among the appendixes is a useful note on definitions of research.

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[*] Science and Public Policy. Vol. 1: A Program for the Nation. A Report to the President by John R. Steelman. Pp. x+73. 20 cents. Vol. 2: The Federal Research Program. By John R. Steelman. Pp. viii+318. 55 cents. Vol. 3: Administration and Research. By John R. Steelman. Pp. viii+324. 55 cents. Vol. 4: Manpower for Research. By John R. Steelman. Pp. viii+166. 35 cents. Vol. 5: The Nation's Medical Research. By John R. Steelman. Pp. x+118. 25 cents. (Washington, D.C.: Government Printing Office, 1947.)

The third volume, "Administration and Research", is concerned with the administrative problems that arise in the departments, bureaux and laboratories in executing the Government's programme, more particularly that part conducted in the Government's own laboratories. Questions of control and scientific freedom, the planning and evaluation of research activities, the 'climate' for research, and the methods of financing government research are discussed here, and recommendations for changes are made. In the fourth report, "Manpower for Research", the shortage of scientific workers and the implications of that shortage are discussed, including changes in distribution and their causes, and the action required for training more of them. The final report, "The Nation's Medical Research", discusses, first, the general problems of medical research, and next the Federal programme and its particular problems, indicating the content and distribution of research projects and describing the existing agencies and facilities for medical research.

Even this comprehensive survey, however, is not quite complete. In the first place, the social sciences are excluded, although some projects were examined in which both physical and social scientists were working. In the second place, the research programmes of the War and Navy Departments, apart from their medical programmes, were only examined very generally, because the Research and Development Board is making a detailed study of these programmes. Again, the delays in establishing the Atomic Energy Commission made impossible a detailed examination of the research programme of that Commission at the present time, apart from questions of national security. Nevertheless, sufficient investigations were made to judge the relation of these programmes to the scientific effort of the Government of the United States as a whole, and to provide a basis for administrative recommendations.

The first of these five reports is of the most general interest, to some extent summarizing the remaining four and detailing the general recommendations of the Scientific Research Board ; it is issued over the signature of its chairman, John R. Steelman. Moreover, side by side with the emphasis laid on research as the basis for an expanding economy and continued high levels of employment, as well as for progress in eliminating poverty and disease, there is in this report a remarkable emphasis laid on the importance of lending every possible aid to the re-establishment of scientific research and development in Europe. This emphasis is derived largely from the recognition that the strength of the United States has lain in the practical application of scientific principles rather than in original discoveries, and that further development must wait on the resumption of fundamental research which was everywhere largely in abeyance during the War.

The Steelman Report contends frankly that it is to the interest of the United States to make a maximum effort to restore the free exchange of ideas and the conditions of free international co-operation among men of science as it existed before the rise of totalitarian States, as well as to assist the reconstruction of the devastated countries of Europe an Asia. Such self-interest is no reason for looking askance at American generosity ; for it is equally t the national interest everywhere, as well as to tha of the progress of science, to re-establish the conditions in which the advance of science and th cross-fertilization of minds can again proceed freely across national frontiers. As the report observes the devastation of scientific work in Europe, th disruption of the normal international exchange o scientific knowledge and the suspension of fundamental work in important fields have altered ever premise upon which our thinking about scientifi research and development has been based.

This is the broad background against which th recommendations of the Steelman Reports have bee framed, and it is clear that they have been influence by very similar considerations to those which hav determined policy in Great Britain, given the difference in emphasis and development between fundamental and applied research in Britain as compare with the United States. They recommend first tha annual expenditure on research and developmen should be increased as rapidly as facilities and traine man-power can be expanded, so that, by 1957, a least one per cent of the national income, or mor than 2,000 million dollars, is devoted to research an development in the universities and industry an by the Government. Greater emphasis should b placed on fundamental research and medical research these expenditures should be quadrupled and triple respectively, in the next decade, while total researc and development expenditure is doubled. Feder support of fundamental research in the universiti and non-profit research institutions should be increased progressively to a level of at least 250 milli dollars by 1957. These figures look almost astronomical beside the estimates for Governme expenditure in Britain on research and developme of about 76·5 million pounds, the distribution which between fundamental and applied resear and between civil and military research was review by the Select Committee on Estimates in a repo for the session 1946–47. The Steelman Report m well observe that with so much public money alrea being spent in furtherance of research and develo ment, careful attention must necessarily be given the manner in which it is spent ; and while it is reco nized that the limiting factor at present is train man-power, a considerable amount of thought h been given to the way in which expenditure research should be controlled and distributed.

This is, of course, the kernel of the debate duri the last few years in the United States over a natio science foundation. There appears to be little disse from the view expressed in this report that at prese too small a proportion of the total resources of t United States is devoted to fundamental researc to health and medicine, and of its developme resources to non-military ends. The conflict opinion occurs over the means by which the balan of the research and development programme is to restored, and the manner in which Federal supp should be given.

The Steelman Report expresses the emphatic opinion that the bulk of the expansion in fundamental research must be in the universities and colleges, and be financed by Federal funds. For this purpose it recommends the establishment within the Executive Office of the President of a 'National Science Foundation', headed by a director appointed by the President and assisted by a part-time advisory board of scientific men and educationists, similarly appointed, half of whom should be drawn from outside the government service, and half from within. No restrictions should be placed upon the fields of inquiry eligible for support, and part of the funds expended by the Foundation should be used to strengthen promising colleges and universities.

The establishment of a national science foundation is not, however, in the view of the Science Research Board, all that is required. Some overall picture of the allocations of research and development functions among the Federal agencies, and of the relative emphasis placed upon fields of research and development within the Federal Government, must be available. Provision should also be made for a central point of liaison among the major research agencies to secure the maximum interchange of information with respect to the content of research and development programmes, and with respect to administrative techniques. At a single point close to the President, it should be possible to bring into the discussion of high policy the most significant problems in the research and development programme of the nation as a whole.

The idea of establishing a department of science to handle these functions was rejected, after consultation with scientific men and administrators, no doubt for similar reasons to those which have led to the rejection of the idea of a Ministry of Science in Great Britain. The Steelman Report recommends instead that a Federal committee be established, composed of the directors of the principal Federal research establishments, to assist in the co-ordination and development of the Government's own research and development programme. In addition, the Bureau of the Budget should set up a unit for reviewing Federal scientific research and development programmes, and the President should designate a member of the White House staff for scientific liaison. (This interdepartmental committee and scientific liaison officer have since been appointed.) Moreover, one of the first tasks of the interdepartmental committee would be a full analysis of the relative advantages of contracts and grants as a means of supporting research, and a careful review of the advantages arising from, and the problems connected with, the establishment of research co-ordinating bodies within large Federal agencies.

As already noted, the Scientific Research Board recognizes that the limiting factor in the expansion of research or development facilities is at present man-power; and, besides suggesting that the Federal Government, without making direct grants to industry, should encourage the expansion of industrial research by taxation incentives and other recognized methods, the Board points out that any programme of Federal assistance to the universities for research must be part of a broader programme of aid to higher education. Even a programme of scholarships or fellowships should not be established in the physical and biological sciences alone. The Board appears to lean to the support of fundamental research by grants rather than contract, and recommends that every Federal agency with major research responsibilities should have authority to make such grants, subject to the co-ordination by the suggested national science foundation. Furthermore, in time of peace, no secret or confidential research or development projects should, as a matter of policy, be placed with the universities; and the opinion of the Bush Report, "Science—the Endless Frontier", that complete freedom of inquiry must be preserved under any plan for government support of science is emphatically endorsed.

While the whole problem of university and college facilities was being examined independently by the President's Commission on Higher Education, the report of which has since been published, the Steelman Reports do not entirely pass by the question of university expansion. The section on "Manpower: the Limiting Resource", in this first report, points out that while between 1940 and 1947 United States expenditure on research and development increased by 335 per cent, the supply of trained man-power only increased by 35 per cent. It appears that the shortage of scientific man-power in the United States is even worse than in Britain, and particularly in the universities and colleges, where the urgently needed expansion of fundamental research is hampered, and there is danger that students will not receive the rigorous training required for such work. The report estimates that a further 15,000 instructors are required; but that there are enough students in the colleges and universities to double the supply of scientific workers within the next decade. Nevertheless, the balance in the research programme cannot be restored in the next year or two by expanding the programme for fundamental research or for non-military research and development without reducing expenditure on military or industrial research; and the Board, so far from being prepared to recommend such reduction, visualizes the possibility of having to increase research in the military sector.

On problems of personnel in science, the report says comparatively little, apart from stressing the importance of salary scales adequate to attract the ablest type of men, of associating the scientific worker with the formulation of policy, and of encouraging professional contacts. Appropriation by Congress of larger sums to enable scientific men in Federal service to travel to professional meetings is recommended, but the report is less searching in this respect than the Barlow report on scientific staff in Britain which was appended to the White Paper on "The Scientific Civil Service" in September 1945. The Select Committee on Estimates was also more penetrating in its report for the 1946–47 session already cited; but appended to the fourth volume of the series of Steelman Reports, "Manpower for Research", is a bibliography on scientific personnel, not confined to American publications, which is of considerable interest. A more comprehensive bibliography on the administration of research is appended to the third volume of the series.

Despite, therefore, the impressive scale of research effort in the United States, both existing and prospective, study of the Steelman Reports does not suggest that, on the whole, Great Britain has much to learn from the United States as regards the organisation of research. Indeed, Britain is free from certain difficulties which the federal system involves, and while it is clear that in both countries the risks and limitations of planning research are fully appreciated, even the Steelman Committee does not appear to be quite sure as to the means to be adopted for the control and organisation of fundamental research. Distrust of government interference goes far deeper in the United States than in Britain; but in considering medical research, the Committee does raise the question whether medical research for the Services could be pooled, and recommends the creation in the United States of an advisory Medical Research Committee for the large-scale, long-range planning of a national medical research policy.

There is thus much that is of interest to British scientific men in these five volumes, and from the immense assembly of facts, data can be selected to support arguments in favour of particular policies or action in Great Britain. The comments on the man-power situation, and especially the facts and observations presented in the appendix to the fourth volume, "Manpower for Research", deserve careful study. When the Scientific Research Board appointed by the President of the United States takes such a wide view, and can still urge generous help towards the reconstruction of scientific institutions in Europe, it is worth remembering that the progress of science in Britain is equally dependent upon the re-establishment of a world community of science.

The Steelman Reports express the view that it is essential that the aid to be given to the research laboratories of Europe should be on terms which ensure the maximum contribution towards the restoration of pre-war conditions of the free exchange of scientific knowledge across national frontiers. The assistance contemplated is not limited to actual reconstruction; it includes encouragement for students from abroad to attend American universities and colleges, as well as the establishment of scientific missions abroad. The solidarity of British and American opinion in such matters as these, the clear recognition that, in the long run, science cannot flourish in the midst of a troubled world, the insistence on those cherished freedoms of expression and association which are the corner-stones of democracy, as they are conditions of scientific advance, are among the most welcome and outstanding features of these reports. For British readers they carry the corollary that our own efforts to foster international exchange of knowledge and understanding must be no less determined, positive and even sacrificial, in the hope that the two great democracies may work together for the good of the whole world.

PLANT LIFE IN BRITAIN

British Plant Life

By Dr. W. B. Turrill. (New Naturalist Series.) Pp. xvii + 315 + 72 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 21*s.* net.

So far as coloured illustrations are concerned, this most recent addition to the "New Naturalist" series is probably the most successful. They consist of fifty-three colour photographs by John Markham, Brian Perkins, F. Ballard and others. The close-up photographs of yew, black bryony and hawthorn in fruit and the ground pine in flower are excellent: that of the fleabane is not so good, the foliage being badly blurred and the flower-heads not very distinct. Moreover, the colour of the close-up of fritillaries has registered rather badly. Perhaps the most beautiful of all the plates is that of bluebells. Among the more distant views attention should be directed to that depicting heather in the fore- and middle-grounds with Scots pine in the background, and that depicting dandelions.

Great care has obviously been taken in the choice of black-and-white photographs by such well-known Nature photographers as John Markham, Eric Hosking, Brian Perkins, Robert Adam, Anne Jackson, etc.

Among the maps are one showing the botanical vice-counties of Great Britain and Ireland, and eight others illustrating the distribution of certain selected species of plant, from the hazel (*Coryllus avellana*), which necessitates shading the map of the entire islands, to the Cheddar pink (*Dianthus cœsius*), represented only by a small shaded patch in Somerset. (Is Cheddar deliberately spelt with a lower case 'c' on the map, following the strange modern craze? If so, then the same style should have been followed in the text on p. 54.)

The aforementioned characteristics of this book will have an immediate appeal to both amateur and professional botanist, for all are excellent. But there is much more in the book than this, namely, the text, written by one of Britain's leading authorities who is keeper of the Herbarium and Library at the Royal Botanic Gardens, Kew.

In no sense is the book a Flora; it is an erudite review of the wild vegetation made from those angles with which other research botanists have come to associate the name of Dr. W. B. Turrill.

Following an introductory chapter are four dealing with the vicissitudes to which the British flora has been subjected before attaining its present composition. From the origin of life itself we come to the beginnings of plant life, and are then led up to the very important changes induced during the Ice Age and the further changes which occurred during the Post-glacial Epoch. In the last-named, the most up-to-date methods of pollen analysis and the conclusions drawn from these studies are presented in a very clear manner.

In the review of the present position of the British flora we learn that there are about 1,500 seed-bearing plants, and a very useful list is given of 91 plant families together with the number of genera and species which constitute each, from Compositæ, containing 42 genera and 114 species, to families containing only one species, such as Cucurbitaceæ—*Bryonia dioica* (white bryony); Loranthaceæ—*Viscum album* (mistletoe), etc.

From then on, the author leads up, through geographical relationships, to an up-to-date study o plant ecology, beginning with habitat factors, namely, climatic, edaphic and biotic. Then a long chapter deals with the different kinds of plant communities. Here Dr. Turrill takes full advantage of the great strides which have recently been made in ecological research, especially in Great Britain.

A study to which the author has made important research contributions is that of variation in plants, and in a chapter of 20 pages he waxes lucid and eloquent on the subject.

Adaptation, natural selection and heredity certainly have an important part to play, especially in such a comparatively crowded flora as that of Britain, and n this book these phenomena are well presented and illustrated with many carefully chosen and clear examples. This implies that the flora of these islands, ike that of many other parts, is still undergoing changes, so the author does well to consider them; for students so frequently fail to realize that though this age is experiencing the 'traditions' of the past, it is also contributing new 'traditions' for the future.

At the end of the text, a fairly full, but not indigestible, bibliography, a useful glossary and an index are appended.

"British Plant Life" has been carefully conceived and well written. It is difficult to imagine who would not benefit by reading it, for it is indeed readable; we would strongly recommend it to all academic students of botany and to the many more amateur naturalists who are making flowering plant life their special line. Not only will they see and read with nterest and enjoyment; but also they can put implicit trust in the factual material.

This is a book worthy of the author so far as text is concerned, a credit to the photographers who have contributed the illustrations and a title which will enhance the reputation of the publishers who are producing this excellent series of books.

L. J. F. BRIMBLE

EVERYTHING ABOUT THE DOG

The Book of the Dog

Edited by Brian Vesey-Fitzgerald. Pp. xviii + 1039 + 24 plates. (London: Ivor Nicholson and Watson, Ltd., 1948.) 42*s*. net.

TO begin with, one must commend the majestic appearance of this in every sense weighty volume —a worthy companion to the same combination's production, "The Book of the Horse". It is stimulating to handle a thing of substance and quality in these attenuated days. At two guineas it is good alue, and here, in material content, is what you et for it: 1,057 quarto pages of good paper, and honest-sized type; 336 illustrations, including twenty-four excellently produced coloured plates; full description and illustration of 119 breeds of dogs; forty-one articles covering practically every aspect of the dog and man's relations with it—at all events I cannot think of any more, except possibly circus dogs, an omission I for one can endure without complaint; all this done by sixty-two contributors, who in this review must mostly remain anonymous, though they are all experts in their own subject. The quantity of material is impressive; so also is the quality, chiefly, because, although a high literary standard was obviously not the target of the planner, yet, notwithstanding the total length of the book, the individual articles are generally concise, factual and clear. There is, too, a general absence of sentimentality—though lots of affection—which is most refreshing.

One of the most interesting and informative passages in the whole book is Dr. Vevers' section on worms, which forms part of his opening chapter on "The Phylogeny, Domestication and Bionomics of the Dog". The things that can go on inside a dog as the result of entertaining these parasites are not to be lightly dismissed with worm powders, and the average casual dog owner needs considerable education in this matter, if one is to judge from the general condition of the dogs one sees about. While on this subject I endorse the condemnation by R. C. G. Hancock ("Nursing and Treatment") of the amateur 'vet.'. The records of such bodies as the P.D.S.A. are witness to the immense suffering caused to dogs, and indeed all domestic animals, by ill-advised amateur attempts at treatment. The reasons for this seem to be twofold: pride—everybody likes to be considered knowledgeable on something he knows nothing about; and meanness—the number of people who will go to almost any length to avoid parting with money to a 'vet.' is positively scandalous. This is very prevalent also among amateur horse owners.

Dr. Vevers gives interesting comparisons between the dog and the cat. A theme I would like to see developed more fully is the extreme psychological divergence of the dog and the cat, which may or may not have something to do with what one might call the physical malleability of the former. Man has moulded the dog into an astonishing variety of shapes and sizes according to his moods and needs; but he has never been able to do anything with that intractable creature the cat; and, while the dog has always worshipped man, man did at one time worship the cat.

Like the horse, the dog appears first in history in pictures, usually in hunting scenes; so Mr. Croxton Smith infers reasonably enough that a very early use of dogs by man was for hunting and tracking other animals—in slight contradiction to the authorities quoted by Dr. Vevers, who suggest that scavenging was the first occupation of the friend of man *qua* friend. From my own experience of 'pi-dogs' in the East I would say that scavenging, though no doubt useful, was not the way the dog took to man's heart. The truth, however, seems to be that we know very little about the matter until we come to the pictures, the first historical record. After that it does not seem to have been long before man began to grow sentimental about the dog, and so he has remained to this day. The chapter on "The Dog in History" is particularly well done. So, too, are the other sections on working dogs, in the shooting and hunting fields, in sheep herding, in which we see the dog at his best, in guiding the blind, and in war. An omission in the latter, in passing, is mention of the training of war and police dogs in the U.S.S.R. They were trained, I believe, to attack and destroy tanks and themselves—by leaping at them with detonating charges on their backs.

John Board writes comprehensively and chattily on "Selecting a Breed", though, so impartial is he in once sense and so partial to all sorts of dogs in another, it would be difficult at the end to resist getting them all. But we are all mostly prejudiced in favour of the last dog we have owned, so I will express my own partiality and recommend my favourite, the Sydney Silky—who receives scant attention in the breed section—one of the gamest, most intelligent and lovable of all terriers, and one still unspoilt by the attentions of exhibitors.

It would be possible to go on browsing indefinitely and happily through the pages of this book. There is so much that could be mentioned: the dog in art, in literature, foxhounds, greyhounds, the Samoyed, the Kennel Club and Crufts, the excellent chapters on breeding, training, and showing, and not omitting a scholarly and scientific dissertation on that canine outcast, the pariah—though I cannot share the anxiety of the Menzels for its preservation. It must be left to others to dig in this canine mine with the certainty that they will extract both pleasure and profit from it.

C. E. G. Hope

THE FREE ELECTRON *IN VACUO*

Vacuum Tubes

By Prof. Karl R. Spangenberg. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. xvii + 860. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 45*s*.

FOR many years the literature of applied physics has lacked a really up-to-date and complete account of the phenomena occurring inside valves. In consequence, students are taught very little about them, a sad contrast with the attention paid to circuit applications. To fill this void, Prof. K. R. Spangenberg has written the present bulky volume, addressed mainly to senior and graduate students, but with the needs of research workers kept in mind. The book begins with the basic physics of the subject: atomic theory, electron emission, electrostatics and the dynamics of charged particles. Potential theory is next discussed, with detailed application to triode and multigrid valves. After a brief consideration of shot effect and resistance noise, a section of 142 pages is devoted to electron optics and the cathode ray tube. Transit-time effects come next, and lead to the elementary theory of velocity modulation valves and cavity magnetrons. Then there are chapters on photo-electric devices and various special tubes, while the final chapter of sixty pages gives a résumé of high-vacuum practice, based on material supplied by C. V. Litton. Some mathematical topics, units, skin effect and Langmuir's diode tables are discussed in appendixes.

This synopsis shows the planning of the book to be logical and comprehensive. Unluckily, the execution is not up to the level of the plan, for the treatment is very uneven in depth and precision. From the point of view of the student, it is particularly unfortunate that the sections on the physical phenomena are the poorest in the book. There is only the most sketchy account of the preparation of oxide cathodes, photo surfaces, fluorescent screens and many other matters essential for the preparation of the simplest valve. On the theoretical side these sections are equally weak. For example, the oxide cathode is not discussed as a semi-conductor, and there is no attempt to derive Richardson's law for a pure metal.

The unfavourable impression made by the first few chapters is largely dispelled by the competent handling of the theory of triodes, tetrodes and pentodes, both as potential problems and in the space charge régime. Prof. Spangenberg has made original contributions to some of the questions discussed here, and on electron optical theory, so it is natural that these should be the best parts of the book. The discussion of transit-time valves is clear and correct so far as it goes; but, considering that nearly two hundred pages are used, this is not far. Some original work on velocity-modulation tubes to cover a frequency-band of more than an octave is, however, included.

A peculiarity of the book is that all the more important expressions are given as nomograms. While this device does give a very clear idea of the magnitudes involved, the accuracy is limited by the page size to a value lower than that of even a six-inch slide rule.

It is to be hoped that, in a second edition, Prof. Spangenberg will divide the work into two separate parts, a students' text-book, and a definitive reference handbook for specialists. This would reduce the bulk of the material sufficiently to allow it to be handled in a university course. In its present form the book, while welcome, will disappoint the more sophisticated readers.

A. H. Beck

PHYSICAL PROPERTIES OF RUBBER

Le caoutchouc

Matériau de construction. Par l'Institut français du caoutchouc. Avec le concours de Georges Colin, André Jarrijon et Pierre Thirion. (Etudes de synthèse et de documentation l'Actualité technique.) Pp. viii + 230. (Paris: Libr. Dunod, 1947.) 560 francs.

ALTHOUGH the remarkable physical properties exhibited by rubber are such as to commend its use for certain specialized engineering applications, it has not been easy for designers to obtain reliable quantitative information upon which to base their work. The volume under review goes some considerable way to filling the need felt by the designer for a comprehensive account of the physical attributes of rubber. The reluctance of the rubber technologist to commit himself to figures in describing the properties of this remarkable substance has been due partly to the fact that the word rubber covers materials having a tremendous range of properties. The width of this range is, indeed, indicated by the authors, although it is felt that in some sections figures are presented without sufficient emphasis on the fact that they are typical only of the compounds of particular manufacturers.

The volume includes a short account of the theories of the rubber-like state, a similar amount of space devoted to industrial processing technique, a thorough review of physical properties and finally a section giving details of the various applications of rubber, including methods of calculation. The balance as between these sections is good in view of the needs of the intended reader. There are a few errors in figures, the most serious in Table V, p. 44, where figures for internal friction are too large by a factor of 10^3.

It is a matter for regret that a book such as this to which frequent reference will be made, should be bound inadequately in paper covers which cannot stand up to a week's careful handling by the reviewer.

W. P. Fletcher

Everyman's Mathematics

By F. G. Brown. Pp. xix+748. (Sydney and London: Angus and Robertson, Ltd., 1947.) 36*s*.

AFTER fifty years of teaching in primary and secondary schools, teachers' training colleges, adult classes, and the Royal Australian Naval College, Mr. Brown is very much dissatisfied with the usual methods of teaching elementary mathematics. He considers that the few basic principles are clouded and hidden by an over-elaboration of the details, and that much time is wasted in doing too much in the wrong way. He has therefore prepared a treatment which, though mainly an attempt to interest the adult who has forgotten what he learned at school, also suggests, in the first half of the book, the minimum amount of mathematics which a school might be expected to teach to boys and girls of fifteen years of age. This part deals with arithmetic (based almost entirely on the "method of Rates"), geometry, algebra and trigonometry. The second half of the book illustrates the type of material suitable for use in an adult education study-group; it lays stress on applications to instalment systems, depreciation, decibels and phons, dynamic design, fallacies and puzzles, as well as on more conventional branches of mathematics such as graphs and calculus.

Both parts of the book are written in amusing and colloquial language, with anecdotes, historical references, and digressions, some of which throw more light on the author's opinions on things in general than on mathematics. There are many examples for solution, and the answers are given at the end of the book, in some cases with hints how to obtain them. There is a full index.

Any portion of the book, taken by itself, is very readable; but taken altogether, there is too much of everything. The publishers' claim that the book is for every man and woman raises two questions. Is every man prepared to read such a large book (more than 750 pages), and if so, is he prepared to pay 36*s*. for it? H. T. H. PIAGGIO

Plasticity in Engineering

By F. K. Th. van Iterson. Pp. ix+174. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1947.) 8*s*. 6*d*. net.

AS the author rightly claims in the preface, the chief reason for writing a book on the theory of plasticity is to direct attention to its importance—from the engineering point of view equal to that of the theory of elasticity. Nevertheless, to be of real value, such a book must review the state of knowledge of the subject as a whole, or, on a smaller scale, provide an introduction to the subject, dealing only with well-established theoretical and experimental results.

This book fulfils neither function adequately, and is correspondingly of limited value to the research worker and of real danger to the student. The author has instead developed in it a group of theoretical results, which are neither based on an adequate consideration of the theoretical background, nor supported by convincing experimental evidence; in this connexion, the author has had access to a considerable field of Dutch work, but unfortunately gives only very abbreviated accounts of it. American work, other than the edition in English of Nadai's famous book, is covered in four brief references, and it is unfortunate that the author has apparently not been aware of the important work being done in Great Britain. In the past eighteen months, for example, a collection of papers has been published by R. Hill and fellow-workers, which involve conclusions very different from many of those described.

The valuable features are a considerable collection of recent references, scattered through the book, to Continental work, some illuminating introductory chapters on fundamental aspects of the subject, and a few interesting photographs and diagrams relating to observed results. G. D. S. MACLELLAN

Flowering Earth

By Donald Culross Peattie. Pp. vii+200. (London: Phœnix House, Ltd., 1948.) 10*s*. 6*d*. net.

THIS book is an unusual introduction to the study and appreciation of plant life. The theme running through it is the unity—more particularly in a symbiotic sense—of all living organisms. It is very clearly shown that plants with chlorophyll are basic to the existence of all living organisms, except a few "bacterial autotrophs". Hence, "we ought not to speak of getting at the root of a matter, but of going back to the leaf of things". The main groups and functions of plants are considered in extremely simple language and with the use of a minimum of technical terms.

The opinion may be expressed that a majority of the persons to whom this book might appeal would prefer a little more 'meat' in the eighteen chapters. On the whole, the statements concerning plants are accurate and up to date; but some corrections are necessary. The number of species of flowering plants is stated on p. 124 to be "some one hundred thousand", while on p. 152 "two hundred thousand species" of Angiosperms are said to "populate our flowering world". Kerguelen was certainly visited by Sir Joseph Hooker, but this island is usually considered as being in the southern part of the Indian Ocean and not in the Pacific. It is unfortunate that the desire for simplification of language has led to the use of such phrases as "tiny acids" and to the manufacture of such a plural as "algas". The author is obviously a sincere lover of plants and many of his philosophical ideas are admirably expressed.

W. B. TURRILL

Royal Society Empire Scientific Conference, June–July 1946

Report. Vol. 1. Pp. 828. Vol. 2. Pp. 707. (London: Royal Society, 1948.) 2 vols., 42*s*. net.

THE Report of the Royal Society Empire Scientific Conference, June–July 1946, now issued in two handsome volumes, includes the speeches at the opening ceremony, the papers presented, and recommendations and notes on the discussions (see also *Nature*, July 27, 1946, p. 136). In addition to the "Notes on Current Scientific Researches in the United Kingdom" prepared by the Royal Society, various papers on the organisation of scientific research in the Colonies, in Canada, India, New Zealand, South Africa and Southern Rhodesia give a very useful conspectus of the organisation of such research throughout the British Commonwealth of Nations. The volumes are admirably indexed, and the immense amount of information they contain is made accessible to the reader in a way worthy of the Royal Society and setting a standard that might well be followed widely. They constitute both a worthy record and a reference work on scientific research, information services and related topics in the Empire that should be valuable for several years to come.

R. B.

THE EVOLUTION OF THE UNIVERSE

By DR. G. GAMOW
George Washington University, Washington, D.C.

THE discovery of the red shift in the spectra of distant stellar galaxies revealed the important fact that our universe is in the state of uniform expansion, and raised an interesting question as to whether the present features of the universe could be understood as the result of its evolutionary development, which must have started a few thousand million years ago from a homogeneous state of extremely high density and temperature. We conclude first of all that the relative abundances of various atomic species (which were found to be essentially the same all over the observed region of the universe) must represent the most ancient archæological document pertaining to the history of the universe. These abundances must have been established during the earliest stages of expansion when the temperature of the primordial matter was still sufficiently high to permit nuclear transformations to run through the entire range of chemical elements. It is also interesting to notice that the observed relative amounts of natural radioactive elements suggest that their nuclei must have been formed (presumably along with all other stable nuclei) rather soon after the beginning of the universal expansion. In fact, we notice that natural radioactive isotopes with the decay periods of many thousand million years (such as uranium-238, thorium-232 and samarium-148) are comparatively abundant, whereas those with decay periods measuring only several hundred million years are extremely rare (as uranium-235 and potassium-40). If, using the known decay periods and natural abundances of these isotopes, we try to calculate the date when they have been about as abundant as the corresponding isotopes of longer life, we find that it must have been a few thousand million years ago, in general agreement with the astronomically determined age of the universe.

The early attempts to explain the observed relative abundances of the elements[1,2] were based on the assumption that the present distribution represents a 'frozen equilibrium state' corresponding to some very high temperature and density in an early stage of universal expansion. Such equilibrium theories lead, however, to the result that the logarithm of the relative abundance must be a linear function of the nuclear binding energy, which in its turn is known to be a linear function of atomic weight. Thus, according to that picture, we would expect a rapid exponential decrease of relative abundances all the way from hydrogen to uranium, in direct contradiction to the observed distribution, (circles in Fig. 1), which shows a rapid decrease for the first half of the natural sequence of elements, but levels up almost to a constant value in the second half.

As the result of this difficulty, I suggested[3] that the observed abundances do not correspond to any equilibrium state at all, but, quite on the contrary, represent a dynamical building-up process which was arrested in a certain stage of its development by a rapid expansion of the universe. According to this point of view, one should imagine the original state of matter as a very dense over-heated neutron gas which could have originated (if one lets one's imagination fly beyond any limit) as the result of hypothetical universal collapse preceding the present expansion. In fact, the extremely high pressures obtaining near the point of complete collapse (singular point at $t = 0$) would have squeezed the free electrons into the protons, turning the matter into the state of over-heated neutron fluid. When the expansion began, and the density of neutron gas dropped, the neutrons would be expected to begin decaying again into protons, and more and more complex nuclear aggregates could be built up as the result of the union between the newly formed protons and the neutrons still remaining. Such a building-up process must have started when the temperature of the neutron–proton mixture dropped below a few times 10^{10} °K., which corresponds to the mutual binding energies of these nuclear particles. The equations governing such a gradual building-up process can evidently be written in the form:

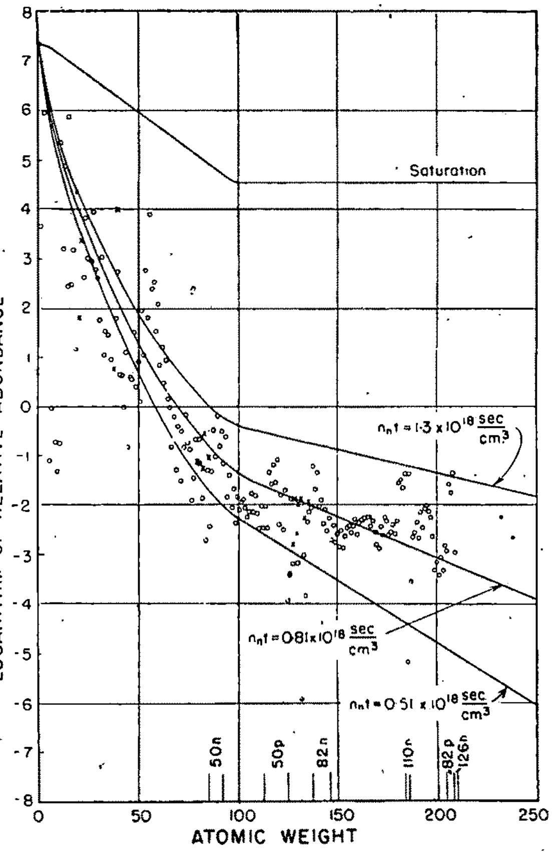

Fig. 1

$$\frac{dn_i}{dt} = \lambda_{i-1}\, n_{i-1} - \lambda_i\, n_i \quad (i = 1, 2, 3, \ldots), \quad (1)$$

where n_i is the number of atomic nuclei of atomic weight i, and λ's are the coefficients depending on the collision frequency, and the capture cross-sections for fast neutrons in the nuclei of various atomic weight.

The numerical study of these equations was carried out by R. Alpher[4,5], who used the recent experimental data on the capture cross-sections of fast neutrons. These cross-sections are known to increase very rapidly by a factor of several hundred for the first half of the atomic weights, and to remain more or less constant for the second half; a fact which is of paramount importance for understanding the general shape of the abundance curve. Suppose that the building-up process goes at a constant density, ρ, for a limited period of time, Δt; the resulting abundances will depend apparently only on the product $\rho\Delta t$, which determines the total number of collisions between the developing nucleus and the free neutrons.

The results of the computations carried out by R. Alpher are shown by continuous curves in Fig. 1, with the values of $n_n \Delta t = \frac{\rho}{m} \Delta t$ marked on each curve. It is seen that for very large values of $n_n \Delta t$, the process reaches saturation, and the number of the various nuclei becomes inversely proportional to the corresponding capture cross-sections. For smaller values of $n_n \Delta t$, heavier nuclei do not have time to build up to the saturation point, and we see from the figure that for $\rho \Delta t \cong 1{\cdot}3 \times 10^{-6}$ gm. cm.$^{-3}$ sec. ($n_n \Delta t \cong 0{\cdot}8 \times 10^{18}$ sec. cm.$^{-3}$) the calculated curve stands in very good agreement with the observational data.

The agreement obtained is amplified by the fact that the observed abundances show the abnormally high values for the isotopes containing the completed shells of neutrons or protons (as indicated along the atomic weight axis in Fig. 1); in fact, it is known that such nuclei possess abnormally small capture cross-sections, which would cause the accumulation of the material at these particular atomic weights. Since the building-up process must have been accomplished within a time period comparable with the decay period of neutrons, we have $\Delta t \cong 30$ min. $\cong 2 \times 10^3$ sec., from which it follows that during that period the density of matter must have been of the order of magnitude 10^{-9} gm. cm.$^{-3}$. On the other hand, since the temperature must have been of the order of 10^9 °K., the mass-density of radiation, aT^4/c^2, was comparable with the density of water. Thus we come to the important conclusion that, at that time, the expansion of the universe was governed entirely by radiation and not by matter.

In this case the relativistic formula for the expansion can be written in the form[6],

$$dl/dt = \sqrt{\frac{8\pi G}{3} \frac{aT^4}{c^2} l^2}, \tag{2}$$

where l is an arbitrary distance in the expanding space, and the constant term containing the radius of curvature is neglected because of the high value of the density. Remembering that for the adiabatic expansion of the radiation $T \sim 1/l$, we can integrate (2) into the form:

$$T = \sqrt[4]{\frac{3c^2}{32\pi Ga}} \cdot \frac{1}{t^{1/2}} = \frac{2{\cdot}14 \times 10^{10}}{t^{1/2}} \text{ °K.} \tag{3}$$

For the mass-density of radiation we have:

$$\rho_{\text{rad.}} = \frac{3}{32\pi G} \cdot \frac{1}{t^2} = \frac{4{\cdot}5 \times 10^5}{t^2} \text{ gm.cm.}^{-3}. \tag{4}$$

For the density of matter we must evidently write:

$$\rho_{\text{mat.}} = \frac{\rho_0}{t^{3/2}} \text{ gm.cm.}^{-3}, \tag{5}$$

where ρ_0 is to be determined from the conditions of the nuclear building-up process. It can be done in the simplest way by considering the building up of deuterons by proton–neutron collisions. Writing X for the concentration of neutrons (with $X(0) = 1$); and Y for the concentration of protons (with $Y(0) = 0$), we obtain the equations:

$$\begin{aligned} \frac{dX}{dt} &= -\lambda X - \frac{XY}{m}\rho v\sigma, \\ \frac{dY}{dt} &= +\lambda X - \frac{XY}{m}\rho v\sigma, \end{aligned} \tag{6}$$

where v is the thermal velocity, and σ the capture cross-section which (for the energies in question) can be sufficiently accurately represented by the formula[7]:

$$\sigma = \frac{2^{3/2}\pi e^2 \hbar \varepsilon^{5/4}}{m^3 c^5} \cdot \frac{1}{E^{3/2}}, \tag{7}$$

$\varepsilon = 2{\cdot}19$ MeV. being the binding energy of the deuteron. Expressing v and E through the temperature, and using (3), we can rewrite (6) as:

$$\begin{aligned} \frac{dX}{d\tau} &= -X - \frac{\alpha XY}{\tau}, \\ \frac{dY}{d\tau} &= +X - \frac{\alpha XY}{\tau}, \end{aligned} \tag{8}$$

where $\tau = \lambda t$ and:

$$\alpha = \frac{2^{13/2}\pi^{5/4} e^2 \hbar \varepsilon^{5/2} G^{1/4} a^{1/4}}{3^{5/2} m^{9/2} c^{11/2} k} \cdot \rho_0. \tag{9}$$

In order that the equations (8) should yield $Y \cong 0{\cdot}5$ for $\tau \to \infty$ (since hydrogen is known to form about 50 per cent of all matter), the coefficient α must be set equal to 0·5. The change of X and Y with time in this case is shown in Fig. 2, which also indicates the corresponding variation of temperature. Assuming $\alpha = 0{\cdot}5$, we find from equation (9) that $\rho_0 = 0{\cdot}72 \times 10^{-3}$, which fixes the dependence of material density on the age of the universe.

Once we have $\rho_{\text{rad.}}$ and $\rho_{\text{mat.}}$ as functions of time, we can follow the physical processes taking place during the further expansion of the universe, and in particular calculate the masses and sizes of the con-

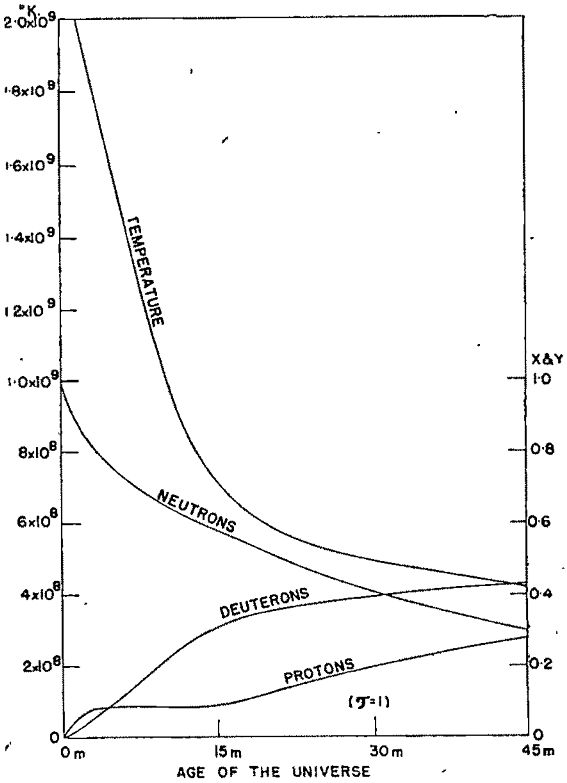

Fig. 2

densations of that primordial gas which must have originated sooner or later according to Jeans' principle of gravitational instability[8]. Jeans' classical formula gives the diameter D of the condensations which will be formed in a gas of temperature T and density ρ in the form:

$$D^2 = \frac{10\pi}{9mG\rho} \cdot \frac{3}{2} kT. \qquad (10)$$

Using the expressions (3) and (5), we get:

$$M = \rho D^3 = \frac{2^{31/8} 5^{7/4} \pi^{5/4} e \hbar^{5/4} \varepsilon^{5/4}}{3^{17/8} m^{15/4} c^{5/4} G^{7/4}} \qquad (11)$$

(where a has been expressed through other fundamental constants).

It is interesting to notice that the time-factor cancels out in the calculation of M, so that the mass of the condensations comes out the same, independent of the epoch when they were formed. It seems, however, reasonable to assume that the effect of gravitational instability became important only when the mass-density of radiation became comparable with the density of matter, since it is hard to imagine a 'gravitational condensation of pure radiation'. Using (4) and (5), we find that $\rho_{\text{rad.}} = \rho_{\text{mat.}} = 3 \times 10^{-26}$ gm.cm.$^{-3}$ at $t = 3 \cdot 9 \times 10^{15}$ sec. $= 1 \cdot 3 \times 10^8$ years, at which point $T = 340°$ K. For this value of t we obtain:

$$D = \frac{2^{45/8} 5^{1/4} \pi^{7/4} e^3 \hbar^{3/4} \varepsilon^{15/4}}{3^{27/8} m^{29/4} c^{35/4} G^{5/4}}. \qquad (12)$$

Substituting numerical values, we have:

$$\begin{aligned} M &= 5 \cdot 5 \times 10^{40} \text{ gm.} = 2 \cdot 7 \times 10^7 \text{ sun-masses} \\ D &= 1 \cdot 3 \times 10^{23} \text{ cm.} = 13{,}000 \text{ light-years,} \end{aligned} \qquad (13)$$

which must represent the masses and the diameters of the original galaxies.

The above estimate of galactic masses falls short by a factor of about one hundred from the mass-values of galaxies obtained from astronomical data. But it must be remembered that the simple Jeans' formula used in these calculations does not take into account the effect of radiation pressure, and also is applicable only to the gravitational condensations in non-expanding space. The effect of additional radiation pressure (which is quite important according to the previous considerations) and the tearing force of expansion will lead to considerably larger condensation masses. The detailed study of this question will require, however, the extension of Jeans' classical arguments for the case of a mixture of gas and radiation in the expanding space. At the present stage one should be satisfied with the fact that, by such comparatively simple and rather natural considerations, *masses and sizes comparable to those of stellar galaxies can be expressed in terms of fundamental constants, and the basic quantities of nuclear physics.*

We may add that, according to the above picture, the galaxies have been originally formed in the purely gaseous form (including a certain amount of solid dust particles), which must account for the regular shapes of rotating bodies. The formation of individual stars within the galactic bodies must have taken place at a somewhat later stage, probably along the lines of the Spitzer – Whipple theories[9,10]. When stars were formed by the condensation process within the rotating gaseous mass, their tangential velocities, being equal to the original velocities of the gas-masses, were clearly not high enough to maintain them on circular Kepler orbits, so that *the newly formed stars must have been moving along elongated elliptical orbits with the points of maximum elongation in the places of their origin.* This situation must have remained essentially unchanged even when all the material of originally gaseous galaxies was used up in the formation of stars.

These considerations give a simple explanation of the otherwise mysterious fact that the elliptical galaxies and the central bodies of spirals rotate 'as solid bodies' with the linear velocities proportional to the distance from the axis. In fact, according to our picture, the maximum Doppler displacements observed at various distances from the axis correspond to the velocities of stars passing through 'aphelion' at these particular distances, and, according to the previous argument, are equal to the velocities which the gas-masses must have had in these regions prior to their condensation into the stars.

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COASTAL WAVES*

RECENT investigations by the Admiralty have shown that storm waves and the swell that leaves the storm area are composed of a mixture of wave-trains, the wave-lengths of which range from a few feet up to a maximum which depends on the greatest wind strength, and may be as much as 3,000 feet. It seems remarkable that such component wave-trains should travel independently across the ocean, and that all except the very shortest should be recognizable after travelling thousands of miles; but such close agreement with theory has been demonstrated, and the component wave-trains have been found to advance across the ocean with the theoretical velocities appropriate to their lengths.

The short waves formed at the beginning of a storm are overtaken and outdistanced by long waves formed when the wind is strongest. With the help of new wave-recording and analysing apparatus, each wave-length can be detected and its amplitude measured when it arrives at a distant coast, and the waves recorded on the coast of Cornwall are found at times to be a mixture of waves generated near the coast with swell-components from more than one North Atlantic storm, and with other swell, probably a few inches high, which was generated in a storm so far away as Cape Horn.

The visible crests and troughs are the result of the combination of trains of waves of different lengths, and since such waves travel with different velocities, the wave-pattern is continually changing. When some of the component wave-trains get into step and reinforce each other, they produce a group of typical waves with relatively high crests and deep troughs; but, when they get out of step and tend to neutralize each other, the wave-crests are low and irregular. Such interaction between component wave-trains explains the recurrence of sequences of high and low waves that is often observed; it is not necessarily the fifth, seventh or any other number of wave that is always the highest, but there is often sufficient regularity to suggest a rhythm, and to allow the coxswain of a boat to take advantage of one of the quiet periods. There is most likely to be a noticeable rhythm when a narrow range of wave-lengths is present, as in long swell from a distant storm. Although the variability of the wave-pattern on deep water and of the height of the crests that approach the beach depends on the interaction of component wave-trains, such interaction appears to be suspended when the waves reach very shallow water; here they rise into sharp crests separated by wide, flat troughs, and each crest seems to travel independently of its neighbours.

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* An account of the symposium held at the meeting of Section A (Mathematics and Physics) of the British Association on September 9, in which Brigadier R. A. Bagnold, Mr. N. F. Barber, Dr. G. E. R. Deacon and Major W. W. Williams took part.

One of the most noticeable changes in waves entering shallow water is an increase in height. The reason, according to an explanation given by Lord Rayleigh in 1911, is essentially that the velocity of a wave decreases as the depth of water decreases, and the height of the wave increases since it must carry energy towards the shore at the same rate. The increase in height depends on the wave-length, and long swell may rise to as much as twice its deep-water height; it may become apparent for the first time when it enters shallow water, and such an emergence has earned for it the name 'ground-swell'.

When waves approach the shore obliquely, the ends which reach shallow soundings first travel slower than the seaward ends, and the waves swing round until they are nearly parallel to the beach. In this way waves can swing round headlands and islands, and enter bays not directly exposed to their original direction; the effect is more marked with long waves, and a long swell may round a headland that offers complete protection against shorter wind-waves. A shallow spit extending out to sea tends to focus the wave-energy; but a deep gulley pointing into shallow water causes the wave-energy to be refracted towards the sides and offers quieter water in the middle. Waves are also affected by tidal streams, and Mr. N. F. Barber argued that waves travelling at 20 knots in still water would make no progress against a tidal stream of 5 knots but would steepen and break. Waves meeting a tidal stream obliquely will be refracted, and the theory suggests that a tidal stream may protect an anchorage.

Brigadier R. A. Bagnold, dealing with the movement of sand and shingle, described model experiments in which it could be seen that long waves approaching a beach give rise to a strong drift of water along the bottom in the direction of wave travel; this movement is continued as far as the plunge-line, where the waves break, and there the water appears to rise from the bottom to form a backward drift at the surface. He remarked that we have no exact knowledge of what happens on the bed of the sea, although it is of great importance to engineers to predict the movements of sand and shingle; the necessary observations on the sea bed would be difficult and expensive, but it is quite possible to make them.

Mr. Barber put forward theoretical reasons for believing that the movements in the sea would resemble those observed in the model. Waves cause a small transport of water in their direction of travel, greatest at the surface but almost as large at the bottom if the waves are long. It is not likely to be affected to any appreciable extent by friction with the bottom, since the vorticity associated with the oscillatory movements of the waves is continually changing sign and therefore unable to diffuse far above the bottom. The seaward drift which must compensate for the shoreward transport can, on the contrary, be treated as a unidirectional flow for which the effect of the bottom drag will be greater, and its velocity will be a maximum at the surface and zero at the bottom. The resultant effect of bottom friction and viscosity on the wave-transport and the compensating seaward drift should be a seaward drift at the surface and a shoreward movement at the bottom; if the waves are short, there would be a shoreward movement at the surface and the bottom and a seaward movement in the intermediate depth. For waves 3 ft. high Mr. Barber estimated the velocity of such movements to be of the order of 5 cm. a second.

Little information is available of the water movements between the breakers and the beach. In the model experiments the movements in this part of the tank are difficult to observe because of the strong turbulence; but it was found that dye put into the water between the plunge-line and the beach showed little tendency to pass outwards across the plunge-line. One of the consequences of the termination of the forward movement at the plunge-line is that sand tends to accumulate there; it was also found that the sand does not move uniformly towards the shore but as a series of regularly spaced bars, the spacing being of the same order as the wave-length. In the sea, the formation of bars is complicated by the shifting of the breaker zone relative to the beach as the tide rises and falls, and they are observed particularly off coasts where the tidal range is small. Major Williams mentioned the research into the effect of waves on beaches that is being undertaken in the Department of Geography at Cambridge, and made special reference to widespread occurrence of bars in the Mediterranean Sea. They were a considerable hazard during landing operations, since men, or vehicles proofed for a certain depth, would find water too deep for them if they left a vessel which had grounded on a bar. The movements of such bars are being studied in relation to the waves and other factors.

Major Williams also described how the reduction in the velocity of waves entering shallow water had been used to obtain accurate information about the underwater profile of the beach. By comparing successive aerial photographs of known scale, the wave-length and velocity of waves at different distances from the shore could be measured and the beach profile calculated.

In the discussion which followed, it was remarked that observations and theory tend to discount reports of strong undertow below waves, and suggest that the resultant movement, after allowing for the backward and forward movement of the waves, is towards the shore. The evidence of a seaward movement at the surface appears, on the other hand, to grow stronger. On the coast of California in particular, it has been observed that strong outward movements may develop at certain points on the beach, presumably where the seaward drift is concentrated; the position and intensity of such 'rip-currents', as they are now called, may vary, but they tend to be associated with some irregularity in the beach or where some natural or artificial barrier extends to seaward. Together with the local tidal streams they may account for the danger of bathing in certain localities; they can sometimes be detected because foam or discoloured water is seen moving outwards through the breakers. It is reasonable to suppose that they are stronger with high waves, especially when a group of high waves is followed by a group of low waves, since the high waves will tend to build up a head of water on the beach. Little is known of the behaviour of breaking waves, but it has been assumed with some success that the wave breaks when the water-particle velocity, which depends on the height of the wave, exceeds the wave-velocity, which depends on the depth of water. Such an argument implies a close relationship between the height of a wave and the depth of water in which it will break; and it has been shown that there is a tendency for waves to break when the ratio of water-depth to wave-height is four-thirds.

Prof. J. D. Bernal gave an evening discourse on "Waves and Beaches" on September 13; all available tickets were issued before lunch-time on the first day of the meetings, and the close attention of the crowded hall showed a lively interest in the subject as well as appreciation of the inspiring lecture. After summarizing the studies made during and since the War, Prof. Bernal described their application to military purposes and the prevention of coastal erosion, and showed how a better knowledge of the transport of sand and shingle by waves would be useful in geological studies. In discussing coastal erosion and other coastal engineering problems, he remarked that no other industry spent such a small proportion of its outlay on research, or stood so much in need of accurate knowledge of the basic principles involved and of some central authority.

MULTIPLE ALLELOMORPHS IN COLOUR VISION

By Dr. R. W. PICKFORD
Department of Psychology, University of Glasgow

EVIDENCE has been found that the main forms of defective red-green colour vision in man are multiple allelomorphs, alternative to each other and to the normal form[1]. In order to prove this hypothesis it would be necessary to show: (*a*) that the forms of red-green vision are discontinuous variations; (*b*) that they are inherited true to type; (*c*) that they segregate independently; and (*d*) possibly that they have an order of dominance. It will be seen that the evidence in favour of the hypothesis is very strong.

Discontinuous Variations

The question is very important whether or not the well-known variations of colour vision, two of which are generally called red-green blindness, are the extremes of a continuous normal curve. Rayleigh[1a] threw doubt on the continuous nature of these variations in 1881. He showed that there were red and green anomalous subjects who were characteristically different from the normal, from each other and from the red-green blind as well. This has been confirmed by Pickford[2]. In addition, Rayleigh indicated in the same paper that the two types of red-green blindness were also distinctively different, a conclusion supported by von Kries and Donders[3] and by Pickford more recently[4]; while Houstoun showed by means of his microscope test[5] that the major red-green defectives formed a small and rather irregular group separated clearly from the large group of normal subjects.

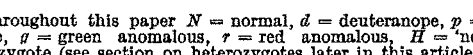
In a recent investigation upon some 900 normal and more than 140 red-green defective subjects (the latter not all found by chance), I have found convincing evidence of a statistical kind that there are four or probably five distinct types of red-green vision in addition to the normal form. This research will be published in full as soon as possible (*J. Psychol.*, in the press). The types are: deuteranope, protanope, green anomalous and red anomalous, the latter being divided into two classes, those with and those without the darkened red of the protanope. Whether the two types of red anomalous subjects are statistically distinct is difficult to decide finally on the basis of the eight cases available, but it is extremely likely.

Adequate tests, which will be published shortly, show that the anomalous subjects are not to be viewed as the intermediates between the red-green blind and the normal. To think of the green anomalous as intermediate between the normal and the 'green-blind', while the red anomalous might be intermediate between the normal and the 'red-blind', is highly tempting. There are, however, grave objections to this: (1) neither class of anomalous subjects is sufficiently variable to fill the gap it is supposed to occupy; (2) both the so-called 'red-blind' and 'green-blind' are, in fact, red-green blind; (3) though most red-green blind subjects are more defective, some are actually less defective than the anomalous, who are possibly to be identified with Houstoun's "colour-different" subjects[6]. Edridge-Green was well aware that the anomalous were not true 'intermediates'[7]. It was only in terms of the Young–Helmholtz theory, now rapidly becoming more and more difficult to sustain[8,9], that they could be thought of as true intermediates; indeed, it has long been realized[10], as Rayleigh foretold[11], that the red-green blind cannot be divided into the 'red-blind' and 'green-blind' classes, but must be divided on the principle that while both types are red-green blind, in the protanopes or scoterythrous the red end of the spectrum is greatly darkened, and in the deuteranopes or photerythrous there is no darkening of the red. That about half of the red anomalous do not have th darkened red of the protanope is a fourth objection to treating them as intermediates.

It is inevitable that we should conclude that ther are four (or probably five) types of major red-green vision defects, which are as clearly discontinuou from each other and from the normal as is usual with familiar Mendelian allelomorphs.

Inheritance True to Type

Few people have realized the implications, for th theory of inheritance of colour vision defects, o Rayleigh's pedigree[12] showing the green anomalou condition in three of his brothers-in-law. The seven siblings he tested are shown in Pedigree 1*. Th three brothers who were green anomalous inherite the defect true to type, and were completely differen



Pedigree 1*

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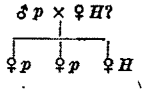
* Throughout this paper *N* = normal, *d* = deuteranope, *p* = pro tanope, *g* = green anomalous, *r* = red anomalous, *H* = 'norma heterozygote (see section on heterozygotes later in this article), ? = doubtful owing to inadequacy or lack of testing.

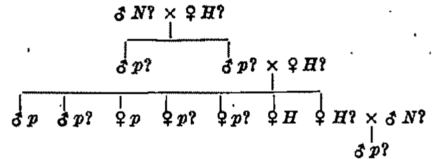
from the other brother, who was normal, and from the sisters, who appeared to be unaffected. This pattern of inheritance fits the Mendelian scheme for a recessive sex-linked allelomorph, which would be for the green anomalous condition in this case.

Several published pedigrees show that the same Mendelian principles apply to the red anomalous condition (protanomaly)[13], to the green anomalous condition (deuteranomaly)[14], to deuteranopia[15], and to protanopia[16], although it is only too well known that some tests in common use have not been above scientific criticism, and that the difficulties of collecting information from relatives for the completion of such pedigrees are always very great.

I have confirmed the implications of these pedigrees in every respect, with the exception of not having had the good fortune to trace the red anomalous condition in the relatives of an affected subject because the relatives were inaccessible. Pedigrees 2, 3, 4, 5 and 6 are good examples taken from a large collection*. All pedigrees which have been collected show that the defect is inherited in such a way that it is either manifested true to type (whether in a man or in a woman), or does not appear; and that the mode of inheritance is invariably that of a Mendelian sex-linked recessive[17,18]. Other experiments have shown that it is, in fact, an incomplete recessive, since it generally appears in a small and recognizable degree in normal heterozygotes[19]. Even where the defect appears to pass from father to son[20], the sex-linked pattern is not necessarily contradicted, because it is probable that the mother was a heterozygote, and unless this possibility is excluded we cannot be sure of transmission directly from father to son. The fact that I have found the following three pedigrees (7, 8 and 9) shows that the greatest care is needed concerning this point. Finally, I have found, without exception, that the defects are inherited not only true to type, but also in degree. That is to say, an extreme deuteranope's defective relatives are also extreme deuteranopes, a moderate deuteranope's are moderate, and similarly for protanopes.



Pedigree 2



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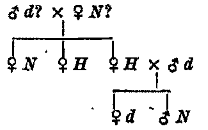
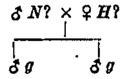


Pedigree 4



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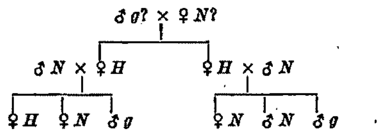

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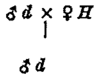

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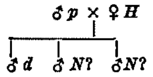
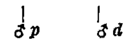


Pedigree 8



Pedigree 9

Independent Assortment

The independent assortment of types of colour-vision defect is clearly shown by certain published pedigrees, in spite of the possible inadequacy of the tests used. For example, the independent assortment of the red anomalous (protanomalous) condition and an unspecified form of red-green blindness is shown by a pedigree due to Göthlin[21]. That of the deuteranope and an anomalous condition unspecified is shown by pedigrees due to Guttmann[22], that of the deuteranope and the green anomalous (deuteranomalous) condition by pedigrees due to Göthlin and Wölfflin[23]; while that of the green anomalous (deuteranomalous) condition and an unspecified form of red-green blindness is shown by a pedigree due to Döderlein[24]. Finally, the independent assortment of protanopia and deuteranopia is shown by certain pedigrees in which there are some members with one and some with the other defect[25], and one in which father and son had different defects[26], as in my Pedigree 8. It is most unfortunate that many of the collectors of pedigrees of colour blindness have not realized the importance of specifying exactly the type and degree of defect (if any) of each person tested, and, indeed, even more unfortunate that no adequate test has been available in the past for separating the types with complete certainty. In the absence of an adequate method of measuring their heights, we should never have been certain that short peas were on the average shorter than tall peas by an amount differing to a statistically significant degree from zero. Nevertheless, in colour vision, the evidence favouring the hypothesis of the independent assortment of red-green major defects in general and the normal condition is overwhelmingly great, while that favouring the same hypothesis in relation to the different types of defect among themselves is very great indeed.

Order of Dominance

The most convincing evidence for the theory that the statistically distinct forms of sex-linked red-green colour vision defect are multiple allelomorphs might come from a study of their combinations. These combinations, however, can occur only in women, and any possible evidence concerning the effects of combinations of defective genes in the same heterozygote will be confined to a proportion of the 0·61 per cent[27] of major defective women. The smallness of this percentage makes research very difficult, and shows that it is of great importance that as many red-green defective women as possible should be discovered and persuaded to undergo adequate tests, together with a sufficient number of their male relatives on both sides of the family, to indicate their genotypes conclusively.

In the present investigation, fifteen red-green defective women were tested efficiently, up to the time of writing, and their pedigrees did in four cases give indications of the possible effect of combinations of different allelomorphic genes, though these were unfortunately all of the same kind. They are Pedigrees 10, 11, 12 and 13. In Pedigrees 10 and 11 the fathers had been dead some time; but there was good hearsay evidence from the relatives that they had been (*a*) colour blind rather than anomalous, because the anomalous rarely become noticed for colour mistakes in the family circle, and (*b*) deuteranopes rather than protanopes, because protanopes usually become notorious by confusions relating to red and

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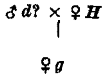
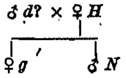
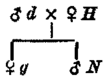
* Where there is a query (?), good evidence, though falling short of a perfectly adequate test, indicated the condition.



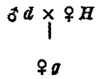
Pedigree 10



Pedigree 11



Pedigree 12



Pedigree 13

black or another dark colour, and in these cases that kind of confusion was not mentioned. In Pedigrees 12 and 13 all relatives were given adequate tests. The four cases all strongly support the view that the daughter was a heterozygote for deuteranopia and the green anomalous condition together, and that the latter was dominant. The possibility that one of the untested fathers was a protanope must be borne in mind, and it would carry with it the implication that the green anomalous condition was still dominant.

In four published pedigrees the underlying principle is the same[28]. All these pedigrees will be found to include a group of relationships such that a green anomalous woman must have been a heterozygote for green anomaly and deuteranopia together, thus again indicating that the green anomalous condition was dominant; and in one of these pedigrees the two conditions segregate independently in the two sons, one of whom is a deuteranope and the other green anomalous.

Four other cases quoted by Bell are also very interesting. One due to Göthlin[29] shows two sons as protanopes, while the father and maternal uncle are both deuteranopes. Here it would not be an unlikely hypothesis that the mother was a protanope heterozygote, inheriting that condition from her father, for her two sons, who must follow the mother, are both protanopes. Another case, also due to Göthlin[30], shows two sons as deuteranopes, two as protanopes and the daughter as normal, while both parents were said to have been normal. A case due to Jeffries[31] shows one son a protanope and the other a deuteranope, while no information is given about the parents. In these two pedigrees the mother might possibly have been a heterozygote for protanopia and deuteranopia together, and, since she was believed to be normal in the one case while no information was given about her in the other, the possibility arises that this particular heterozygote does not differ much from the normal condition, though it is more likely that the defect was not revealed by the tests used. A fourth case, due to Hess[32], shows father and daughter as deuteranopes, though it is not known for what condition the mother was a heterozygote. It is clear that added information in this case would have been most valuable, as in so many others.

Heterozygotes

If it is true that there are five defective allelomorphs for red-green colour vision, then the possible number of genotypes in women will be twenty-one. Of these, one will be the normal homozygote, five defective homozygotes, five normal heterozygotes and ten will be defective heterozygotes. The probable frequencies of these genotypes may be calculated from the observed frequencies of the corresponding defects in men[27], and some would be very rare indeed. It has been shown that the majority of the normal heterozygotes have a small red-green defect[19]. Fuller study of these and of the other combinations would be most valuable.

Conclusion

The hypothesis that there are six multiple allel morphs for red-green colour vision and its defects i man is supported by the following evidence: (*a*) A least four and probably five different types of re green sex-linked defect are statistically distinc namely, deuteranopia, protanopia, green anomal red anomaly with and red anomaly without th darkened red of the protanope. (*b*) Many pedigre indicate that these are inherited true to type, or n at all. (*c*) Many pedigrees show that these typ segregate independently. (*d*) Eight pedigrees sho that the green anomalous condition is dominant t that of the deuteranope, while all the defective form are recessive to normal red-green colour vision.

[1] Gates, R. R., "Human Genetics", Chapter 6 (1946).

[1a] Rayleigh, Lord, *Nature*, **25**, 65 (1881).

[2] Pickford, R. W., *Nature*, **153**, 656 (1944).

[3] Parsons, J. H., "Colour Vision", 168 (1915).

[4] Pickford, R. W., *Nature*, **161**, 27 (1948).

[5] Houstoun, R. A., "Vision and Colour Vision", 194 ff. (1932).

[6] Houstoun, *op. cit.*, 214.

[7] Edridge-Green, F. W., "The Physiology of Vision", Chapter 24 (192

[8] Hartridge, H., *Science*, **108**, 395.

[9] Pickford, R. W., *Nature*, **162**, 414 (1948).

[10] Collins, M., "Colour Blindness", 2 and 217 (1925).

[11] Rayleigh, *op. cit.*, 66.

[12] Rayleigh, *op. cit.*, 65.

[13] Bell, Julia, *The Treasury of Human Inheritance*, 2, *Anomalies a Diseases of the Eye* (1933), Plate XLI, pedigree 595.

[14] Bell, *op. cit.*, Plate XLI, pedigrees 591, 597, etc.

[15] Bell, *op. cit.*, Plate XXXVI, pedigree 513, and Plate XXXVII pedigree 565.

[16] Bell, *op. cit.*, Plate XXXVI, pedigree 511, and Plate XXXVI pedigree 526.

[17] Ford, E. B., "Genetics for Medical Students", 44–6 (1946).

[18] Crew, F. A. E., "Genetics in Relation to Clinical Medicine", 47- (1947).

[19] Pickford, R. W., *Nature*, **153**, 409 (1944); **160**, 335 (1947); an Ford, *op. cit.*, 151.

[20] Bell, *op. cit.*, Plate XXXVII, pedigrees 516, 521, 544.

[21] Bell, *op. cit.*, Plate XLI, pedigree 593.

[22] Bell, *op. cit.*, Plate XLI, pedigrees 596 and 599.

[23] Bell, *op. cit.*, Plate XLI, pedigrees 598 and 601.

[24] Bell, *op. cit.*, Plate XLI, pedigree 600.

[25] Bell, *op. cit.*, Plate XXXVI, pedigree 512, and Plate XXXVI pedigree 527, and Plate XXXVIII, pedigree 563.

[26] Bell, *op. cit.*, Plate XXXVIII, pedigree 551.

[27] Pickford, R. W., *Nature*, **160**, 335 (1947).

[28] Bell, *op. cit.*, Plate XLI, pedigrees 594, 598, 600 and 601.

[29] Bell, *op. cit.*, Plate XXXVI, pedigree 512.

[30] Bell, *op. cit.*, Plate XXXVII, pedigree 527.

[31] Bell, *op. cit.*, Plate XXXVIII, pedigree 563.

[32] Bell, *op. cit.*, Plate XXXVIII, pedigree 565.

OBITUARIES

Prof. Alan F. C. Pollard

FEW people in the world of science and engineerin have had such a strong sense of order and directio as Alan Faraday Campbell Pollard, who died suddenl at the age of seventy years at Thames Ditton o August 15. He was essentially a crusader, and hi sense of mission was such that he spared no amoun of trouble and effort to further the objects in whic he so optimistically believed. He will perhaps b best remembered both for his efforts to reform method of instrument design on a sound scientific basis, an not less for his untiring advocacy of comprehensiv schemes for indexing scientific literature and, in fact all serious knowledge. He was fortunate that in thes things he seemed, comparatively late in life, to fin his true *métier*, when the very varied experiences o his earlier days had given him a foundation on whic to build.

The son of Lieut.-Colonel B. H. Pollard, of the Indian Staff Corps, he thought at first of an Army career, but later studied medicine at St. Bartholomew's Hospital and King's College, London. Circumstances making it impossible for him to complete his medical training, he turned to engineering, which he studied at University College and (as an apprentice) at Siemens Bros. However, during his period at University College, he acted for some time as demonstrator and assistant to Prof. Karl Pearson, a contact which powerfully affected his thought and methods.

In 1911 Pollard joined the staff of Nobels Explosives, Ltd., and established a special physical laboratory at Croydon for this firm. He was presently given the post of chief physicist and superintendent of the firm's testing station, but on the outbreak of war in 1914 he was gazetted a second lieutenant in the Royal Scots Fusiliers (having previously held a commission in the militia forces). In 1918 he was appointed sub-director of the Instrument Section in the Ministry of Munitions (Aircraft Production) and was gazetted captain in the R.A.F. However, the exigencies of war had led to the formation of a Technical Optics Department at the Imperial College, under the directorship of the late Prof. F. J. Cheshire, and Pollard was appointed to the chair of instrument design, which he held until he reached the age of sixty-five. Even then he seemed to have lost little of his health and vigour, and until his death he was director and consultant to Messrs. Daniel Varney, Ltd. He was awarded the degree of D.Sc. (Engineering) in 1943. He was made a professor emeritus of the Imperial College and held numerous honorary posts of public importance.

Being extremely inventive and versatile, Pollard developed many instruments and appliances, including a new nephelometer, appliances for artificial limbs, reflector lights, an interchangeable nosepiece for microscope objectives, and many other things. He felt very strongly that instrument makers in Great Britain were dominated by ideals more appropriate to heavy engineering production than to scientific instruments, and he turned to the kinematical theories of Clerk Maxwell as a satisfactory basis for reform. His views were expounded especially in his Cantor Lectures to the Royal Society of Arts in 1922, and in a book on "The Kinematical Design of Couplings in Instrument Mechanisms", published in 1929 by Adam Hilger, Ltd. He tried to show that instrument design is essentially a special subject and demands a discipline all its own. Although his chair at the Imperial College has not so far been filled, it may be claimed that his influence can be felt in such steps as the beginning of the new Department of Instrument Technology at the Northampton Polytechnic, London, and in numerous examples of modern instruments in which kinematical principles are employed.

Pollard had essentially a tidy mind, and he loved card-indexes and files. His personal possessions were well catalogued ; he did not keep his gospel merely for others. This trait was sometimes the source of quips by others with more haphazard methods—'slovenly' was his most severe word of scorn, and there was unholy joy when on one occasion he was human enough to lose a library book. The Universal Decimal Classification made an instant appeal to him, and he not only became an enthusiastic advocate, but also contributed very materially to its development in the field of optics. He became the first president of the British Society for International Bibliography in 1927, and took a leading part in the conferences of the International Federation for Documentation held on the Continent. A noteworthy address was on "A Proposed Plan for the Mobilization of the Bibliographical References to the contents of the World's Non-fiction Literature", in which there is a plan for National Bureaux of Information which might, working under an International Information Council, make (and keep up to date) complete U.D.C. indexes of human knowledge; for a student of a special subject might then obtain all the useful references to papers or books in his field simply by citing the appropriate classification numbers. He beheld with dismay human knowledge growing not only out of control but also out of reach. Like H. G. Wells, he believed in wisdom as contained in books, and wanted badly to make it accessible. He will be missed in an age in which such optimism is more rare, but at least he has helped us to grasp the magnitude of the problems involved.

Pollard had a wide circle of friends both in Great Britain and abroad, and was always willing to give time and attention to those who asked his help or advice. In 1915 he married Gabrielle, daughter of Mr. Frederick Urwick, and he leaves also a son and a daughter.

L. C. MARTIN

Mr. G. J. Arrow

WE regret to record the death on October 5, after a brief illness, of Gilbert John Arrow, late deputy keeper in the Department of Entomology in the British Museum (Natural History). Born on December 20, 1873, the son of John Garner Arrow, of Streatham, Arrow was trained for the profession of architecture, but in 1896 entered the more congenial service of the British Museum (Natural History) at South Kensington. Here he was assigned to the study of beetles and early specialized on the Lamellicornia, upon which group he soon made himself an authority. His greatest work was the four volumes on the Lamellicorn Coleoptera of the Fauna of India series. He also contributed numerous papers, more than a hundred in all, to the *Transactions of the Royal Entomological Society of London*, the *Annals and Magazine of Natural History*, and other scientific journals.

Mr. Arrow retired under the age limit in 1938, but continued voluntarily his work at the Museum until within a few weeks of his death. This work was of untold value to the Museum, especially during the war years and the trying times that followed, and was recognized by the Trustees of the Museum by the bestowal upon him recently of the special distinction of 'honorary associate' of the British Museum. His imperturbability was immense ; he would continue calmly at work during air-raid warnings, and even when found under a shower of glass when a flying bomb fell almost outside his window, his main concern was that he could not find his spectacles.

He was a great lover of music, and did much to encourage musical talent among the junior members of the Museum staff until increasing deafness made this no longer possible. He was also an expert photographer and would frequently use his own photographs in illustration of his papers.

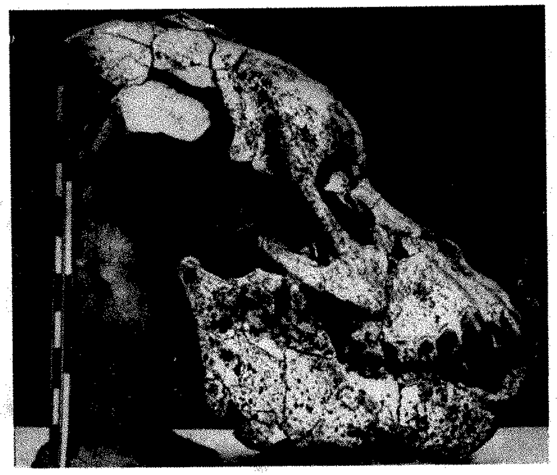
He married in 1912 Miss Rachel Katharine Davis, who survives him, and to whom we would tender our sincere sympathy in her bereavement.

K. G. BLAIR

NEWS and VIEWS

Skull of *Proconsul* from Rusinga Island

THE second season's work of the British–Kenya Miocene Expedition in the Kavirondo region of Lake Victoria has culminated in one of the most important discoveries yet made there. Dr. L. S. B. Leakey, the field director of the Expedition, has announced the finding on Rusinga Island on October 2 of the greater part of a skull of one of the species of Miocene apes belonging to the genus *Proconsul*, probably *Pr. africanus* (Hopwood). Up to now, fossil remains of Miocene and Pliocene apes in Africa and other parts of the world have been practically confined to teeth and fragments of jaws, and this new discovery for the first time provides information regarding the whole of the facial skeleton and much of the brain case. As will be seen from the accompanying photograph, the jaws and facial skeleton are remarkably complete, though they are somewhat displaced by distortion on the left side. The forehead region is particularly interesting, for it shows a complete absence of the supra-orbital torus which is so characteristic of the modern African anthropoid apes. Another interesting feature is the unusual thinness of the cranial wall. The specimen is extremely fragile, and evidently must have required consummate skill for its successful removal from the deposits in which it was found. Mrs. Leakey was actually the first to see some small fragments of the skull, where they had been washed out on the slope of one of the gullies which were being explored. She directed the attention of her husband who, cutting back into the beds, brought to light this most important, and indeed unique, fossil. Mrs. Leakey is bringing the skull by air to Great Britain, where she expects to arrive on October 31, and in the first instance it will be deposited at the Department of Human Anatomy at Oxford, where it will be studied in detail, in connexion with more than a hundred other specimens of Miocene fossil apes which the British–Kenya Miocene Expedition has collected over the last two years. It is particularly gratifying to note that this Expedition, which was mainly financed in its first year (1947) with the aid of a grant from the Royal Society, has proved such an outstanding success. Apart from the fine collection of fossil Primate material, many hundred specimens of other Early Miocene vertebrates have also been accumulated.



Skull of *Proconsul*. On the left are centimetre and inch scales. ½ naturalsize

Millport Marine Laboratory: Mr. R. Elmhirst

MR. R. ELMHIRST retires from the directorship of the Millport Laboratory on March 31, 1949. His association with the Laboratory goes back to 1906, when he was appointed to the staff as naturalist, after previous experience at Plymouth and Monaco. On the resignation of the director, Mr. S. Pace, in the following year, he was appointed superintendent and has been in charge of the Laboratory, apart from service with H.M. Navy during the First World War, since that date. He was appointed director in 1933. For many years Mr. Elmhirst *was* the Millport Laboratory, the sole member of the scientific staff, and he maintained it in being during the difficult years that preceded 1914. After 1921, when financial aid came from the Development Commission, the staff was enlarged and the Laboratory under his guidance made steady progress to its present high standing as a research institute. Mr. Elmhirst is an accomplished field naturalist who has guided and stimulated the interests of generations of students and research workers. The Easter classes he has conducted at Millport have played a big part in the education of British marine biologists, and he has lectured on marine ecology in the Department o Zoology at Cambridge. As a popular lecturer he has long been well known to Scottish audiences. His knowledge of the fauna and flora of the Clyde Sea area is unique and will be greatly missed when he leaves Millport. His observations and experiments are recorded in a long series of papers and also i his revision of Newbiggin's "Life by the Seashore" A bibliography of his writings and a more detaile account of his career will appear in the annual repor for 1948–49 of the Scottish Marine Biological Association. Their many friends will join the member of the Association in wishing Mr. and Mrs. Elmhirs much happiness in retirement.

Mr. E. For

MR. E. FORD, assistant director of the Marin Laboratory, Plymouth, will succeed Mr. Elmhirst After graduating at the Royal College of Science Mr. Ford gained the Sarah Marshall Exhibition fo research work as Huxley Scholar in 1913 and wa appointed assistant naturalist at Plymouth at th end of that year. He served as an infantry officer i the First World War, when he was wounded i Belgium, and again on the staff of the R.A.F. a intelligence officer during 1941–45. His work a Plymouth, where steady promotion culminated i his appointment as assistant director in 1935, ha been primarily on fish, and he is the author of series of admirable studies on larval and post-larva fishes, on the life-history of the dogfish, on herrin and on osteological variation in the backbone an the skull. In addition, he extended the quantitativ survey of bottom fauna, initiated by Petersen, to th waters of Plymouth Sound. He was 'Bucklan Professor' in 1936, and his lectures have been pub lished under the title of "The Nation's Sea-Fis Supply". The Scottish Marine Biological Associatio may be considered most fortunate in persuading M Ford to assume responsibility for the further develo ment of the Millport Laboratory, where his admini trative ability, his high scientific attainments an above all, his qualities of friendly leadership will fin full scope.

Mr. Ford will take over scientific staff and equipment greatly exceeding what existed before the War. Apart from Dr. A. P. Orr, recently appointed deputy director, and Dr. Sheina M. Marshall, who did so much to establish the reputation of the Laboratory before the War, the staff now consists of three zoologists, a chemist and an algologist, while a further post has been authorized but is not yet filled. A new research vessel, the *Calanus*, has recently been acquired and is now operating from the Laboratory. She is a motor fishing vessel, 75 ft. long, of which the hull only was built when she was purchased from the Admiralty, so that it has been possible to fit her out as a research vessel with all the modern equipment needed for both physical and biological investigations in the sea. She carries a permanent crew of five, and will enable the Millport Laboratory to extend the range of its work from the Clyde sea area to the west of Scotland generally. A much belated addition to the facilities of the Laboratory is the provision recently of electric current from the hydro-electric grid system. It will now be possible to use standard electrical equipment; further, a workshop with power-driven tools is being constructed. The Millport Laboratory, which has always had the advantage of being adjacent to clean waters with a rich fauna and flora, has now both the research vessel and the laboratory facilities for making full use of its natural advantages.

Prof. P. C. Mahalanobis, F.R.S.

PROF. P. C. MAHALANOBIS retired from the Indian Educational Service and from his post as principal of Presidency College, Calcutta, on June 30. He is chiefly known as a mathematical statistician with wide interests, and particularly as a pioneer in the theory and practice of sample survey. His work in building up the Statistical Laboratory at Presidency College is appreciated throughout the world, and it is undoubtedly one of the best centres for statistical research and advanced teaching. In recent years, Prof. Mahalanobis has been largely engaged on the Statistical Commission of the United Nations. He is still carrying on his scientific work, especially in the Indian Statistical Institute, of which he is honorary secretary.

Plant Physiology at Ghent: Prof. Paul Froeschel

DR. PAUL FROESCHEL has been appointed professor of plant physiology at Ghent State University as a successor to the late Prof. G. L. Funke. Dr. Froeschel was born in Vienna in 1888. He studied botany and especially plant physiology with Julius v. Wiesner, Richard v. Wettstein and Hans Molisch, and became known for his work on plant irritability and especially short phototropic presentation times. After graduating, Dr. Froeschel worked with Prof. Linsbauer (Czrnowitz), Prof. Goebel (Munich) and Prof. Wasitzky (Vienna). At the end of the First World War he took up agriculture; he worked on the cultivation of medicinal plants, and as an agricultural consultant he had the opportunity of becoming closely acquainted with agricultural problems. In 1938, Dr. Froeschel emigrated to Belgium, where he was given a place in the department of Prof. Funke, director of the plant physiology laboratories of Ghent State University. There Dr. Froeschel in the first place worked on the growth-inhibiting substances of plants, and furnished valuable contributions not only to the physiology of these substances, but also to their practical use.

Cocoa Disease in the Gold Coast

THE Secretary of State for the Colonies has appointed the following commission to visit the Gold Coast and report on the measures necessary for the eradication of swollen shoot disease of cocoa trees: Dr. G. Berkeley, of the Dominion Laboratory of Plant Pathology, Canada; Dr. W. Carter, head of the Department of Entomology, Pineapple Research Institute, Hawaii; and Prof. van Slogteren, of Holland. Their terms of reference are: "Having regard to the research work in swollen shoot disease of cocoa trees in the Gold Coast being carried out by the West African Cocoa Research Institute, to study the incidence and nature of the disease and to report on the technical measures necessary for its speedy eradication".

British Museum (Natural History): Acquisitions

THE following acquisitions to the British Museum (Natural History) have been announced: Sir Sidney Harmer, director of the Museum from 1919 to 1927, has presented 374 volumes of reprints and zoological publications dealing principally with Cetacea and Polyzoa, together with card-indexes of authors and subjects. The Governing Body of King's College, Newcastle-upon-Tyne, have given about 10,000 slides of Crustacea and Foraminifera containing the type specimens of many species collected by the *Challenger* and other expeditions for the exploration of the sea; these slides were prepared by the late Prof. G. S. Brady. The extensive collection of Diptera formed by the late Colbran J. Wainwright, a recognized authority on the study of this order of insects, has been presented by his daughters, Miss Wainwright and Mrs. Reid; the collection is estimated to contain approximately 65,000 specimens, of which the greater part are from the palæarctic region, although some 18,000 are from other parts of the world. Finally, three important bequests have been made to the Department of Botany, the first being the remainder of the late Colonel A. H. Wolley-Dod's herbarium and consisting of about 10,000 sheets of British plants mainly of his own collecting (Colonel Wolley-Dod was the author of "Flora of Sussex", and his herbarium contains many of the specimens on which records were based). Second is the very important collection of British and European plants estimated at 30,000 specimens and brought together by the late Mr. Herbert William Pugsley; the material is excellently preserved and the alpine plants are exceptionally good. The third bequest is that of the late Mr. J. W. Long's herbarium of about 15,000 sheets of British and European plants.

Marconi Jubilee Congress

THE publication is announced of the *Proceedings* of the International Congress held in Rome last September in connexion with the Marconi Jubilee (see *Nature*, November 29, 1947, p. 473). The volume, which comprises some 970 pages and 470 illustrations, is published by Dr. Giovanni Bardi, Salita de' Crescenzi 16, Rome, at the price of 4,000 lire. In a preface, Prof. Gustavo Colonnetti, president of the Italian National Research Council, describes the aims of the Congress, and the success which accompanied it with the interested support of many participants from various nations. The full texts of the fifty-nine papers, of which ten are by British authors, are reproduced in the volume, classified in four sections under the titles of electromagnetic waves, electric and acoustic oscillations, electronics and radiocommunication. The papers are published in the language in which they were submitted by the authors. The numbers of papers in the four sections, with those in English indicated in brackets, are: 14 (9), 21 (8), 8 (5) and 16 (10). The publication provides an interesting survey of the many scientific and technical developments in this field in the half-century following Marconi's first successful demonstration of wireless signalling.

New Zealand Earthquakes during June

DURING June, five strong earthquakes were registered on the New Zealand seismographs at Arapuni, Auckland, Christchurch, Kaimati, New Plymouth, Tuai and Wellington. The one on June 28 was that which destroyed the Japanese city of Fukui, and that on June 29 was felt at Apia with Modified Mercalli Scale 5. In addition, twenty-three earthquakes and earth tremors occurred within 10° of Wellington. The greatest two of these both occurred on June 19 and were felt extensively in South Island but particularly near Bruce Bay with Modified Mercalli Scale 6.

The Night Sky in November

NEW moon occurs on Nov. 1d. 06h. 02m., U.T., and full moon on Nov. 16d. 18h. 31m. The following conjunctions with the moon take place: Nov. 3d. 17h., Mars 2° N.; Nov. 4d. 20h., Jupiter 4° N.; Nov. 24d. 02h., Saturn 3° S.; Nov. 28d. 06h., Venus 2° N. Mercury rises at 5h. 10m. and 5h. 49m. on Nov. 1 and 15, respectively, and can be seen in the eastern sky. The planet reaches its greatest easterly elongation on Nov. 4. At the end of the month Mercury rises only half an hour before sunrise and is then too close to the sun for observation. Venus rises at 3h. 15m., 3h. 55m. and 4h. 40m. at the beginning, middle and end of the month, respectively, and can be seen in the morning hours, stellar magnitude −3·5; 0·75 to 0·84 of the illuminated disk is visible. Mars is too close to the sun to be favourably observed, setting about 1¼ hours after the sun throughout the month. Jupiter sets at 18h. 55m., 18h. 10m. and 17h. 25m. at the beginning, middle and end of the month, respectively, and can be seen low in the western sky; but it is not favourably placed for observation through the greater portion of the month. Saturn, in the constellation of Leo, rises at 0h. 45m., 0h., and 23h. at the beginning, middle and end of the month, respectively, and is visible throughout the morning hours, stellar magnitude 0·9. Occultations of stars brighter than magnitude 6 are as follow: Nov. 8d. 17h. 51·1m., 35 Capr. (*D*); Nov. 19d. 01h. 13·1m., 112B Auri. *m*, (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the latitude of Greenwich is assumed. A total eclipse of the sun takes place on Nov. 1. The eclipse is invisible at Greenwich, but is visible over large portions of the southern hemisphere. The central line passes through lat. + 3° 42′, long. − 22° 03′, at the beginning of the eclipse and ends at lat. − 43° 23′, long. −165° 27′.

Announcements

THE Lord President of the Council has made the following appointments to the Advisory Council for Scientific Research: Mr. James Bowman, vice-president of the National Union of Mineworkers, and a member of the T.U.C. Scientific Advisory Committee; Mr. E. Fletcher, secretary of the Research and Economic Department of the T.U.C.; and Dr. H. W. H. Warren, managing director of Associated Electrical Industries, Ltd.

THE Cambridge Philosophical Society announces that the adjudicators for the Hopkins Prize have made the following awards: for the period 1939–42, to Prof. H. J. Bhabha, for investigations on the theory of elementary particles; for the period 1942–45, to Dr. C. F. Powell, for experimental investigations in nuclear physics, including development of the photographic plate technique for the study of nuclear reactions.

AN Eddington Prize of 50,000 Belgian francs is being offered by the Institut International des Sciences Theoriques for an exposition and critique of the conceptions of Eddington concerning "The Philosophy of Physical Science". The committee of award consists of Dr. I. Dockx, director of the Institute; Prof. L. de Broglie (Paris); Prof. Th. de Donder (Brussels); Prof. F. Gonseth (Zurich); and Prof. E. A. Milne (Oxford). Memoirs (five copies) must be submitted to the secretariat of the Institut International des Sciences Theoriques, 221 avenue de Tervueren, Brussels, before December 31, 1950. Participants must sign their memoirs by a device, and include a sealed envelope containing name and address.

THE Atomic Scientists' Association is holding its annual conference at the Beaver Hall, Garlick Hill, London, E.C.4, on October 30. There will be two sessions, the first from 2.30 to 5 p.m., and the second from 7 p.m. to 9.30 p.m. The first session is concerned with "Atomic Energy and Society", and speakers will include Prof. P. M. S. Blackett on atomic weapons, Sir George Thomson on international control, Prof. N. F. Mott on national policy, and Prof. M. H. L. Pryce on the constructive applications of atomic energy. In the evening, speakers will include Sir Henry Dale, Prof. R. E. Peierls and Prof. M. L. Oliphant on the position of scientific men with regard to atomic energy and related problems. The hon. general secretary, Dr. F. C. Champion, will conclude with an outline of the future policy of the Association.

A SERIES of lectures for schools, which began on October 20, has been organised by the Institution of Civil Engineers, the Institution of Electrical Engineers and the Institution of Municipal Engineers, in co-operation with the Education Officer of the London County Council. The lectures are being given at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, and deal with such subjects as railway transport, water and electricity supply, tunnelling, telecommunications, etc. These lectures, which can be given either at individual schools or for groups of schools, are supplemented by the annual Christmas lectures to boys at the Institution of Civil Engineers. For Christmas 1948 the subject will be "Big Ships and their Docks"; three lectures will be given: "Building Big Ships"; "Running and Navigating a Ship"; and "Constructing a Dock".

ERRATUM.—In "Dielectric Properties of Mixed Barium and Strontium Titanates at 10,000 Mc./s." printed in *Nature* of October 23, p. 655, Fig. 2 should be rotated 90° clockwise; the descriptions of the axes remain as they are.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

New Method for the Separation, Detection and Estimation of Inorganic Compounds

A FEW years ago, Dr. A. J. P. Martin and his olleagues at the Wool Industries Research Associaion[1] developed a technique using solvent extraction n absorbent paper for the separation and detection f mixtures of amino-acids. This process, which the iscoverers termed 'partition chromatography', has nore recently been applied to other problems, for xample, the separation and identification of amino-cids derived from human metabolism[2], and to the nalytical study of different varieties of penicillin in nixtures[3].

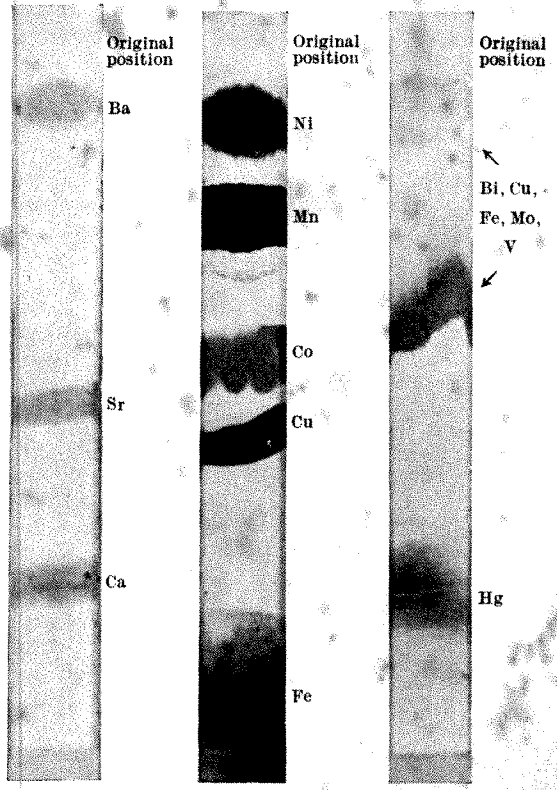
We have now applied a similar procedure to nvestigations in the inorganic field with marked uccess. The essential feature is the combined use f an *organic solvent* (generally containing some acid r other reagent) and an adsorbing material, such as ellulose, for the separation of inorganic substances. he present note gives examples of the progress hich has, so far, been achieved from qualitative nd quantitative investigations of metallic salts. The tudy of other materials is in progress.

The main technique which we have employed, and hich is described below, is essentially the paper-trip method of Martin, Gordon and their collabortors. We have also obtained very promising results n a larger scale which will be described shortly.

Method. A measured volume of the solution to be tudied is placed near one end of a strip of absorbent aper, such as Whatman No. 1 or No. 3 filter paper, o form a small patch about 1 in. square which is llowed to dry in air. The paper strip is then transerred to a gas jar or similar vessel fitted near the op with a container for organic solvent and adjusted o that the end nearest the test patch is immersed n the solvent tank while the remainder of the paper angs vertically down the jar. A vessel containing n aqueous solution is usually placed at the bottom f the jar to maintain suitable conditions of humidity. he organic liquid is allowed to diffuse down the paper ufficiently far beyond the test patch to achieve he desired separations, after which the paper strip s removed, dried in a draught of warm air and tested ith suitable reagents for development of characterisic colours. For qualitative or semi-quantitative work he stains produced are compared with standard olours formed from known amounts of material, hereas in more accurate quantitative estimations the oloured band is cut out, organic matter destroyed, nd the metallic content determined by the polaroraph, colorimeter, spectrograph or by other suitable icro-methods.

Results. Examples of the separation of metals are iven below.

(1) *Calcium, strontium and barium* (see illustraion). These elements can be separated as the chlorles with pyridine containing 4 per cent of potassium hiocyanate as solvent. Under these conditions the alcium travels the greatest distance down the paper, arium moves very little and strontium appears beween the two. Sodium rhodizonate is employed for he development of barium and strontium, and lizarin for the calcium.



(2) *Aluminium, gallium, indium and zinc.* This group has been studied as solutions of the chloride, and with n-butyl alcohol containing hydrochloric acid as the solvent. Aluminium scarcely moves at all, gallium travels down with the solvent front, while indium appears between the two. As zinc is a common impurity in indium and gallium, it has also been included in this series. It appears between the indium and gallium. Aluminium and gallium are developed with 'aluminon', while dithizone is used for indium and zinc.

(3) *Vanadium.* This element can be separated from a large number of other metals by using diethyl ether or tetrahydrosylvane (2-methyl tetrahydrofurane) containing nitric acid and a small quantity of hydrogen peroxide as the solvent. The vanadium moves as a pink band due to the formation of a soluble peroxy-compound. Colour development is achieved with 8-hydroxyquinoline.

(4) *Mercury* (see illustration). Tetrahydrosylvane, or tetrahydropyran, may also be used to separate mercuric chloride from many other metallic chlorides. These solvents, containing hydrochloric acid, quickly carry mercury down the paper, leaving the other salts behind. The position of the mercury is revealed by means of dithizone, and it can be estimated quantitatively by standard methods after such separation.

(5) *Cobalt, copper, iron, manganese and nickel.* The chlorides of these metals can be readily separated using methyl n-propylketone or acetone containing hydrochloric acid. Mixtures of these solvents may be employed, a convenient one being 80 per cent methyl n-propylketone, 10 per cent acetone and 10 per cent concentrated hydrochloric acid. Iron moves the greatest distance, followed by copper, cobalt and manganese; nickel moves only slightly.

For the best results it is advisable in this case, as also in the separation of aluminium, gallium and indium, to maintain the relative humidity in the chamber at 65 per cent. Nickel, cobalt and copper are identified by means of rubeanic acid; manganese by reduction of ammoniacal silver solution; and iron by potassium ferrocyanide. Nickel and cobalt have been determined quantitatively by polarographic measurements. Some typical results are illustrated in the accompanying reproductions.

Limits of detection and estimation. The procedure provides a delicate means of separating and estimating small quantities of metallic ions. The limits of detection vary with different elements and depend on the sharpness of the bands and the sensitivity of the spot tests. Quantities of the order of 1·0–0·1 microgram have been detected, while the normal range for quantitative work is in the region of 5–200 micrograms.

Mechanism. The processes involved in this type of separation are being investigated; but it is clear that a number of factors must be taken into consideration. These are: (*a*) selective extraction of the salts by the organic solvent, an effect prevailing at the site of the test patch; (*b*) where substantially immiscible solvents are used, partition of the inorganic substances between organic solvent and aqueous layer, since water is present as a normal constituent in the absorbent paper and is usually added to the organic solvent; this partition, therefore, takes place as the liquid mixture moves down the paper, and separations are due to slight changes in conditions at different points on the absorbent strip; (*c*) adsorption of metallic ions by the paper; (*d*) the formation of complexes with high solubility in organic media under specific conditions.

In view of the uncertainty as to mechanism, it seems to us best for the present to refer to this method non-committally as 'extraction analysis'. Further study will, it is hoped, provide a logical theoretical background for the processes taking place.

The investigations so far carried out indicate that the broad application of this and closely related techniques should make possible the separation, detection and estimation of a very wide range of inorganic products. The method is simple and fairly rapid, requires only very small quantities of material, operates with complicated mixtures of ions and does not demand any specialized equipment, at least for qualitative examination. The work is being actively pursued at this Laboratory.

We wish to acknowledge the collaboration in the experimental work of the following colleagues: Miss J. M. Clarke, Mr. N. F. Kember, Miss A. P. McGlone, Mr. I. C. Macwilliam, Miss P. J. Maple, Miss J. M. Patterson and Mr. R. A. Wells. More detailed publications will follow in due course.

T. V. Arden
F. H. Burstall
G. R. Davies
J. A. Lewis
R. P. Linstead

Chemical Research Laboratory,
(Department of Scientific and Industrial Research),
Teddington, Middlesex.

---

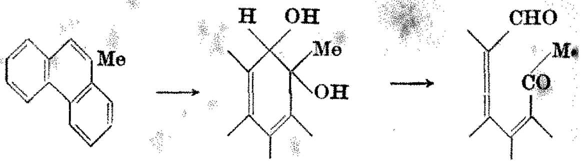
[1] Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **37**, (1), 79 (1943). Consden, R., Martin, A. J. P., and Gordon, A. H., *ibid.*, **38** (3), 224 (1944).

[2] Dent, C. E., *Lancet*, **251**, 637 (1946).

[3] Goodall, R. R., and Levi, A. A., *Nature*, **138**, 675 (1946).

Synthesis of Colchicine Derivatives

While the methoxylated carbon-system of (IV) is conclusively established for certain degradation products of colchicine[1,2], the synthesis of such unsymmetrically substituted dibenz*cyclo*heptatrienes, necessary for further work, has hitherto miscarried because of difficulties which are partly concealed and partly apparent[2–4]. A synthesis which promises to afford the requisite degree of adaptability has now been found and is based on the oxidation of appropriate 9- or 10-methylphenanthrenes with osmium tetroxide in benzene-pyridine[5,6]. In a model experiment, 9-methylphenanthrene (I) was thereby oxidized to 9 : 10-dihydroxy-9 : 10-dihydro-9-methylphenanthrene (II), m.p. 130–131° (found: C, 79·9; H, 6·1; $C_{15}H_{14}O_2$ requires C, 79·7; H, 6·2 per cent), from which, by cleavage with lead tetra-acetate and renewed cyclization, there was obtained the known 3 : 4 : 5 : 6-dibenz*cyclo*hepta-1 : 3 : 5-trien-7-one (III)[3] Similarly, 2 : 3 : 4 : 7-tetramethoxy-10-methylphenanthrene, m.p. 134–135° (found: C, 73·2; H, 6·4 $C_{19}H_{20}O_4$ requires C, 73·1; H, 6·4 per cent), was converted *via* the corresponding 9 : 10-dihydro-9 : 10 diol, m.p. 156° (found: C, 66·0; H, 6·4; $C_{19}H_{22}O$ requires C, 65·9; H, 6·4 per cent) into the unsaturated ketone (IV), which was identical with the part product previously obtained[1] by oxidizing deamino-colchinol methyl ether with sodium dichromate in acetic acid.



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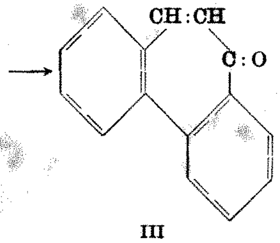
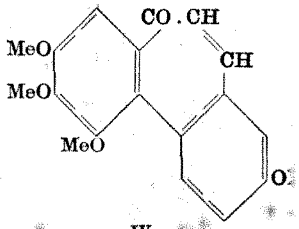


III



IV

2 : 3 : 4 : 5- and 2 : 3 : 4 : 7-Tetramethoxy-9-methylphenanthrenes[7] have given apparently analogou results, and full experimental details will be published when the developments now in hand, which include the attempted synthesis of colchinol methyl ether have been completed. One of us (J. M.) thanks th Department of Scientific and Industrial Research for a maintenance allowance.

G. L. Buchanan
J. W. Cook
J. D. Loudon
J. MacMillan

Universities of Glasgow and
Aberdeen.

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[1] Barton, Cook and Loudon, *J. Chem. Soc.*, 176 (1945).

[2] Cook, Dickson and Loudon, *J. Chem. Soc.*, 746 (1947).

[3] Frank, Fanta and Tarbell, *J. Amer. Chem. Soc.*, **70**, 2314 (1948

[4] Barton, Cook and Loudon, *J. Chem. Soc.* (in the press).

[5] Criegee, Marchand and Wannowius, *Annalen*, **550**, 99 (1942).

[6] Cook and Schoental, *J. Chem. Soc.*, 170 (1948).

[7] Buchanan, Cook and Loudon, *J. Chem. Soc.*, 325 (1944).

Structure of Ketoyobyrine

THE recent publication of a paper by Woodward and Witkop[1] suggesting a new structure for ketoyobyrine, based on degradative evidence, and of another by Schlittler and Speitel[2], claiming the synthesis of this substance, prompts us to point out that on May 28, 1948, we submitted to the Chemical Society a paper describing the synthesis of ketoyobyrine. This has been accepted for publication in the *Journal*; but unfortunately its appearance cannot be expected for many months.

In the main, our work is along similar lines to that of Schlittler and Speitel; but differs in certain details.

G. R. CLEMO
G. A. SWAN

King's College,
University of Durham,
Newcastle-upon-Tyne 1.
Aug. 26.

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[1] *J. Amer. Chem. Soc.*, **70**, 2409 (1948).

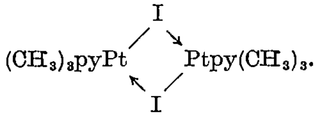
[2] *Helv. Chim. Acta*, **31**, 1199 (1948).

Trimethylplatinum Derivatives

Lile and Menzies[1] report some new derivatives in the trimethylplatinum series, the first members of which were prepared from platinum tetrachloride some forty years ago by Pope and Peachey[2]. Since we are similarly engaged in investigating these compounds, it is desirable to record some of our observations on this subject.

(*a*) *Cis*-dipyridinetetrachloroplatinum, $Ptpy_2Cl_4$, which unlike platinum tetrachloride is not hygroscopic, is a very good source of trimethylplatinum derivatives, just as pyridinetrichlorogold, $AupyCl_3$, is the most convenient starting material for the preparation of dialkylgold compounds[3].

(*b*) Methylmagnesium iodide and *cis*-$Ptpy_2Cl_4$ gives in excellent yield the compound $(CH_3)_3PtpyI$, which decomposes slowly at temperatures above 150°. It is soluble in pyridine, chloroform and in benzene, in which it is dimeric by the freezing-point; thus the 6-covalency of the platinum is maintained as in



$$(CH_3)_3pyPt\begin{matrix}I\\ \nearrow\ \searrow\\ \nwarrow\ \swarrow\\ I\end{matrix}Ptpy(CH_3)_3.$$

(*c*) By treatment with further pyridine, this new compound is converted into $(CH_3)_3Pt(py)_2I$, m.p. 168°, without decomposition. The complex formed from $(CH_3)_3PtI$ and pyridine, described by Lile and Menzies, has the same composition and melting point and is presumably identical with ours. It is of interest that the same isomer is formed by the two alternative routes. In the tetrameric $(CH_3)_3PtCl$ (in which the platinum has an octahedral configuration[4]), the three methyl groups are all *cis* to one another, and it may well be that this same arrangement persists throughout.

We have also observed that the dipyridine complex undergoes dissociation in benzene solution, probably into pyridine and the dimeric complex mentioned in (*b*) above.

(*d*) The other molecule of pyridine is certainly much more firmly held and cannot be removed by dilute acids and alkalis. It is displaced with ease, however, when ethylene diamine is added to a cold chloroform solution of the dimer, and the compound $2(CH_3)_3PtI.3en$ (see also Lile and Menzies, *loc. cit.*) separates in crystalline condition.

(*e*) Although methylmagnesium iodide reacts so readily, no product has been obtained from ethyl magnesium iodide and *cis*-$Ptpy_2Cl_4$. This recalls Pope and Peachey's inability to prepare ethyl derivatives from platinum tetrachloride[5].

(*f*) *Trans*-$Ptpy_2Cl_4$ has so far given no alkyl derivative with methyl magnesium iodide. It undergoes reduction and halogen exchange with formation of trans-$Ptpy_2I_2$.

Work in this field is proceeding, and a fuller account will be given elsewhere in due course.

C. S. GIBSON
R. V. G. EWENS
M. E. FOSS

Chemistry Department,
Guy's Hospital Medical School,
University of London.

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[1] Lile and Menzies, *Nature*, **162**, 299 (1948).

[2] Pope and Peachey, *J. Chem. Soc.*, 571 (1909).

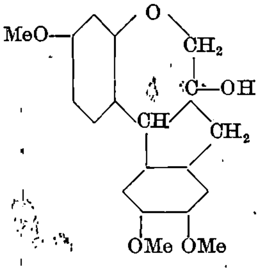
[3] Gibson *et al.*, *J. Chem. Soc.*, 219 (1935) *et seq.*

[4] Rundle and Sturdivant, *J. Amer. Chem. Soc.*, **69**, 1561 (1947).

[5] Private communication (C. S. G.).

Structure of O-Trimethylbrazilone

OXIDATION of O-trimethylbrazilin (I)[1] yields O-trimethylbrazilone (II), the proposed structure[2] of which is satisfactory in most respects. Nevertheless, the explanation of the unusual loss of two atoms of oxygen which occurs when it is converted into deoxytrimethylbrazilone (anhydrotrimethylbrazilin) by interaction with phenylhydrazine is not apparent.



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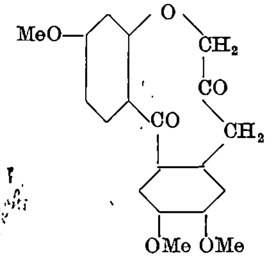
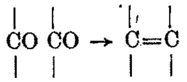


II

It was therefore thought desirable to examine the infra-red absorption spectra of (I) and (II). The spectra were measured in a double-beam spectrometer, using a very dilute solution in carbon tetrachloride at 3 μ and a solid suspension in 'Nujol' at 6 μ. As was to be expected, (I) exhibited an absorption band at a frequency of 3,610 cm.$^{-1}$ and no marked absorption in the 1,720 cm.$^{-1}$ region, indicative of the presence of the hydroxyl group and the absence of any ketonic grouping respectively; (II), on the other hand, showed no absorption in the region of 3,610 cm.$^{-1}$, but exhibited a strong band at 1,720 cm.$^{-1}$. This is consistent with the absence of a hydroxyl and the presence of a ketone group. Moreover, it follows that if there is a ketone group present any modified structure such as $\underset{O-O}{>C-C<}$ is untenable, and it therefore appears that the proposed large ring, diketone structure is correct.

Herzig and Pollak[3] prepared a monoxime of O-trimethylbrazilone, m.p. 203–205° (decomp.). Repetition of this preparation has now yielded two forms of the monoxime; one (from aqueous alcohol) consisted of fine needles, m.p. 197° (decomp.) (found: C, 63·9; H, 5·4; N, 3·9 per cent) and the other (from alcohol) of small prisms m.p. 208–210° (decomp.) (found: C, 64·3; H, 5·4; N, 3·8; calc. for $C_{19}H_{19}O_6N$: C, 63·9; H, 5·3; N, 3·9 per cent). A mixture of the two forms decomposed at an intermediate temperature, and they appear to be polymorphic because crystallization of the form with melting point 208–210° under appropriate conditions yields the needle form, which is slowly reconverted into the substance with the higher melting point when it is left to stand in the mother liquor.

The explanation of the change



$$\underset{|}{\overset{|}{CO}}\,\underset{|}{\overset{|}{CO}} \rightarrow \underset{|}{\overset{|}{C}}{=}\underset{|}{\overset{|}{C}}$$

in the course of the reaction between O-trimethylbrazilone and phenylhydrazine must clearly involve the propinquity of the carbonyls in the large ring structure; but the postulation of a radical change in the bonds contained in these groups is now excluded.

R. E. Richards
Physical Chemistry Laboratory,
M. L. Tomlinson
Dyson Perrins Laboratory,
Oxford.
June 8.

[1] Gilbody and Perkin, *J. Chem. Soc.*, **81**, 1040 (1902).

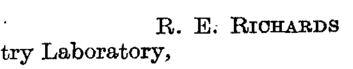
[2] Perkin and Robinson, *J. Chem. Soc.*, **93**, 498 (1908). Perkin, Ray and Robinson, *J. Chem. Soc.*, 2096 (1927); 1054 (1928).

[3] Herzig and Pollak, *Ber.*, **36**, 398 (1903).

Structure of α-Fagarine

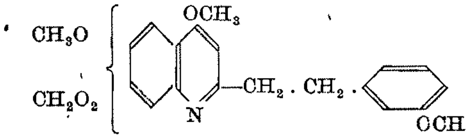
The more significant experimental facts for basing the structure of α-fagarine, one of the alkaloids isolated from *Fagara coco*[1], were the presence of one methylimino group, two methoxyls and one dioxymethylene group, and the formation of *m*-methoxybenzaldehyde by oxidation[2]. α-Fagarine behaves as a tertiary base, since it does not react with nitrous acid and also lacks rotatory power.

A tertiary base, with a methylimino group and giving *m*-methoxybenzaldehyde by oxidation, may have a structure: $R - \underset{\displaystyle CH_3}{\underset{|}{N}}.CH_2.C_6H_4OCH_3$ (*m*), as oxidation experiments with similar simpler bases have shown[3]. A substance of this type might be expected to be degraded by the action of tetranitromethane as similar bases are[4], and also by hydrogenolysis under the action of palladium-charcoal.



Fagarine was found to be resistant to both types of degradation. We believe, then, that the methylimino group, that was determined in two laboratories (in our laboratory, Slotta and Haberland's[5] method was employed) and isolated as methylamine when α-fagarine is heated with soda-lime, is an artefact. The methylimino group determined could be a resistant methoxyl that is only split off at higher temperatures than usual, or that transposes to a methylimino group under the action of the reagents. The methylamine isolated would also result from a molecular transposition.

This type of reaction could be expected from a γ-methoxyquinoline, and accordingly the following structural formula for α-fagarine is now proposed:



similar to the structures of cusparine, galipine and galipoline, all alkaloids from angostura bark, a plant belonging to the family Rutaceæ, as is the case with *Fagara coco* (Gill.) Engl., from which α-fagarine was isolated.

Thus the first formula proposed, $C_{19}H_{23}NO_4$, should be changed to $C_{21}H_{21}NO_5$. The carbon and hydrogen determinations of the free base given in our paper[2] agree well with the new formula. Fagarine salts gave lower values for carbon than those expected.

We have carried out a series of determinations of the halogens of the salts and the methoiodide of α-fagarine, which differentiate clearly between the formulæ $C_{19}H_{23}NO_5$ and $C_{21}H_{21}NO_5$, and obtained figures that agree with the last one. (Hydrochloride: calc., Cl, 8·91; found, 8·13. Hydrobromide: calc., Br, 17·85; found, 18·28. Hydroiodide: calc., I, 25·67; found, 25·64. Methoiodide: calc., I, 24·97; found, 24·47).

When α-fagarine is treated with dilute nitric acid, a nitro-derivative is obtained which gives a crystalline nitrate melting at 254–55° and of formula $C_{21}H_{20}NO_5.NO_2.NO_3H$ (calc.: C, 53·05; H, 4·21; N, 8·84; found: C, 52·85; H, 5·10; N, 8·90). This nitro-derivative gives a picrate melting at 255–57°, $C_{21}H_{20}NO_5.NO_2.C_6H_3N_3O_7$ (calc.: C, 50·54; H, 3·59; found: C, 50·53; H, 3·96).

The absorption spectrum of α-fagarine, for which we are indebted to Dr. H. Puente, also supports the quinoline structure. It presents an absorption maximum at 285 mμ and is very similar to the absorption spectrum of quinoline, with a maximum about 280 mμ, and to that of 4-quinolylmethyl ether, with a maximum about 280–285 mμ, as determined by Ewing and Steck[6]. An N-methyl quinolone structure would explain the methylimino determination and the isolation of methylamine, but leaves unexplained the formation of a methiodide and the similarity of the absorption spectrum of the base to those of quinoline and its derivatives.

V. Deulofeu
R. Labriola
B. Berinzaghi
Laboratorio de Química Orgánica,
Facultad de Ciencias Exactas,
Físicas y Naturales,
Buenos Aires.
May 24.

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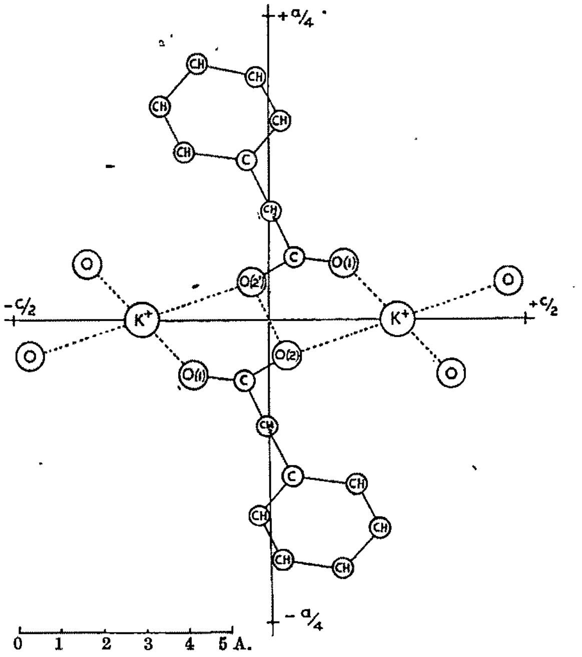
Crystal Structures of the Acid Salts of some Monocarboxylic Acids

THE crystal structure of potassium hydrogen phenylacetate, $KH(C_8H_7O_2)_2$ (a substance already discussed in another connexion[1]), has been examined by X-ray analysis. The crystals belong to the monoclinic system, the unit cell having $a = 28·4$ A., $b = 4·50$ A., $c = 11·9_7$ A., $\beta = 89·8°$ ($\pm$ 0·3°), and comprising four stoichiometric molecules. The space-group is $I\ 2/a$ (that is, $C\ 2/c$ of the International Tables with change of axes).

Using the isomorphous rubidium salt, a Patterson projection on the (010) plane indicated provisional x- and y-co-ordinates for the atoms; and, with this guidance, a corresponding Fourier synthesis has been carried out for the potassium compound. In the resulting projection, all eleven atoms of the asymmetric unit were well resolved, and the projected structure deduced is shown in the figure. Detailed consideration of this projection (and taking note of the strength of the reflexion from the (510) plane) gave a clue to the molecular orientation in the b-direction. The C—C_6H_5 group lies in a plane inclined at about 31° to (010), and the C—CO_2 group in one inclined at about 36° in the opposite direction. On this basis the complete structure has been elucidated, with some assistance from a Fourier projection on (001).



Interest is chiefly attached to the situation near he carboxyl groups. A hydrogen bond must be presumed to exist between the atoms O(2) and O(2′); and, since these atoms lie about a centre of symmetry, the hydrogen atom appears to be centrally placed. All hydrogen bonds described hitherto seem to be unsymmetrical. It is possible that the virtual symmetry found here is a statistical effect. It is difficult to determine the y-co-ordinate of O(2) very accurately, but the true distance between the oxygen toms is estimated to be $2·5_5$ ($\pm$ 0·1) A. This is nusually short (the dimers of carboxylic acids give alues of about 2·7 A.) and recalls the short bonds reported for same inorganic acid salts[2] and for the dihydrates (probably oxonium salts) of some dibasic acids[3]. Each potassium ion lies on a vertical twofold axis, and is surrounded by six approximately equidistant (~ 2·8 A.) oxygen atoms which are situated at the corners of a distorted octahedron; two pairs, O(1), are superposed, at unit b-translation, in the projection shown. A number of different valency bond structures can be written, each lacking the necessary symmetry about the origin. The actual structure is taken to be a resonance hybrid, with consequent enhanced stability.

The structure of potassium hydrogen p-hydroxybenzoate, which is also being investigated, appears to be based on the same plan. Acid salts are formed by most monocarboxylic acids, and it seems likely that they may generally conform to this plan.

Further details of both structures will be published elsewhere.

J. C. SPEAKMAN

Chemistry Department,
University, Glasgow, W.2.
Sept. 13.

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Gamma-Rays from Proton Bombardment of Separated Argon Isotopes

ARGON targets can be prepared by bombarding silver disks with the separated beams of the argon isotopes in a mass-spectrograph. This technique has already been used in a study of the resonance capture of protons in the isotopes of neon[1]. The possibility of collecting argon atoms in a metal surface has previously been demonstrated[2], and has recently been used as a method of producing samples of separated argon isotopes[3].

With the abundant isotope ^{40}A (99·632 per cent) four targets were made which had received about 55 milli-coulombs per cm.^{2} of $^{40}A^+$-ions, and in addition one target which had received about 3 milli-coulombs per cm.^{2}. For the measurements on ^{36}A (0·307 per cent) only one target, which had received about 3 milli-coulombs per cm.^{2}, was made. No target was prepared containing the rare isotope ^{38}A (0·061 per cent), due to a contamination of the ion beam of mass 38 by fluorine molecular ions. The targets were used to search for capture resonances in the two argon isotopes for protons in the energy region from 0·5 to 1·8 MeV. The techniques of proton bombardment and gamma-ray detection were the same as those used in an earlier investigation[4].

In the case of ^{40}A, six peaks were found standing out clearly above the background radiation, as determined with a dummy target. Five of these peaks are ascribed to ^{40}A. The accompanying table gives their resonance energies, and in addition the yields as measured with the four targets, which had been strongly bombarded with argon. Measurements of the resonance at 1,100 keV. with the weakly bombarded target gave half the yield, indicating that the targets are saturated with argon when they have received about 6 milli-coulombs per cm.^{2}, corresponding to about 2 μgm. per cm.^{2}. The same saturation effect has also been found in the case of neon[1]. The half-widths of the peaks were in all cases 5–10 keV.

and cannot be explained by the inhomogeneity of the proton beam, which was less than half of this amount.

E	900	1050	1080	1100	1235
$y-y_0$	0·2	0·4	0·5	1·0	0·5

E is the resonance energy in keV.; $y-y_0$ is the difference between the resonance yield y in counts per micro-coulomb and the background radiation y_0, which for all the resonances is about 0·1.

The peak remaining is ascribed to fluorine. It was found at 865 keV. and gave a yield of 0·1 count per micro-coulomb. As the ion source of the mass-spectrograph had previously been run with fluorine compounds, very small amounts of $(F_2H_2)^+$-ions may possibly have given rise to this contamination of the target. This view is strongly supported by the fact that a control target, which during the collection of ^{40}A was hit by ions of mass 38 (such as F_2^+), showed an intense resonance peak at 865 keV. and in addition the weaker fluorine lines to be expected.

It was found that the content of argon in the target gradually decreased during the proton bombardment. A new spot of the target was chosen, therefore, as soon as the yield of the 1,100 keV. resonance, which was frequently checked, decreased too much.

In the case of ^{36}A, no gamma radiation was found which could not be explained as statistical fluctuations of the background radiation. These measurements are somewhat uncertain as it was not possible to know when a spot of the target was worn out; but the experience with the ^{40}A targets was taken as a guide.

The result, that no resonances are found in ^{36}A, is in agreement with the general experience, that the mean distance between the levels of a compound nucleus, formed by impact of 1-MeV. protons on a nucleus of the α-particle type, is of the order of a few million electron volts. This fact is explained by the low excitation of the compound nucleus due to the loose binding of the incoming proton. For ^{36}A, thus, the binding energy of the proton is only about 3 MeV. At the corresponding excitation, scattering and capture of the protons are, further, the only processes energetically possible; hence the lack of gamma-resonances cannot be due to competition from other disintegrations.

The compound nucleus formed by impact of 1-MeV. protons on the isotope ^{40}A is, on the other hand, excited to about 10 MeV. and should, therefore, have many levels in the energy region investigated. The yields of the resonances are, however, for low proton energies limited by the poor penetrability of the barrier which the protons have to overcome. The proton energy at which the resonance yield begins to rise above the background is, thus, determined by the proton width.

In order to determine the proton width from the experimental data, it is necessary to calculate the absolute yield, and for that purpose to know the concentration of argon in the silver. This concentration is given by the total amount of argon in the target and the thickness of the layer containing it. The thickness can be estimated from the experimental width of the resonance peaks by means of the stopping power for protons; the natural width, for example, must be very small, in fact close to the radiation width, because the energy available for α-particle emission is too small to give an α-particle width of any importance. The relative concentration of argon to silver atoms obtained in this way is about 1 : 10. The absolute yield of the resonances can then be determined by the help of the known efficiency of the gamma-counter[4].

For the 1,100-keV. resonance this estimate gives a proton width of the order of a few electron volts, and the corresponding width without barrier is then about 10 keV., which is in accordance with the fact that the first resonance detectable was found at 900 keV. According to theory, 2π times the width without barrier should be of the order of the spacing of levels having the same spin, and this is roughly in agreement with the experiment, as at 1 MeV. only protons of angular momentum zero can penetrate the barrier sufficiently easily to be responsible for the resonances found.

The lack of resonances when the energy exceeds 1,235 keV. can be explained as the passage of the threshold energy for neutron emission, because above this energy the radiation processes are unable to compete with the neutron emission process. The threshold energy of the protons, calculated from the masses, is 1 MeV.; but the uncertainty is about ± 1 MeV. The experimental threshold is not necessarily equal to this value, because the conservation law for the angular momentum may force the neutrons to penetrate a centrifugal barrier, and thus make neutron emission improbable. As the spin is not known for all the nuclei concerned, the experiment cannot be used to determine the binding energy of the neutron in the compound nucleus with higher accuracy than that with which it is already known A direct detection of the neutrons is practically impossible even at higher excitation energies, because of the low efficiency of neutron counters.

It is seen that the experiments are in qualitative agreement with the theoretical expectations.

In conclusion, we wish to thank Prof. Niels Bohr for his continuous interest in the work.

K. J. BROSTRØM
T. HUUS
J. KOCH

Institute for Theoretical Physics,
University of Copenhagen.
July 31.

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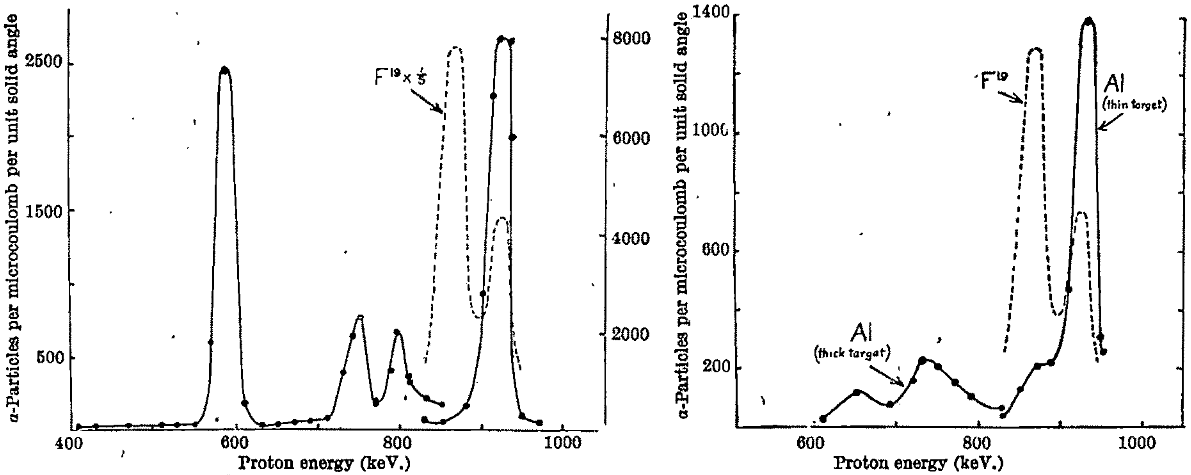
Short-Range α-Particles from the Disintegration of Sodium, Aluminium and Fluorine by Protons

THE emission of short-range α-particles in th proton bombardment of oxygen, nitrogen and fluorin has been known for some time[1]. Calculations base on published mass values[2] show that there shoul also be a release of energy in the (p,α) reactions i sodium and aluminium, according to the equations

$$Na^{23} + H^1 \rightarrow Ne^{20} + He^4 + Q_1 \qquad (1)$$

$$Al^{27} + H^1 \rightarrow Mg^{24} + He^4 + Q_2. \qquad (2$$

These processes have now been observed, and the Q-values obtained, by a method of magnetic analys similar to that used by Burcham and Devons[3] fo the detection of the short-range α-particles in th proton disintegration of fluorine. Some furthe observations on this latter reaction have also bee made.



(a) Sodium chloride (thin target)

(b) Aluminium

Fig. 1. Excitation functions for sodium and aluminium (p,α) reactions. The absolute value of the ordinates is approximate only. In (a), left-hand and right-hand ordinates refer to the curves for proton energies below and above 830 keV. respectively

Disintegration particles emitted at 90° to the proton beam were allowed to pass through a 90°-focusing magnet, so that the α-particles could be resolved from the longer-range scattered protons. The α-particles were focused on to a zinc sulphide screen and the resulting scintillations were detected by an E.M.I. photo-electric multiplier. For accurate range measurements the screen and multiplier were replaced by a mica window of 2 mm. stopping power, and a shallow air-filled ionization chamber placed at a variable distance from the window. The range scale was calibrated with α-particles from a thin thorium-C source.

The yield of α-particles from reactions (1) and (2), observed as a function of incident proton energy, is shown in Figs. 1(a) and 1(b). For comparison, α-particles from the reaction:

$$F^{19} + H^1 \rightarrow Ne^{20*} \rightarrow \left.\begin{array}{l} O^{16*} + He^4 + Q_3 \\ O^{16*} \rightarrow O^{16} + \gamma \end{array}\right\} \quad (3)$$

were also observed; the excitation function thus obtained was compared with the well-known excitation function for the γ-rays in this reaction[4,5], in order to calibrate the proton energy-scale. The yield of fluorine α-particles for proton energies from 830 to 950 keV. is shown by the broken curves in Fig. 1.

The ranges of the α-particles emitted in the sodium and aluminium reactions (1) and (2) were measured by direct comparison with the range of α-particles from the fluorine reaction (3), for which an absolute measurement had previously been made (1·11 cm. at 930 keV.). Fig. 2 shows the ionization chamber measurements for the case of aluminium. The mean ranges for sodium and aluminium α-particles were found to be 1·38 cm. and 1·00 cm. respectively, at 930 keV. proton energy.

In the course of the work on fluorine, α-particles of slightly greater range than that associated with reaction (3) were also observed, at a proton energy of 830 keV. These are attributed to the process:

$$F^{19} + H^1 \rightarrow Ne^{20*} \rightarrow \left.\begin{array}{l} O^{16*} + He^4 + Q_4 \\ O^{16*} \rightarrow O^{16} + \pi \end{array}\right\}, \quad (4)$$

in which the excited state of O^{16} reverts to the ground-state with the emission of an electron pair. A pair-production resonance at 830 keV. is known[4,6]. The Q-value deduced from this process agrees well with the measurements of Becker *et al.*[7] at the 1,220-keV. pair-production resonance.

The Q-values for reactions (1) to (4), calculated from the range measurements by using the 1938 Cornell range-energy curve for α-particles, are:

$Na^{23}\ (p,\alpha)\ Ne^{20} : Q = 2\cdot14 \pm 0\cdot07$ MeV.
$Al^{27}\ (p,\alpha)\ Mg^{24} : Q = 1\cdot32 \pm 0\cdot07$,,
$F^{19}\ (p,\alpha\gamma)\ O^{16} : Q = 1\cdot73 \pm 0\cdot05$,,
$F^{19}\ (p,\alpha\pi)\ O^{16} : Q = 1\cdot89 \pm 0\cdot06$,,

The difference between the γ-ray and pair-production states in the two fluorine processes could be determined, by direct comparison, more accurately than either value individually, and is 0·16 ± 0·02 MeV. The Q-value found for the $F^{19}(p,\alpha\gamma)O^{16}$ reaction upon which the sodium and aluminium results depend is in fair agreement with other measurements[7,8].

If it is assumed that the α-particles observed from sodium and aluminium are associated with the formation of the residual nucleus in its ground-state, then the Q-values found provide fresh data for the cal-

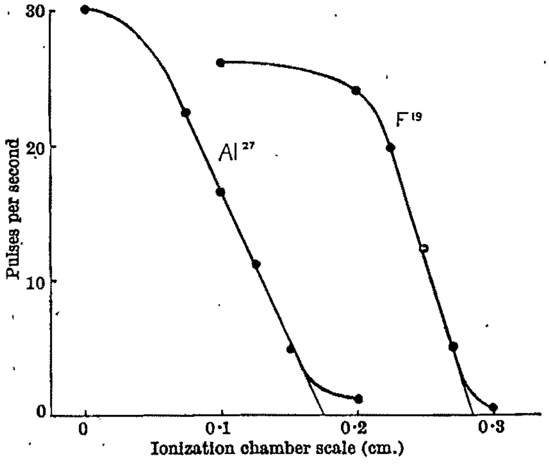


Fig. 2. Comparison of ranges of α-particles from Al^{27} and F^{19} at 930-keV. proton energy. Ordinates (scales arbitrary) represent counting-rates of pulses greater than a given size determined by the discriminator bias

culation of the masses of the nuclei Mg^{24} and Na^{23}. The values obtained fit very well into the scheme of mass values suggested for the elements between neon and silicon by Allan and Wilkinson[9].

The capture of protons by sodium and aluminium may alternatively result in the emission of γ-rays with sharply defined resonances for varying proton energy[10-12]. The inhomogeneity of the proton beam used in the present experiments makes it difficult to establish with certainty any connexion between α-emitting and γ-emitting levels of the compound nucleus concerned.

The work is continuing and further details will be published later.

JOAN M. FREEMAN
A. S. BAXTER

Cavendish Laboratory,
Cambridge.
June 3.

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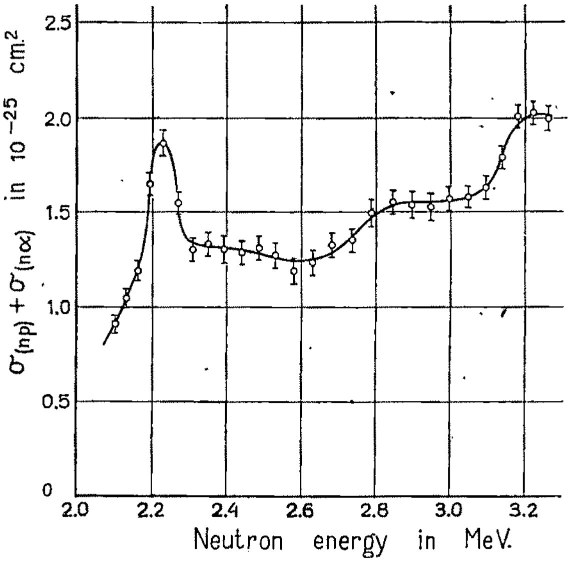
Disintegration of Nitrogen by Fast Neutrons

THE reactions $^{14}_{7}N\ (np)\ ^{14}_{6}C$ and $^{14}_{7}N\ (n\alpha)\ ^{11}_{5}B$ have been investigated using the mono-energetic neutrons, obtained by bombarding a thin heavy-ice target by deuterons (D+D neutrons). With a deuteron energy of 400 keV. and a variation of the angle between the direction of the neutrons used and the beam of impinging deuterons from 34° to 138°, the neutron energy is varied between 3·2 and 2·1 MeV. This method was suggested to me by Dr. Hl. de Vries. The number of (*np*) and (*nα*) reactions is measured in a nitrogen-filled proportional counter, which is placed in various positions in the above-mentioned interval, with respect to the target. In order to eliminate fluctuations in the yield of the neutron source, the number of kicks from this counter is divided by the number of counts given in the same time by a proportional counter filled with boron fluoride which is kept in a fixed position. For the calculation of the cross-sections, the absolute number of neutrons getting into the nitrogen counter must be known. Therefore the number of neutrons per unit of solid angle in the direction of the boron fluoride counter for a given number of counts was determined from the response of this counter to a source consisting of 90 mgm. radium + beryllium, placed close to the target. For other directions this number was calculated, assuming the $(1 + A\cos^2\theta)$-law in the centre of gravity co-ordinate system, with $A = 1{\cdot}5$ in this case[1].

The cross-sections obtained are represented in the accompanying figure as a function of the neutron energy. The peak indicates a resonance for 2·23 MeV. neutron energy, corresponding to an excited state of the intermediate $^{15}_{7}N$ nucleus. The height of this level above the ground-state is 12·87 MeV., which is easily calculated with the help of the mass values[2]. Other possible irregularities in the curve are being studied in more detail. Other resonances have been found in the region between 0·2 and 1·7 MeV. neutron energy by Barschall and Battat[3], using mono-energetic neutrons, (Li + *p*) reaction, namely, at 0·55, 0·70 and 1·45 MeV.



The combined cross-sections for the (*np*) and (*nα*) reactions in nitrogen as a function of the neutron energy. Only statistical errors have been plotted

The other way in which fast neutron resonances have been studied is by the method, first applied by Wilhelmy[4], in which a neutron source with continuous energy distribution is used, and groups of protons and α-particles of different energies are observed. The relation between the energies of such groups, and those of the corresponding resonance neutrons, is given by the energy balance of the (*np*) and (*nα*) reactions:

$$E_{p,C} = E_n + Q_1;\quad E_{\alpha,B} = E_n + Q_2,$$

in which $E_{p,C}$ means the sum of the kinetic energies of a proton and the residual carbon nucleus (measured by Wilhelmy's method), etc. If the residual nucleus is in the ground-state, the *Q* values are equal to the mass differences in MeV. According to the latest measurements $Q_1 = -0{\cdot}24$ MeV.; $Q_2 = 0{\cdot}63$ MeV.[5].

Stebler and Huber[5], calculating resonance neutron energies from their groups in this way, find the values 0·48, 0·64, 1·41, 1·77 and 2·20 MeV., in good agreement with our value (2·23 MeV.) and those of Barschall and Battat (0·55, 0·70 and 1·45 MeV.).

If we also calculate those resonance neutron energies from earlier measurements which lay within our region, we find: 2·28, 2·83, 3·45 MeV. (Wilhelmy[4]); 2·38, 2·75, 3·24 MeV. (Ortner and Protiwinsky[6]); 2·18, 2·39, 2·88, 3·22 MeV. (Zagor and Valente[7]). The lowest value of each series may be identified with our value and the corresponding one of Stebler and Huber. There is some indication in our measurements also for the highest resonance of about 3·30 MeV. The resonance at about 2·83 MeV., on the contrary, does not appear clearly in our curve. This does not necessarily mean a discrepancy, however, as the authors mentioned used neutrons up to high energies. Therefore excited states of the residual nucleus may occur, giving other groups which cannot be found in this experiment.

Absorption measurements. As Valente and Zagor[8] find for the total cross-section of their resonance neutrons the exceedingly high value of 60×10^{-24} cm.^{2}, we made absorption measurements in the region of the maximum with dicyandiamide ($C_2H_4N_4$) which resulted in a value for the total cross-section of about 2×10^{-24} cm.^{2}. Thus, as contrasted with the results of Valente and Zagor, we may conclude that no real conflict with theory seems to exist for these neutrons.

I wish to express my thanks to Prof. D. Coster for suggesting the problem and for his interest in the work, and to the "Stichting voor fundamenteel onderzoek der materie" for financial support.

C. P. SIKKEMA

Natuurkundig Laboratorium
der Rijks-Universiteit,
Groningen.
June 1.

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A Magnetic Resonance Accelerator for Electrons

IN his paper, "A New Method of Acceleration of Relativistic Particles", Veksler[1] proposed two methods of overcoming the limitation of the cyclotron due to he relativistic increase of the mass of the particle. One of these is the synchrotron, now well known; and the other, which has been called the microtron[2] and is essentially an electron cyclotron, is the subject of the present note.

We have constructed a small electron accelerator to operate on this principle, and have observed that he electrons are accelerated in the expected manner. The radio-frequency voltage on the accelerating gap s between 500 and 600 kV., and the magnetic field about 1,000 oersteds. The electrons make eight uccessive passages across the gap and have a final energy of 4·6 MeV. Further acceleration is at present limited by the size of the magnet.

Veksler pointed out the very important fact that for a relativistic particle subject to periodic accelerations the difference in the time required to execute successive orbits in a magnetic field is a constant, and independent of the total energy of the particle. In an accelerator which makes use of this fact, H, the magnetic field, and V, the radio-frequency voltage, are adjusted so that the time difference between uccessive orbits is equal to T, the period of the adio-frequency field. This defines the resonance ondition:

$$\frac{2\pi V}{HC} = T. \tag{1}$$

Further, for the particle to be in resonance with the radio-frequency field, Veksler showed that the itial energy of the particle must be such that:

$$\frac{2\pi M_0 C}{He}(k+1) = T\gamma, \tag{2}$$

where $k = V_k/M_0C^2$ is the energy in mass units of the particle before acceleration by the radio-frequency eld, and γ is an integer.

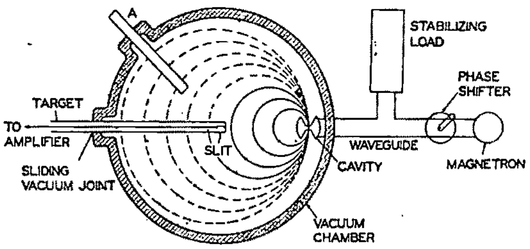

Fig. 1

The accelerator takes the form shown in plan in Fig. 1. A cavity resonant at $\lambda = 10{\cdot}7$ cm. is contained in one side of a vacuum chamber placed between the poles of an electromagnet. Power is fed to the cavity through an evacuated wave-guide from a tunable magnetron. A stabilizing load and phase shifter operating in vacuum allow the adjustment of the loading of the magnetron.

Geometrical considerations limit the length of the accelerating gap in the cavity, and we have chosen a 1-cm. gap as a compromise between poor geometry and lower shunt resistance. The cavity is an ellipsoid hyperboloid cavity, the electrical characteristics of which have been calculated by Hansen[3]. With a 1-cm. gap the theoretical constants are $Q = 12{,}000$; $R_s = 2{\cdot}2 \times 10^6$ ohms. The poles of the cavity are flattened and pierced with ¼-in. diameter holes.

The following considerations made it appear probable that the condition (2) on the initial energy could be satisfied without attempting to control the injection energy, but rather by using the electrons which originate within the cavity itself. Preliminary experiments with such a cavity showed that this current was about 20 m.amp. peak value. A theoretical study of the passage of the electron across the gap showed that for an electron starting from rest across a 1-cm. gap the process is quite efficient, and for starting phase angles from 40° to 80° in the radio-frequency cycle the electron acquires an energy within a few per cent of the peak voltage on the gap. If, therefore, the gap voltage is equal to the rest mass of the electron in electron volts, both conditions will be fulfilled by electrons starting from rest; that is, $k = 0$ in (2). For phase stability in succeeding orbits it is necessary that the electron crosses the gap beyond the peak of the radio-frequency cycle, the centre of the phase-stable region being at about 100°. It therefore seemed probable that the electrons starting from rest in the region of 60° and having a transit angle of 54° would enter the phase-stable region of the radio-frequency cycle and be subjected to further accelerations.

To observe the orbits, which are the family of circles shown in Fig. 1, a target is mounted on a sliding vacuum seal on the opposite side of the vacuum chamber from the cavity, and is coated with fluorescent material to show the position of the orbits visually. With power being fed to the cavity and the magnetic field adjusted to the resonance value, the various orbits can be seen by slowly withdrawing the fluorescent target. As the target is withdrawn until an orbit just clears it, the next one appears at once. This is evidence that the orbits are circular and passing through the accelerating gap. That such is the case has been verified by placing adjustable obstructions at other points such as A.

The fluorescent target is also fitted with an insulated Faraday collector behind a 1-mm.-wide lead slit to record the electron current. The current is

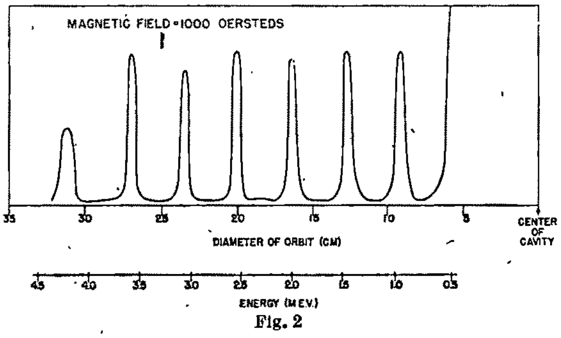

Fig. 2

amplified and fed to a recording meter. Fig. 2 shows a typical plot of the current collected as a function of the distance from the slit to the centre of the cavity. Although the eighth orbit appears broadened due to its proximity to the edge of the magnetic field, there is little, if any, loss of current between orbit 2 and orbit 8.

Instead of the sharp resonance at 1,000 oersteds to be expected from (1) and (2), the resonance value of the magnetic field is found to be broad, and with a particular cavity eight successive orbits are obtained for values of the magnetic field anywhere between 900 and 1,200 oersteds. We have no adequate explanation of this, but believe it is connected with the possibility that electrons with the required phase may cross the first gap with a range of energies. In this way it is possible to satisfy (1) and (2) simultaneously for a range of magnetic fields. It may be possible to make use of this phenomenon in future designs to permit the use of higher magnetic fields and cavity voltages.

In addition to the main resonance, other modes of resonance operation at lower magnetic fields are also observed. These may be identified with the resonance conditions when $\gamma = 2, 3, 4, \ldots$, and the time difference between successive orbits is $2T, 3T, 4T, \ldots$

W. J. HENDERSON
H. LECAINE
R. MONTALBETTI

National Research Council,
Ottawa.
May 15.

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Sea Waves and Microseisms

It is well known[1] that the pressure variations beneath a progressive gravity wave of Stokes's type are insufficient, in deep water, to generate microseisms of the observed magnitude. This is because the pressure variations on the sea-bed decrease exponentially with the depth. The following argument, however, shows the existence, in a general class of wave motions, of 'second-order' pressure variations which are not attenuated with the depth.

The surface elevation in a simple stationary wave, for example, is given, in Lamb's notation[2], by

$$(A) \qquad \eta = a \cos kx \cos \sigma t + O(a^2),$$

where

$$\sigma^2 = gk \tanh kh.$$

Consider the mass of water contained between the bottom $z = -h$, the surface $z = \eta$ and the two vertical planes $x = 0, \lambda$ where $\lambda = 2\pi/k$. There is no flow across the vertical planes and therefore this mass o water consists always of the same particles. Therefore, if F is the vertical component of the total externa force acting on the mass, we have, summing the equations of motion for each particle of mass m and cancelling internal forces,

$$F = \Sigma\, m \frac{d^2 z}{dt^2} = \frac{1}{g} \frac{d^2}{dt^2} \text{ (potential energy).}$$

Now the forces across the vertical boundaries contribute nothing to F; the pressure p_0 at the fre surface contributes a downwards force λp_0 an gravity a constant force $\lambda \rho g h$. Hence

$$F = \lambda(p - p_0 - \rho g h),$$

where p is the mean pressure on the bottom. Now for the stationary wave (A) we have, neglectin compressibility,

$$\text{potential energy} = \int_0^\lambda \tfrac{1}{2} \rho g \eta^2 \, dx$$

$$= \tfrac{1}{4} \lambda \rho g a^2 \cos^2 \sigma t + O(a^3)$$

Hence

$$(B) \qquad \frac{p - p_0}{\rho} = gh - \tfrac{1}{2} a^2 \sigma^2 \cos 2\sigma t + O(a^3).$$

The second term is of order (wave-height)², whic explains why it is not revealed in the ordinary first order theory. It is also of double the fundamenta frequency and, for a given frequency and amplitude is independent of the depth h. Equation (B) has bee derived by Miche[3] in the course of a complet evaluation of the second approximation to th stationary wave-motion. By a slight extension o the present argument one can evaluate the mea pressure below the series of long-crested waves give by

$$(C) \qquad \eta = \sum_{m,n} a_{m,n} \cos (mkx + nky + \sigma_{m,n} t + \varepsilon_{m,n})$$

where m and n are integers and

$$\sigma_{m,n}^2 = (m^2 + n^2)^{1/2} gk \tanh (m^2 + n^2)^{1/2} kh, \quad (\sigma_{mn} \geqslant 0$$

If p is the mean pressure on the bottom, we find

$$(D) \qquad \frac{p - p_0}{\rho} = gh -$$

$$\sum_{m,n} a_{m,n}\, a_{-m,-n}\, \sigma_{m,n}^2 \cos (2\sigma_{m,n} t + \varepsilon_{m,n} + \varepsilon_{-m,-n}$$

Hence this type of pressure fluctuation occurs whe ever wave-trains cross which are of the same fr quency and travel in opposite directions (correspon ing to integers (m,n), $(-m,-n)$). A single wav train gives zero fluctuation in the mean pressure.

These results provide the basis for a new theory microseism generation. They explain how micr seisms come to be generated in deep water[4,5], an why the frequency of the microseisms is sensib double that of the waves associated with them The theoretical orders of magnitude are in agreeme with those observed. A fuller account of the theor is in preparation.

M. S. LONGUET-HIGGINS
F. URSELL

Admiralty Research Laboratory,
Teddington, Middlesex.
May 20.

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Spreading Phenomenon and Inflammation

A STUDY has been made of the spreading activity of certain inflammatory agents in rabbit skin. As the results of this work may be of general interest, a brief account of them are given here.

Using hæmoglobin as an indicator of spreading, it has been found that the intradermal injection of inflammatory agents into the shaved skin of anæsthetized rabbits produces significant spreading as compared to saline controls. The agents investigated (concentration in mgm. per c.c.) were the following: trypsin (10), chymotrypsin (10), 'Bactopeptone' (100), Wittes' peptone (100), casein digest (100), $\frac{1}{2}$–$\frac{1}{4}$ saturated urea, and snake venoms (0·1) (copperhead, diamondback rattlesnake and mocassin), wherein the hyaluronidase originally present was destroyed by treatment with alkali[1].

The spreading observed with these inflammatory agents differs from that produced by hyaluronidases in that the rate of spreading is slow and the injected bleb persists as spreading proceeds. When these agents are injected into the skin of recently killed rabbits, where inflammatory œdema cannot occur, no spreading response is observed. This demonstrates that inflammatory agents do not directly alter the permeability of the dermal barrier to fluid diffusion. To determine whether the inflammatory agents acted via liberation of 'bound' hyaluronidase in skin[2], the effect of a hyaluronidase inhibitor upon the spreading activity of inflammatory agents in live rabbits was evaluated. Nitrated and partially de-esterified nitrated hyaluronates which markedly reduce hyaluronidase viscosity-reducing activity by competitive inhibition[3] were used in these experiments. It was observed that whereas the spreading activity of purified testis hyaluronidase or of snake venoms containing hyaluronidase was either inhibited or abolished by the inhibitors, the spreading activity of these inflammatory agents uniformly was not affected.

The mechanism by which inflammatory agents produce spreading in skin is explicable in terms of simple mechanical forces. It has previously been found that the area of spread produced by saline – hæmoglobin mixtures is proportionate to the volume of fluid injected, or on the interstitial fluid pressure of the bleb[2]. Since inflammatory agents produce œdema consequent to capillary damage in the injected area, this increases the interstitial pressure of the bleb, thus giving rise to greater spreading than is observed with the saline control. This view explains why the injection bleb persists (or even becomes higher), in association with spreading of the indicator, with these agents in contrast to the spreading seen with hyaluronidase or saline, where the bleb flattens as spreading proceeds. It should be emphasized that the permeability of the dermal barrier need not be affected in these acute inflammatory spreading reactions.

These findings may provide an explanation for the fact that diverse agents ranging from simple chemicals like arsenious oxide to biological factors present in some bacteria and venoms, while without influence upon hyaluronic acid *in vitro*, nevertheless possess significant spreading activity *in vivo*[4]. The suggestion is advanced that these spreading factors, some of which are known to be inflammatory agents, act via the capillary damage they induce. In this connexion, it may be important to note that the spreading activity of extracts of rabbit organs such as spleen, lung, and liver (prepared according to the method of Claude and Duran-Reynals[5]), is similar to the inflammatory agents studied, in that the slow spread obtained with these tissue extracts is not inhibited by nitrated hyaluronates, and the spreading response is absent, in the skin of dead rabbits.

In previous studies it was demonstrated that inflammatory agents present in snake venoms markedly increase the final area of spread produced by purified testis hyaluronidase[1]. It has now been observed that this augmentation of spread can be duplicated by non-specific inflammatory agents such as concentrated urea and peptones. In experiments where a constant hyaluronidase concentration was injected with variable concentrations of inflammatory agents (peptones, proteolytic enzymes and alkali-treated snake venoms), it has been observed that the final area of spread is proportional to the concentration of inflammatory agent employed.

These studies illustrate the importance of inflammation in spreading phenomenon and may have implications for local bacterial invasiveness. It would appear that bacteria which do not produce hyaluronidase may spread extensively, although less dramatically than hyaluronidase-producing organisms, via the inflammatory changes they induce. The invasiveness of hyaluronidase-producing bacteria may depend quantitatively upon the degree and character of the inflammation they induce, and only secondarily upon the concentration of hyaluronidase produced *in situ*.

Full details of these studies will be published elsewhere. This work was aided in part by a grant from the G. D. Searle Company.

OSCAR HECHTER
SIDNEY SOLOMON

Worcester Foundation for
Experimental Biology,
Shrewsbury, Mass.,
and
Department of Physiology,
Tufts Medical School,
Boston, Mass.
May 8.

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Destruction of Urinary Glucuronide by Bacteria

IN a recent publication, Senior[1] has emphasized the importance of the preservation of rabbit urine preceding estimations of its glucuronide content. This point has been previously made by, for example, Venning[2] and by Bucher and Geschickter[3] with regard to pregnanediol glucuronide in human urine, and has lately been further investigated[4].

We have carried out experiments to try to determine what organisms may be responsible for the apparently complete destruction of 'pregnanediol-like-glucuronide'[4] which may occur in unpreserved human urine. We have found that, whereas a number of common bacteria were without effect on this substance, its destruction, as well as that of added sodium pregnanediol glucuronidate, occurred when certain strains of *Staph. albus* were grown in sterile urine containing the glucuronide. Our experiments suggest that more than a simple hydrolysis of the glucuronide may be involved in the action of the organism, for we have not always been able to detect glucuronic acid itself, which should be present after hydrolysis.

Staph. albus might occur as a contaminant of urine collected in the usual way. Our work, however, does not show that this organism is the only common one which may be concerned in glucuronide destruction, and we are at present engaged in a more systematic search for bacteria of the glucuronide-destroying type.

MARY BARBER
British Postgraduate Medical School,
B. W. L. BROOKSBANK
G. A. D. HASLEWOOD
Guy's Hospital Medical School,
London.

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Intermediates in Soil Nitrification

ON somewhat indirect evidence, the theory has been put forward[1,2] that hydroxylamine is an intermediate in the first stage of soil nitrification, that is, the stage in which ammonium ions are oxidized to nitrite ions. I have now tested this theory directly by making use of the observation[3] that fresh soil percolated with an ammonium salt and potassium chlorate produces no nitrate but only nitrite, because the chlorate ion selectively inhibits the proliferation of the nitrite-oxidizing micro-organisms. It therefore follows that if hydroxylamine is an intermediate in nitrite formation, a soil percolated with hydroxylamine and chlorate should produce nitrite in the percolate. Because the colorimetric estimation of very low concentrations of nitrite is simple and certain, the hydroxylamine may be tested at very low concentrations and its possible toxic effect[4] minimized.

The soil percolators[5] were actuated by a stream of air, previously sterilized and freed from traces of ammonia by passage through $M/50$ copper sulphate in $M/50$ sulphuric acid, fed in through the bubbler tubes. In these percolators, 10-gm. lots of the crumb layer of San Juan chocolate soil (air-dried and sieved 4·0 mm.–1·0 mm.) were percolated for 24 hours with 100 ml. distilled water. This wash percolate was then discarded, and the soils repercolated with 100 ml. of either $M/10,000$ potassium chlorate, or $M/10,000$ potassium chlorate containing ammonium sulphate and/or hydroxylamine. Parallel tests were also run with hydrazine in place of hydroxylamine, hydrazine being another possible intermediate. All nitrogen compounds were added to a concentration of 7 μgm. nitrogen per ml. percolate. After five hours of test percolation, the nitrite concentrations of the percolates were determined by the Griess – Ilosva reagent. The results are given in the accompanying table.

These results do not prove that neither hydroxylamine nor hydrazine is an intermediate in the first stage of soil nitrification; they suggest that neither compound acts as such when added extracellularly. It is possible, for example, that neither compound can penetrate the cell wall, or that both are destroyed by other soil reactions before they can reach the nitrifying cells.

Nitrite formation by 10 gm. lots of San Juan soil percolated wit 100 ml. $M/10,000$ potassium chlorate with or without the additio of various nitrogen compounds at concentrations of 7 μgm. N/ml

Nitrogen compound added to percolate	Nitrite–nitrogen concentration o percolate after 5 hours percolatio (μgm. N/ml.)			
None	$<0·01$	$<0·01$	$<0·01$	$<0·0$
Ammonium sulphate	0·26	0·26	0·26	0·2
Hydroxylamine hydrochloride	$<0·01$	$<0·01$	$<0·01$	$<0·0$
Hydrazine sulphate	$<0·01$	$<0·01$	$<0·01$	$<0·0$
Hydroxylamine hydrochloride plus ammonium sulphate	0·26	0·26	0·26	0·3
Hydrazine sulphate plus ammonium sulphate	0·29	0·29	0·27	0·2

If it is true, however, that hyponitrite is an intermediate[6] and that carbon dioxide is essential in soi nitrification[7], then there is a distinct possibility tha the first *recognizable* step in nitrification in soil i the dismutation of ammonium bicarbonate into hyponitrite and formaldehyde :

$$NH_4HCO_3 \rightarrow HNO + H_2O + H.CHO.$$

This equation is tentative and lacks experimenta proof; but the similarity it bears to the 'basic' equation of photosynthesis is interesting in view o Godlewski's suggestion[8] that the energy released by ammonium oxidation by the nitrifying organism replaces that captured by the photosynthetic proces in photosynthesizing organisms.

HOWARD LEES
Imperial College of Tropical Agriculture,
Trinidad.
June 1.

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Nomenclature of the British Littorinidæ

THE currently accepted classification of the Britis Littorinidæ (= Lacunidæ) is that of Winckworth[1] In his earlier publication[2] on the nomenclature o this group, Winckworth assigns the species formerly included under *Littorina*, on the basis of difference in the methods of reproduction, to four genera, thus (1) *L. littorea* (L.) to *Littorina* Ferrusac, (2) *L. saxatili* (Olivi) to *Littorivaga* Dall, (3) *L. neritoides* (L.) t *Melarhaphe* Menke and (4) *L. obtusata* (L.), *L* *æstuarii* (Jeffreys) and *L. littoralis* (L.) to *Neritoide* Brown (the occurrence of *obtusata* in Great Britai being, however, thought doubtful). "It has long bee known that *L. littorea* has pelagic egg-capsules an passes through a free Veliger stage, while *L. rudi* is viviparous and *L. littoralis*, like the species o *Lacuna*, deposits eggs in oothecæ on the seaweeds.' To the objection that these differences are ecologica and should have no place in a classification base on morphology, Winckworth's reply was: "Th closest groups are *Littorina* and *Neritoides* and to m mind the distinction between a Mollusc with a fre Veliger stage and one that does not pass through thi stage still remains of generic importance, while i ther groups the genera could be separated on natomical and conchological distinctions. Those ho do not see with me in this may regard the names s of a sub-generic rank." Accordingly, in his later ublication[1], he treats *Littorivaga, Melarhaphe* and *eritoides* as sub-genera of *Littorina*, without any rther discussion.

In a previous communication[3], I reported the occurence of oviparity in some of the so-called varieties f *L. saxatilis* (a species that has always been condered to be viviparous) at high-tide levels on the ore at Cullercoats, and suggested that these thin-elled *rudissima* forms should be regarded as disnct from the thick-shelled *rudis* forms as well as om the other viviparous varieties and sub-species f *L. saxatilis*. Further studies have, however, vealed that while the *rudis* forms are always viviarous and distinct, a small proportion of the thin-helled animals which are otherwise indistinguishable om the oviparous ones do contain shelled embryos the uteri. One is led to the conclusion that here a case of the same species exhibiting both the viparous and the viviparous modes of reproduction ven in the same locality.

A careful study of the available literature has also vealed that such cases of pœcilogony have already een recorded among the Gastropods. Pelseneer[4] tates: "There is no clear demarcation between the viparity proper of the generality of Molluscs and voviviparity which is realized in some of the specialed forms", and gives several instances where the ame species may reproduce either by the one or e other method according to circumstances (for xample, *Helix carthusiana, Achatina panthera, Balea erversa*). Regarding the stage of emergence from he egg-capsule and the duration of free larval life, so, variations are possible within the same species. horson[5] mentions the case of *Brachystomia rissoides*, hich varies both in egg-size and in the larval deelopment (pelagic or non-pelagic) from place to ace. The same author also describes examples *lanaxis sulcatus, Natica catena*, etc.) in which the nbryos may hatch at any time and in any stage f development depending upon the quantity of ourishment ('nurse-eggs') available to them in the g-capsules, and a planktonic larval phase may or ay not be present according as the 'nurse-eggs' are w or plentiful. These 'nurse-eggs' may vary conderably in number in a given species not only from ace to place but also within the same locality. In e case of *Thais hæmastoma*[5], 'nurse-eggs' may be mpletely absent in one place while present in other, a planktonic larval stage being present in e former but not in the latter. Finally, there are e observations of Tattersall[6] on the hatching of *obtusata* (= *L. littoralis*, according to Colman[7]) der laboratory conditions in south-western Ireland; hile a planktonic stage is known to be absent in this ecies, in this particular case the eggs hatched out late veligers and had a short planktonic phase. lman[6], who repeated the experiment in fingerwls at the Plymouth laboratory, found that the ung ones hatching out of the egg-capsules "always awled out and never swam". He concludes: "All at can be said from these observations is that under ughly similar laboratory conditions there was a tinct and important difference in the hatching ges of *L. obtusata* from South-western Ireland and m Church Reef".

In the light of the circumstances summarized ove, it may be suggested that the (generic or) sub-generic differences recognized by Winckworth are not valid. A fuller discussion will be published elsewhere along with the details of the work on *L. saxatilis*.

My thanks are due to Prof. A. D. Hobson, under whose supervision this work has been carried out.

G. SESHAPPA

Dove Marine Laboratory,
Cullercoats,
Northumberland.
June 25.

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Ustilago microchloæ: a New Record

RECENTLY, Dr. H. F. Mooney collected some grasses from the sandy soil around Angul, Orissa. These were sent to me in the ordinary way for naming at Kew. The specimens were 4–7 cm. high, and were peculiar in that each stem terminated in a dark fruit-like swelling. These were due to a smut *Ustilago microchloæ* Syd. et Butler, the host plant being *Microchloa indica* (Linn. f.) Beauv. (syn. *Microchloa setacea* R. Br.). As no material of the smut was available for comparison at the Kew Herbarium or at the Commonwealth Mycological Institute, Kew, a request was sent to Stockholm for a loan of the type specimen in Sydow's herbarium. This was made available through the courtesy of Dr. Arwidsson of the Naturhistoriska Riksmuseet, and the provisional identification of *Ustilago microchloæ* was confirmed. A point of interest in this smut is that the whole inflorescence, which is usually 5–7 cm. long in normal plants, is replaced by one fruit-like ovoid body of only 2 mm. in diam. This is packed with soot-like smut spores. By further correspondence I was able to secure additional specimens which are being distributed to Kew, New Delhi, Stockholm, Paris, Farlow Herbarium, Cambridge, Mass., and the U.S. Department of Agriculture, Washington, D.C.

This smut was first collected by Butler on September 19, 1903, at Bilikere in Mysore, and was described by Sydow and Butler[1] in 1906. This collection was cited by Butler and Bisby[2] in 1931; but I am not aware of any further gathering until the present one by Mooney (August 18, 1948). The latter appears to be the first record for Orissa and extends the known range of the species several hundred miles to the north-east of Mysore. Mooney says: "the grass is very inconspicuous and ephemeral and seemingly rarely collected". The present plentiful gathering is therefore valuable in allowing distribution of this rare and interesting species, besides giving a new record for Orissa.

D. CHATTERJEE

c/o Royal Botanic Gardens,
Kew.
Sept. 25.

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Resistance to the Potato-Root Eelworm

SINCE 1941, I have been testing South American tuber-forming *Solanum* species for immunity and resistance to the potato-root eelworm. The material, kindly supplied by Dr. P. S. Hudson and Dr. J. G. Hawkes, of the Commonwealth Bureau of Plant Breeding and Genetics, Cambridge, forms part of the Commonwealth Potato Collection[1]. An interim report on this work was published in 1945[2], when about fifty forms had been examined. Since then, however, owing to a grant from the Commonwealth Agricultural Bureaux, it has been possible to increase the scale of the tests, and about seven hundred forms have now been examined.

The plants are grown in duplicate, in pots of infected soil sunk in the field. At the end of the season, the roots are examined in the field for eelworm cysts. Only in the case of a single type has this examination failed to reveal cysts; in 1945, no cysts were found on either of the extensive root systems of two well-grown specimens of *S. Ballsii*. The same result was obtained with two plants of the same species tested in 1946; however, while microscopic examination of roots stained with acid fuchsin had revealed no larvæ in the roots of the 1945 specimens, larvæ were found in 1946. More material was available in 1947 and tests were carried out on eleven plants. Again no cysts were found in the field; but on this occasion microscopic examination revealed the presence of a few very small cysts on the roots of some of the plants.

I have already referred to the difficulty of assessing relative resistance[2], and my subsequent work has emphasized this[3]. Nevertheless, the conclusion seems amply justified that, whereas *S. Ballsii* is not immune, it does appear to be exceptionally resistant. Mai and Lownsbery, of Cornell, have kindly allowed me to state that their preliminary trials with this form tend to support this finding.

C. ELLENBY

Department of Zoology,
King's College,
Newcastle-upon-Tyne.
June 4.

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'Weeding' in Fish-Farming

THE papers by Dr. C. F. Hickling in *Nature* of May 15 and by Messrs. L. H. N. Cooper and G. A. Steven in *Nature* of April 24 are related. In particular is this so in the case of 'weeding'.

In the Far East, fish culture by the peasants is traditional, either in inland waters or in enclosed areas 'bunded off' from the sea. I will give two examples of how 'weeding' is dealt with, at the peasant level, for these people have been faced for countless generations with the same problems that Messrs. Cooper and Steven discuss at some length in their article.

In the brackish water ponds of Java, where *Chanos chanos* (Forsk.) is cultivated, there are growths of *Zostera* and related genera, *Ruppia*, *Chondrocrispus* and other algæ which are not eaten by the fish. The fish are harvested by emptying the ponds and netting from a sump. I have seen the peasants at Soemenep in Madura digging the plants and algæ into the pon as green compost prior to refilling with water f the next crop of fish. In our small fish cultu station at Tapah in Malaya we are carrying this stage further, literally by composting the weed together with a considerable quantity of incident molluscs, worms, crustaceans and the eggs Amphibia. This compost is being permitted to r on the sides of the ponds and is ultimately returne to the ponds as manure. Critical analyses of th results will be published elsewhere.

In the Chinese-type pond, where the main speci cultivated are *Ctenopharyngodon idellus* (Cuv. an Val.), *Hypophthalmichthys molitrix* (Cuv. and Va and *Arristychthys nobilis* (Richardson), the 'weedin and composting take a different form. The flor population of the ponds is normally a rich phyt plankton. On this, a varied crustacean plankto fauna and small cyprinid fish fauna thrive, th perpetually reducing the essential productivity of t pond so far as the cultivated fish are concerned. T Chinese peasant realizes this, and in many ponds have seen them seine-netting their pond with a fin mesh net twice a week in order to catch the incidental organisms. These are then put into 'mash' which is fed to ducks and pigs living in pe on the side of the pond. The phosphates and nitrat are then returned to the pond by sweeping the pi and duck-droppings back. The Chinese peasant tes the nutrient salt concentration of the pond judging the density of the phytoplankton in th water, into which he will throw a broken piece white crockery, and by taking a mouthful of t water and gargling with it to ensure that the wat is 'sweet and fat'.

An extension of this principle of 'weeding' applied to the sea has come to light as the result preliminary studies on the catches of the sma mesh nets used by the fishermen in the Straits Malacca between peninsular Malaya and Sumatr Here we have a constantly moving body of wat which is almost totally surrounded by land on thr sides. There is a perpetual run-off from the ri volcanic mountains of Sumatra and the less ri mountains of Malaya. The bulk of the food fish Malaya are pelagic and pelagic feeders; but the fi population also contains a mass of small fish whi never grows to more than three inches in lengt They consist largely of Percomorphs. On the w coast of Malaya alone about twenty thousand to per annum of these small fish are taken by specia designed fishing gear with small meshes, and specifically fed to pigs and ducks or used as ag cultural fertilizer. Throughout the year, only 7 cent of the catch is the young of fish which wh adult are used as human food. As the result studies by this Department, it seems clear that taking of this mass of small fish from the sea p petually is a form of 'weeding' which permits th species which are of economic value as human fo the more readily to grow and proliferate. C sequently, under these conditions, a rational empl ment of small-meshed nets is encouraged, as it p motes proper conservation of our fish resources a plays an important part in the ultimate product of protein food.

D. W. LE MAR

Fisheries Department,
Federation of Malaya and Singapore,
Penang.
July 21.

REVERSIBILITY OF THE PROPAGATION REACTION IN POLYMERIZATION PROCESSES AND ITS MANIFESTATION IN THE PHENOMENON OF A 'CEILING TEMPERATURE'

By DR. F. S. DAINTON and K. J. IVIN
Department of Physical Chemistry, Cambridge

ALL addition polymerizations are exothermic and involve a decrease in entropy. The heat f reaction ($q = -\Delta H$) and the decrease in entropy $-\Delta S$) per mole of monomer polymerized really fer to the values of these quantities appropriate the *propagation* step, at the concentration of onomer ($= [m_1]$) prevailing in the system*. We ay write this reaction conventionally as

$$_p = A_p\, e^{-E_p/RT}, \quad m_1 + m_j{}^* \rightarrow m_{j+1}{}^* + q \text{ (k.cal.mole}^{-1}\text{)}, \quad (1)$$

which $m_j{}^*$ denotes an active species, either a radical an ion, containing j sub-units, m_1 denotes mono- er, k_p the rate constant, E_p the energy of activation nd A_p the frequency factor. From the principle microscopic reversibility, it can be shown that a everse reaction, which we shall call the *depoly- erization* reaction, also exists, namely:

$$_d = A_d\, e^{-E_d/RT}, \quad m_j{}^* \rightarrow m_{j-1}{}^* + m_1 - q. \quad (2)$$

his was first pointed out by Taylor and Tobolsky[1], nd later, Tobolsky and others[2] showed that at any emperature an equilibrium molecular weight distribu- ion exists which can be demonstrated for a solution f styrene in toluene at 100° C., and approached from oth high and low molecular weight sides by a supply f free radicals. More recently, Grassie and Melville[3] ave shown that under conditions in which the quilibrium is artificially displaced by continuous emoval of monomer, the depolymerization of poly- ethyl-methacrylate radicals will proceed to com- letion. In the course of a study of the copolymeriza- ion of olefines and sulphur dioxide[4] we have re- onsidered the effect of temperature on polymeriza- ion reactions in general and conclude that, as the mperature is increased, the rate should first rise xponentially, then pass through a maximum value nd finally fall to zero at a 'ceiling temperature' (T_c) efined by $T_c = \dfrac{\Delta H}{\Delta S}$, and which, under certain con- itions, should be realizable experimentally[5]. The ain features of the argument and conclusions are tlined below.

(*a*) *Kinetic Argument.* The propagation reaction (1) enerally has a small energy of activation but a large egative entropy of activation ($\Delta{}^{s}{}_{p}{}^{\ddagger}$). For example, amford and Dewar[6] have shown that for the poly- erization of styrene $E_p = 6{\cdot}5$ k.cal., $A_p = 1{\cdot}02 \times 10^6$ re mole^{-1} sec.$^{-1}$, that is, $\Delta S_p{}^{\ddagger} = -35$ cal.mole^{-1} eg.$^{-1}$. For reactions in the liquid phase for which $\Delta E^0 \simeq \Delta H^0$, we may write $E_d = E_p - \Delta H^0 = E_p + q$, but also A_d should be much larger than A_p, of the order of magnitude 10^{+13} sec.$^{-1}$ characteristic of unimolecular decomposition processes. Correspondingly, $\Delta S_d{}^{\ddagger} = \Delta S_p{}^{\ddagger} - \Delta S^0 \simeq 0$. Since heats of polymerization lie in the range 10–20 k.cal.mole^{-1}, k_d will increase with temperature much more rapidly than k_p and there may well be a temperature above which it is no longer justifiable to neglect k_d in comparison with $k_p[m_1]$. The rate of reaction should then be written

$$-\frac{d[m_1]}{dt} = \Sigma[m_j{}^*]\,\{A_p[m_1]\, e^{-E_p/RT} - A_d\, e^{-(E_p+q)/RT}\}. \quad (3)$$

When steady state conditions are attained the concentration of growing ends, that is, $\Sigma[m_j{}^*]$, will be a function of the initiation and termination rates only. For photochemically initiated chains this term may decrease with temperature, whereas for thermally initiated chains it will always increase due to the considerable energy of activation of the initiation reaction. The form of the terms in brackets is depicted in Fig. 1 and the forms of the log rate *vs.* $1/T$ curve for the two cases of photochemical and thermal initiation will therefore take the form shown in Fig. 2. There is thus a 'ceiling temperature'[7], T_c, characteristic of every reaction, and above which it will not proceed. From equation (3)

$$T_c = \frac{q}{2{\cdot}303\, R \log_{10}\left(\dfrac{A_d}{A_p[m_1]}\right)} = \frac{-\Delta H}{-2{\cdot}303\, R\left\{\log_{10}\dfrac{A_p}{A_d} + \log_{10}[m_1]\right\}}, \quad (4)$$

and therefore the ceiling temperature (1) is proportional to the heat of polymerization, (2) increases with the monomer concentration, (3) is independent

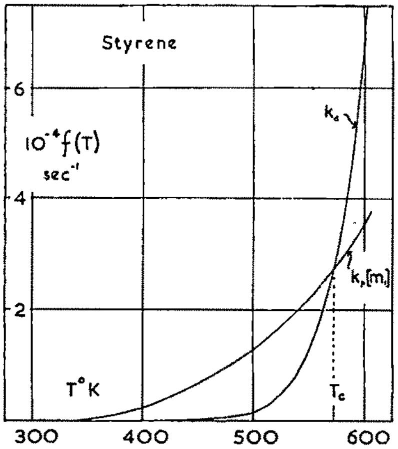

Fig. 1. Variation with temperature (T) of the propagation ($k_p[m_1]$) and depolymerization (k_d) velocities in liquid styrene. Data: $A_p = 1{\cdot}02 \times 10^6$, $E_p = 6{\cdot}5$ k.cal., $[m_1] = 8\,M$, $E_d = (6{\cdot}5 + 16{\cdot}1)$ k.cal., A_d assumed $= 10^{13}$. All in litre-mole-sec. units

of the mechanism of the initiation and termination reactions, provided the same type of product is formed, that is, A_d/A_p constant, and (4) is the temperature at which the specific viscosity of a solution of the final polymer should have fallen to zero.

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* The justification for this statement is as follows. Let the average mber of monomer units (m_1) per polymer molecule (m_r) be r, and e increment in any thermodynamic function χ per molecule of mono- er added in the propagation step be $\delta\chi_p$, per molecule of monomer tivated ($m_1 \rightarrow m_1{}^*$) in the initiation process be $\delta\chi_i$, and per polymer ain terminated ($m_r{}^* \rightarrow m_r$) be $\delta\chi_t$. Assuming $\delta\chi_p$ to be independent chain-length, the value of $\Delta\chi$, the increment in χ for 1 mole of mono- er polymerized ($Nm_1 \rightarrow \frac{N}{r}\, m_r$, where $N = 6{\cdot}023 \times 10^{23}$) will be ven by $\Delta\chi = \frac{N}{r}(r-1)\,\delta\chi_p + \frac{N}{r}\,\delta\chi_i + \frac{N}{r}\,\delta\chi_t$. For long chains, $\simeq r - 1$, the last two terms may be neglected and therefore $\chi = N\delta\chi_p$. Since $\Delta\chi$ is determined solely by the initial (monomeric) d final (polymeric) states of the system, the interesting corollary that $\delta\chi_p$ is independent of the reaction mechanism, that is, $\Delta S =$ $/A_d$, and q should have the same values whether mj^* is a radical, or is merely polarized.

(*b*) *Thermodynamic Argument.* At the ceiling temperature the reaction-rate is zero and the system is in thermodynamic equilibrium. Writing $\Delta G = 0 = \Delta H - T_c \Delta S$

$$T_c = \frac{\Delta H}{\Delta S}, \qquad (5)$$

where ΔH and ΔS refer to the change in the thermodynamic functions for the reaction carried out at the prevailing monomer concentration. If the standard state refers to unit concentration and the monomer behaves ideally, $\Delta S = \Delta S^0 + R \log [m_1]$, whence

$$T_c = \frac{\Delta H}{\Delta S^0 + 2{\cdot}3R \log_{10} [m_1]}. \qquad (6)$$

Equation (6) emphasizes that T_c is characteristic of the monomer-polymer relationship only and is quite independent of reaction mechanisms, that is, whether free radicals or ions or polarized double bonds are the active centres.

The link between equations (4) and (6) is the usual one between the kinetic and thermodynamic approach to problems of reaction kinetics. On the transition state theory[8] a frequency factor $A = e^2 \frac{kT}{h} e^{\Delta S^{\ddagger}/R}$, and making appropriate substitution $\Delta S^0 = \Delta S_p{}^{\ddagger} - \Delta S_d{}^{\ddagger} = -R \log\left(\frac{A_d}{A_p}\right)$ and equation (6) becomes

$$T_c = \frac{-\Delta H}{-\Delta S^0 - R \log [m_1]} = \frac{q}{2{\cdot}3\, R \log_{10}\left(\frac{A_d}{A_p [m_1]}\right)}. \qquad (7)$$

Measurements of ceiling temperatures and heats of polymerization thus have a dual importance thermodynamically. First, they permit actual entropy changes in polymerization reactions to be determined, and secondly, if q is known as $f(m_1)$, the variation of T_c with $[m_1]$ can be used to examine any departures from ideal behaviour of monomer solutions.

(*c*) *Experimental Verification.* Existing data concerning the polymerization of single vinyl compounds do not provide a rigid test of these conclusions. There are many reasons why this should be the case. The ceiling temperature may be so high that in this temperature region the monomer may be cracked or the thermal initiation be so rapid that the photochemical reaction cannot be adequately studied separately. Nevertheless it is interesting that, taking $A_p = 1{\cdot}02 \times 10^6$ litre mole^{-1} sec.$^{-1}$, $E_p = 6{\cdot}5$[6], $A_d = 10^{13}$ sec.$^{-1}$ and $q = 16{\cdot}1$ k.cal.[9], the ceiling temperature for liquid styrene ($[m_1] = 8$ mole litre^{-1}) deduced from equation (4) is 299° C. We have found that liquid styrene sealed in capillary tubes polymerizes rapidly at 300° C., but a solution of polystyrene in the monomer depolymerizes readily at 330°. Unfortunately the absolute rates at these temperatures are too large to permit accurate verification of the existence of a maximum rate. Further experiments are projected with molar solutions of styrene for which T_c may be in the region of 220°–230° C.

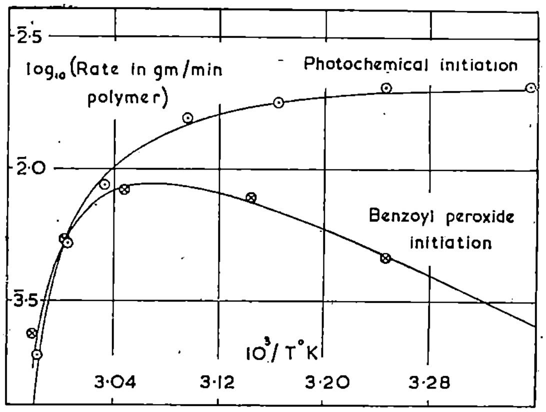

Fig. 2. Temperature dependence of the rate of polysulphone formation in mixtures containing 1 mole of 1-butene in 10 moles sulphur dioxide. ⊙ and ⊕ denote experimental observation for photochemical and peroxide initiation. Full lines represent theoretical variation .

The same principles apply to copolymerizatio reactions. In the special case of the copolymerization of sulphur dioxide and olefines[4]; points (3) an (4) in section (*a*) have been verified, and Fig. 2 show data we have obtained for 1-butene–sulphur dioxid mixtures in which the mol fraction of the olefine i 0·091. The three ceiling temperatures observed fo the photochemical reaction, the benzoyl peroxid catalysed reaction, and the silver nitrate catalyse reaction all lie in the range 62–64° C. Moreover the values obtained by the short extrapolation of th $\frac{\eta_{sp}}{c}$ *vs.* T curves are also within these limits. Suc constancy of T_c is the more striking in view of th mixed termination mechanism which is operativ and also in that the dead polymer is not reactivate in the reaction. In fact, at 77° C., 1-butene polysulphone, either alone or in the presence of radicals does not revert to reactants. Some support for thes ideas is also afforded by the work of Snow and Frey[7] who observed that the ceiling temperature varied wit the olefine used. The order of increasing ceiling temperatures (isobutene, 4° C.; 2-butene, 43° C. 1-butene, 63° C.; propylene, 87° C.) is the order o decreasing steric hindrance in the polymerizatio reaction and therefore also the probable order o increasing heat of reaction. Accurate measurement of the heats of formation of polysulphones are no in progress (see note at end, p. 707).

The detailed kinetics of the 1-butene reaction cannot be discussed here. It must suffice to say that radical with a butene end can only add sulphu dioxide and vice versa. If the corresponding frequency factors are $A_p{}^b$ and $A_p{}^s$, and for depolymerization are $A_d{}^b$ and $A_d{}^s$, it can easily be show that

$$T_c = q/2{\cdot}303 \log_{10} \left\{\frac{A_d{}^b\, A_d{}^s}{A_p{}^b\, [\mathrm{SO_2}]\, A_p{}^s\, [\mathrm{Bu}]}\right\}. \qquad (8$$

q was found from calorimetric measurements to b 22 k.cal., and hence $\Delta S = -66$ cal. deg.$^{-1}$ per mo SO$_2$ *and* butene polymerized. The full lines in Fig. corresponding to $T_c = 62{\cdot}7°$ C., imply that $\frac{A_p{}^b\, A_p{}^s}{A_d{}^b\, A_d{}^s} =$ $2{\cdot}77 \times 10^{-15}$ litres^{+2} mole^{-2}; that is, $\Delta S^0 = -64{\cdot}9$ cal. deg.$^{-1}$ per mole SO$_2$ + butene. If we assum $A_d{}^s = A_d{}^b = 10^{13}$ sec.$^{-1}$, then $A_p{}^s A_p{}^b = 3 \times 10$ litre^2 mole^{-2} sec.$^{-2}$. This latter value is not unreaso ble for the product of the two (probably unequal) propagation frequency factors and should be compared with the value of 10^{12} litre^2 mole^{-2} sec.$^{-2}$ for the product of two successive (equal) propagation requency factors in styrene.

We wish to express our thanks to the Royal Society and the Chemical Society for grants made in aid of this investigation.

Note added in proof, October 4, 1948.—We have now obtained direct experimental verification of oints (1) and (2) in section (*a*). Thus, in 1-butene polysulphone formation T_c depends on [Bu][SO$_2$] xactly as predicted in equation (8); the heat of eaction for 1-butene is 22·0 ± 0·7 and for 2-butene s 20·5 ± 1·7 k.cal., indicating that the lower T_c for the latter is due to the smaller q, as suggested. (We are indebted to Mr. D. G. L. James for help with he adiabatic calorimetry.)

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Tobolsky and Mesrobian, *J. Amer. Chem. Soc.*, **67**, 785 (1945); *J. Polymer Sci.*, **2**, 463 (1946); Tobolsky and Blatz, *J. Phys. Coll. Chem.*, **49**, 77 (1945).

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Details will be published elsewhere.

The ceiling temperature phenomenon in the copolymerization of sulphur dioxide and olefines was discovered in 1938 by Snow and Frey[7]. The cause was then unknown.

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UNIVERSITY OF BERGEN

THE University of Bergen was opened on August 30 by the Crown Prince of Norway. At the same time three hundred new students were matriculated and welcomed.

The University of Bergen starts with three faculties, namely, mathematics and natural sciences, humanities, and medicine. It will be further built up in accordance with plans prepared by a committee for the University, which forwarded its proposals to the executive body so long ago as 1939.

The Faculty of Mathematics and Natural Sciences and the Faculty of the Humanities are being developed from the old and well-known institution, the Bergen Museum, whereas the Faculty of Medicine based on the municipal hospitals and the State gynæcological hospital in Bergen. From August 30, 1948, these different institutes are associated together a common scientific institution, the University of Bergen.

The Bergen Museum already had ten different departments, eight of which now belong to the Faculty of Mathematics and Natural Sciences. These departments are the following: (1) Zoology, professorship for the moment vacant. (2) Mineralogy and geology, Prof. N.-H. Kolderup. (3) Systematic botany, with a botanic garden, Prof. K. Fægri. The collections belonging to these departments are kept in the old main building of the former Bergen Museum. A biological station built in 1927 at Herdla the neighbourhood of Bergen is associated with e Department of Zoology. (4) General botany, Prof. O. Hagem. (5) Chemistry (and biochemistry), Prof. T. Gaarder. In the Geophysical Institute, which was built in 1928 in the neighbourhood of the main building of the Bergen Museum, three different departments have laboratories, offices and workshops: (6) Oceanography, Prof. H. Mosby. (7) Meteorology, Prof. C.-L. Godske. (8) Cosmic physics with terrestrial magnetism, Prof. B. Trumpy. According to the plans of the committee of 1939, the Department of Cosmic Physics will take over the duties of a Department of Physics at the new University. Two new institutes are now being built in the neighbourhood of the Geophysical Institute. According to present plans, these buildings will be completed and come into use during the session 1949–50. They will provide laboratories, offices and workshops for the Departments of Chemistry, General Botany and Physics.

It may be mentioned that on the initiative of O. Dahl and B. Trumpy a laboratory building for nuclear physics has just been completed to plans drawn up by them. In the near future it is hoped to begin work on the installation of a 1·8-MeV. van de Graaff generator and a 50-MeV. betatron in this building. The Institute of Nuclear Physics, which has been built by the aid of funds not appearing in the University budget, will nevertheless in the future be the property of the University.

Funds for a professorship in mathematics have been granted from the beginning of the year 1948–49; and an appointment will be made in the near future.

At the present time, the Faculty of the Humanities consists of two departments only. The corresponding departments of the former Bergen Museum, namely, the Department of Archæology (Prof. Johs. Böe), with valuable collections relating to the old history of Norway in the new Museum (1927), and the Department of Norwegian Philology (Prof. O. Skulerud), have been taken over unchanged by the University.

A professorship in philosophy is vacant; a new professor will be appointed in the near future. For the moment, a number of temporarily appointed instructors are lecturing on different subjects belonging to the Faculty of the Humanities, as, for example, philosophy, Latin, general philology, phonetics, and different living languages such as Norwegian, English, French and German. It is to be hoped that the Norwegian Government will encourage the rapid development of the new University by establishing the necessary new teaching posts in the Faculty of Mathematics and Natural Sciences, as well as in the Faculty of the Humanities.

As mentioned before, the Faculty of Medicine is based upon the municipal hospital in Bergen—Haukeland Sykehus—and the State gynæcological hospital in Bergen. The instruction of medical students started at these hospitals in 1946 as a subsection of the Faculty of Medicine of the University of Oslo. From August 30, 1948, the section in Bergen has been working as an independent faculty at the new University.

Medical studies in Bergen will for the present be purely clinical. Instruction in the pre-clinical subjects will temporarily be given only at the University of Oslo. Indeed, the institutes of anatomy and physiology in Oslo have a considerably greater capacity for instruction than the clinical departments; consequently the extension of the possibilities of clinical studies by the foundation of a Faculty of Medicine at Bergen had become very desirable.

The departments of the Faculty of Medicine at the University of Bergen are as follow: gynæcology and obstetrics (Prof. J. Lövset); pathology (Prof. E. Waaler); surgery (Prof. H. Gade); clinical medicine (Prof. H. Rasmussen); dermato-venerology

(Prof. I. Rokstad); psychiatry (Prof. F. Rud); bacteriology (Prof. Th. M. Vogelsang); roentgenology (Prof. S. N. Bakke). Instruction is also given in pharmacology, orthopædics and hygiene.

On July 9, 1948, an act creating the University of Bergen was sanctioned by the King's order in council. It was decided that the University, during a transition period, should be governed by a temporary senate, consisting of: Prof. B. Trumpy, Rector of the University; Prof. E. Waaler, dean of the Faculty of Medicine; Prof. N.-H. Kolderup, dean of the Faculty of Mathematics and Natural Sciences; and Prof. Johs. Böe, dean of the Faculty of the Humanities.

B. TRUMPY

RULES OF ZOOLOGICAL NOMENCLATURE

DURING the thirteenth International Congress of Zoology, which closed in Paris on July 27, the International Commission on Zoological Nomenclature, holding its first meeting since the close of the Second World War, put forward a comprehensive programme for the reform and development of zoological nomenclature. All the thirteen meetings held by the Commission were open to all the members of the Congress, who were thus enabled to take an active part in the discussion of the proposals put forward by the Commission. As a result it was possible not only to obtain decisions on a much larger number of questions than would otherwise have been practicable, but also to ascertain much more readily the needs and general wishes of zoologists. The scheme finally adopted was approved unanimously by the Section on Nomenclature and, on the recommendation of the Section, by the Congress itself at its final plenary session.

Prior to the opening of the Paris meeting, extensive discussions had been undertaken by the Commission with leading scientific institutions and individual specialists in different parts of the world, with the double purpose of drawing up a scheme which would ensure for the Commission the highest possible representative and international character, and would secure that at the Paris meeting all practicable measures should be taken to improve and develop the *Règles Internationales de la Nomenclature Zoologique.*

Measures taken to secure a fully representative and international character for the Commission. Hitherto the International Commission has had a fixed membership of eighteen commissioners, but in future there will be no fixed upper limit to its membership, though the number of eighteen will be retained as the minimum membership. Under the new system it will be possible therefore for the zoologists of any country in which any considerable body of zoological work is being carried out to have direct representation on the Commission. The change now made will make it possible also for the Commission to call to its membership leading specialists in particular fields irrespective of country. Machinery is at the same time provided for consultation with the leading scientific institutions in any country in regard to the selection of its representative on the Commission.

Measures taken to reform the procedure of the Commission. The extensive series of changes in the procedure of the Commission are designed to secure that in future the Commission shall be able to reach decisions much more rapidly than has been possible in the past. The most important single reform is the abandonment of the *Liberum Veto* under which either 'during a meeting or when business is conducted by correspondence a single member of the Commission could prevent any decision being taken by the Commission either in the formulation of recommendations for the improvement of the *Règles*, or in the use of the plenary powers given to the Commission to conserve zoological names which are in common use but are technically defective. Other reforms agreed upon are designed to eliminate all unnecessary delay in the consideration of nomenclatorial problems submitted to the Commission by specialists. It is hoped that under this revised procedure it will normally be possible for the Commission to promulgate its decision on any question put to it within eighteen months of the date of the application.

Reform and development of the Règles. At the opening of the Paris meeting, the *Règles* in force were substantially the same as those which had been adopted at the Congress of Zoology held in Berlin in 1901. The object of the reforms now agreed upon is to clarify the text of the *Règles*, which experience has shown to be in many cases obscure, to make the *Règles* more comprehensive by introducing provisions on questions not hitherto included in that instrument and, where necessary, to introduce changes into them in order to bring their provisions into harmony with general wishes. By these means it is hoped to retain everything that experience has shown to be valuable, to eliminate all those passages which have been found to be unsatisfactory, and to meet the needs of zoologists by the introduction of provisions on matters which have hitherto not been subject to international regulation.

Codification of the international law on zoological nomenclature. A large part of existing international law on zoological nomenclature is to be found not in the *Règles* themselves but in "Opinions" rendered by the International Commission acting in the judicial capacity entrusted to it by the International Zoological Congress at Boston in 1907. The complex body of case law which has thus grown up over the last forty years has made the task of zoologists extremely difficult. A wide welcome will therefore be given to the decision now taken in Paris to codify the law by incorporating in the *Règles* themselves the decisions hitherto embodied only in the "Opinions" of the Commission. Another reform of great practical value is afforded by the decision to record in special schedules attached to the *Règles* the decisions taken by the Commission in particular cases. With regard to decisions to be taken by the Commission in the future, these will be of either of two kinds: (1) decisions on matters of principle which will be issued as *Declarations* and take the form of proposed amendments to be incorporated in the *Règles* after approval by the next Congress; and (2) decisions on individual cases which will be issued as *Opinions* and which after the next Congress will be inserted in the appropriate schedule to the *Règles.* Thus the Commission intends to ensure that in future a zoologist will be able to find the whole body of international law in regard to zoological nomenclature within the covers of a single volume.

Preparation and promulgation of the revised substantive French text of the Règles. Recognizing the highly technical problems inevitably involved in the preparation of a substantive text giving effect to the numerous changes which have now been agreed upon e Congress, on the advice of the Commission, cided that this task shall be entrusted to jurists fore whom the decisions of the Congress will be id; the text prepared by the jurists will be sub- itted to the members of the Commission for final proval; the task of considering any drafting points hich may emerge from the foregoing consultation s been entrusted to a special Committee of three, nsisting of: Mr. Francis Hemming (United King- m), secretary to the Commission; Dr. van Straelen elgium) and Prof. Robert E. Usinger (United ates).

Contrasted provisions for dealing with old names d new names. The *Règles* in their amended form ll come into operation immediately they are omulgated. In the meanwhile, arrangements are ing made for the publication as soon as possible of e *Procès Verbaux* of the Commission during its aris meeting in the Commission's *Bulletin of Zoo- gical Nomenclature*. In general, it will be found that, order to ward against the risks involved in retro- tive legislation, the provisions relating to names ready published are simpler and less rigorous than ose to be applied to names to be published in the ture. From now onwards workers giving new ames will have at their disposal rules which are mple, clear, and easy to operate. The position as gards names already published—and especially mes published before the introduction of the *Règles* fty years ago—will necessarily be rather more mplicated. It is hoped, however, that, as regards neric names, these difficulties will be largely over- me by a rapid and substantial extension of the Official List of Generic Names in Zoology", for nder the arrangements now agreed upon, a name ce placed on this List is not to be changed for any rely nomenclatorial (as contrasted with taxonomic) ason without the prior approval of the International mmission. A similar provision has been made in gard to the trivial names of species, and for these so there has now been established an "Official List" names which are not in future to be changed for rely nomenclatorial reasons without the prior proval of the Commission. The establishment of ese two "Official Lists" makes it possible for ecialists in any group to concert proposals for bmission to the Commission for the insertion on ese "Official Lists" of the names of the genera and ecies in their group and thereby to protect those mes from changes for any reason other than xonomic considerations.

Value of preliminary studies on particular problems. e work of the present meetings was greatly assisted two important matters by the decision taken at the evious Congress (held at Lisbon in 1935) that before e present meeting a detailed study should be made two important questions of nomenclature which d been a cause of difficulty for many years. In ch case the reports so submitted to the Paris eetings provided the basis for an agreed settlement. e first of these reports was concerned with the eaning of the expression "nomenclature Binaire" as ed in the *Règles*: in this case the Commission and e Congress have agreed to substitute the expression omenclature binominale" for the expression referred above, subject to the incorporation of safeguards generic names published by "binary" though t binominal authors. The second of these reports s concerned with the problem of the nomenclature forms of less than subspecific rank, a matter on ich no provision had hitherto been made in the *Règles*. In this case also the report submitted provided the basis for an agreed settlement. The Commission and the Congress have been so much impressed by the value of this procedure that they have now agreed that similar reports should be prepared for consideration at the next Congress in regard to other difficult problems, including (1) the treatment of family names; (2) the nomenclature of orders and higher groups; (3) the rules which should govern the emendation of names and (4) the problems presented by the demand for the recognition of 'neotypes'.

Settlement of outstanding individual cases. Owing to the War and other causes, the Commission at the beginning of the Paris meeting were confronted with heavy arrears of work in connexion with individual applications submitted by specialists in different parts of the world. During the recent meeting decisions were taken on almost all these cases, and these decisions will be promulgated in the near future.

The outlook. The effect of the reforms in the *Règles* instituted during the Paris meeting will be to provide zoologists with a system of law which will be much easier to operate and will ensure stability and uniformity in the nomenclature. At the same time the reforms in the constitution of the Commission and its procedure will assure to zoologists a central authority in regard to all matters relating to zoological nomenclature far more representative and international than ever before and, as such, capable of providing a service more extensive and of much greater value than has been possible at any previous time.

FRANCIS HEMMING
(Secretary to the International
Commission on Zoological Nomenclature)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 1

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. K. Linderstrøm-Lang: "Enzymatic Breakdown of Proteins, II".*

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Mrs. F. N. Betts: "Innermost Assam" (Kodachrome films with commentary).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. B. Brown: "Soil Mechanics and the Practical Engineer".

Tuesday, November 2

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. Z. Young, F.R.S.: "Process of Learning in Octopus".*

CHADWICK PUBLIC LECTURE (in the Sir Edward Meyerstein Lecture Theatre, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1), at 2.30 p.m.—Mr. Wyndham E. B. Lloyd: "The Prevention of Tuberculosis, with special reference to Environment".*

ROYAL ANTHROPOLOGICAL INSTITUTE (joint meeting with the INTERNATIONAL AFRICAN INSTITUTE, at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mrs. G. M. Culwick: "An Investigation into the Diet of the Zande of the Sudan".

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 5.15 p.m.—Discussion on "Some Statistical Problems Arising in Genetics" (to be opened by Prof. J. B. S. Haldane, F.R.S.).

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS AND RADIO SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. F. C. Williams and Mr. T. Kilburn: "A Storage System for use with Binary Digital Computing Machines".

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Prof. P. M. S. Blackett, F.R.S.: "The Atomic Age—The Military Consequences of Atomic Energy".*

INSTITUTE OF METALS, SOUTH WALES SECTION (at University College, Singleton Park, Swansea), at 6.30 p.m.—Mr. Ivor Jenkins: "Controlled Atmospheres in Non-Ferrous Metallurgy".

Textile Institute, Midlands Section (joint meeting with the Derby Textile Society, at the Midland Hotel Derby), at 6.45 p.m.—Mr. H. Halkyard: "Processing of Acetate Rayon".

Chemical Society, Eire Branch (at University College, Dublin).—Prof. H. J. Emeléus F.R.S.: "The Production and Uses of Radioactive Tracers". (To be repeated on Thursday, November 4, at University College, Cork; on Monday, November 8, at University College, Galway; and on Thursday, November 18, at University College, Hull.)

Wednesday, November 3

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. W. A. Dummer: "Aids to Training—The Design of Radar Synthetic Training Devices for the R.A.F.".

Manchester Metallurgical Society (joint meeting with the Local Section of the Institute of Metals, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. N. P. Allen: "Recent Developments at the National Physical Laboratory".

Society of Public Analysts and other Analytical Chemists (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Scientific Papers.

Thursday, November 4

Physical Society, Acoustics Group (at the Royal Society of Arts, 6 John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Discussion on "Concert Hall Acoustics" (to be opened by Mr. Hope Bagenal).

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Miss Audrey U. Smith: "Some Antigenic Properties of Mammalian Spermatoza"; Mr. H. McIlwain: "Metabolic Charges which form the basis of a Microbiological Assay of Nicotinic Acid".

Chemical Society, Sheffield Branch (joint meeting with the University Chemical Society, in the Chemistry Department Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. W. T. Astbury, F.R.S.: "The Electron Microscope and some Recent Discoveries with it in the Field of Macromolecules".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. J. Erroll, M.P., and the Lord Forrester: "Some Projects favourable to Direct-Current Transmission, and the Role of the British Electrical Industry in relation Thereto".

King's College (in the Department of Civil, Mechanical and Chemical Engineering, Strand, London, W.C.2), at 5.30 p.m.—Prof. S. J. Davies: "Heat Pumps and Thermal Compressors".* (Further Lectures on November 11, 18 and 25.)

Royal Institute of Chemistry (at the Technical College, Brighton), at 6 p.m.—Dr. K. G. A. Pankhurst: "Protein-Detergent Complexes and some of their Uses in Industry".

Leeds Metallurgical Society (in the Chemistry Department, The University, Leeds), at 7 p.m.—Dr. R. Genders: "War-time Metallurgical Developments in Great Britain".

Textile Institute Yorkshire Section (at the Technical College, Keighley), at 7 p.m.—Mr. R. J. Steele: "The Mystery of Colour".

Friday, November 5

Association of Applied Biologists (in the Botany Lecture Theatre, Imperial College of Science and Technology, London, S.W.7), at 2 p.m.—"The Insecticidal Properties of Certain Organo-Phosphorus Compounds".

Physical Society (in the large Physics Theatre, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Extraordinary General Meeting; at 5.10 p.m.—Scientific Papers.

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5 p.m.—Prof. G. Levi: "Relations of Interdependency between the various parts of the Nervous System in the Embryo and in the Adult".* (The Lecture will be delivered in French.)

Society of Chemical Industry, Manchester Section (joint meeting with the Local Sections of the Chemical Society and the Royal Institute of Chemistry, at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Prof. J. Read, F.R.S.: "Studies in Australian Plant Chemistry".

Paper Makers' Association, Technical Section, Northern Division (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. G. G. Taylor: "Colour Measurement".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. G. Butler: "Bee Behaviour".

Saturday, November 6

Royal Institute of Chemistry (joint meeting with the Institute of Physics and the Institute of Metallurgists, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 10 a.m.—"The Origins and Prevention of Laboratory Accidents".

Geologists' Association (at Chelsea Polytechnic, Manresa Road, London, S.W.3), at 2.30 p.m.—Annual Re-union.

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mrs. F. N. Betts: "The Zemi Nagas—the Life of an Assam Hill Tribe" (with film).*

Institution of Chemical Engineers, North-Western Section (joint meeting with the Chemical Engineering Group of the Society of Chemical Industry, at the College of Technology, Manchester), at 3 p.m.—Mr. J. Leyland: "The Cooling of Circulating Water for Coolers and Condensers".

APPOINTMENTS VACANT

Applications are invited for the following appointments on before the dates mentioned:

Head (male) of the Poultry Department, and Teacher (fema in Dairying, for the Ulster Dairy School (for girls), Cookstown, C Tyrone—The Establishment Officer, Ministry of Agriculture, Stormon Belfast (November 6).

Educational Psychologist by Middlesex County Council Educ tion Committee for Ealing—The Borough Education Officer, Castlebar Road, London, W.5, quoting F.22.T (November 8).

Assistant Lecturer in Phonetics—The Registrar, The Un ersity, Leeds 2 (November 9).

Civilian Lecturers (2) in the Department of Physics a Electrical Engineering of the Royal Naval College, Greenwich—T Secretary, Admiralty (C.E. Branch), Whitehall, London, S.W (November 12).

Principal Scientific Officer or Senior Scientific Offic (Mineralogist), and a Principal Scientific Officer (with Fi or Second Class Honours degree in chemical engineering, or in engine ing with corporate membership of the I.C.E., or in science or math matics with post-graduate study in chemical engineering), at t Ministry of Supply Research Establishment, Harwell—The Secreta Civil Service Commission, Scientific Branch, 27 Grosvenor Squa London, W.1, quoting No. 2304 (November 12).

Lecturer in Applied Mathematics—The Registrar, Univers College, Southampton (November 13).

Alan Johnston, Lawrence and Moseley Research Fellows —The Assistant Secretary, Royal Society, Burlington Hou London, W.1 (November 15).

Lectureship in Chemistry, with special qualifications in physi chemistry—The Secretary, The University, Aberdeen (November 1

Lectureship in Physical Chemistry—The Secretary, The Un ersity, Aberdeen (November 15).

Assistant Lecturer in Physics, and an Assistant Lectur in Geography—The Registrar, The University, Manchester (November 19).

Assistant Lecturer in Geography—The Registrar, The Un ersity, Nottingham (November 19).

Lecturer (Grade III) in Chemistry—The Registrar, Queen Ma College, Mile End Road, London, E.1 (November 22).

Laboratory Technician with knowledge of simple biochemi procedures and also of electrical apparatus—The Professor of Surge Queen Elizabeth Hospital, Birmingham 15 (November 30).

Imperial Chemical Industries Fellowship tenable in the Durh Division or the Newcastle Division of the University of Durham The Registrar, University Office, 46 North Bailey, Durham (Nove ber 30).

Professor of Veterinary Science at Makerere College, Kampa Uganda—The Secretary, Inter-University Council for Higher Edu tion in the Colonies, 8 Park Street, London, W.1 (November 30).

Lecturers (2) in Physics at the Natal University College (o lecturer in the Department of Physics at Pietermaritzburg, and o lecturer in the Department of Experimental Physics at Durban) The Secretary, Association of Universities of the British Commo wealth, 32 Woburn Square, London, W.C.1 (December 1).

Lectureship in Economic Statistics in the Faculty of Econom at the University, Sydney—The Secretary, Association of Universit of the British Commonwealth, 32 Woburn Square, London, W. (December 31).

Assistant Biochemist—The Medical Superintendent, Dud Road Hospital, Birmingham 18.

Scientific Assistant—The Director, Commonwealth Bureau Horticulture and Plantation Crops, East Malling, Maidstone, Kent.

Senior Assistant in Dyeing and Textile Chemistry at t Technical College—The Director of Education, Town Hall, Bradfo

Senior Lecturer in Chemistry—The Clerk to the Governo Chelsea Polytechnic, Manresa Road, London, S.W.3.

Assistant Experimental Officer in the Bacteriologic Department, to assist with investigations into mastitis in dairy co —The Secretary, National Institute for Research in Dairying, Sh field, Berks.

Lecturer in Physical and Inorganic Chemistry at Brigh Technical College—The Education Officer, 54 Old Steine, Bright

Laboratory Steward in the Science Department of the C stantine Technical College—The Director of Education, Middlesbrou

Technician with special experience in hæmatology, a Gene Laboratory Technician, and a Histological Technician, for Department of Pathology and Bacteriology—The Secretary, We National School of Medicine, 34 Newport Road, Cardiff.

Chair of Geology—The Registrar, The University, Nottingham

REPORTS and other PUBLICATIO

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 846: Part 3: 1948. Burettes and Bulb Buret Part 3: Burettes with Pressure-filling Device and Automatic Z Pp. 14. (London: British Standards Institution, 1948.) 2*s*. net.

John Murray Expedition, 1933–34. Scientific Reports, Vol. 9, No. Report on the Echinoidea of the Murray Expedition, Part 2. By Mortensen. Pp. 16+1 plate. (London: British Museum (Nat History), 1948.) 5*s*.

Diptera of Patagonia and South Chile. Part 6, Fascicule 6: Acal trata, Key to the Families of Acalyptrata. By John R. Mall Pp. 491–500. (London: British Museum (Natural History), 19 2*s*.

B.I.O.S. Overall Report No. 6: Some Agricultural Aspects Germany during the Period 1939–1945. Pp. 12. (London: H Stationery Office, 1948.) 4*d*. net.

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SCIENTIFIC RESEARCH AND MAN-POWER

THE address which Mr. Herbert Morrison, the Lord President of the Council, delivered to the Conference of Industrial Research Associations on October 15 (see *Nature*, October 23, p. 645) should be studied carefully by all who are concerned with the conduct of scientific research and, in this time of stringently limited man-power, with the most effective distribution of the available scientific man-power between industry, the universities and the Government services in Britain. The development of the industrial research associations, with which the Lord President was ostensibly concerned, cannot wisely be considered apart from the general research effort of the country. As the recent report of the Advisory Council on Scientific Policy indicated, approximately ten per cent of the qualified scientific workers engaged in Great Britain's research effort are already employed by the research associations. At the present time, any appreciable increase in their numbers must be at the expense of those employed in research in industry, in the universities or in other Government departments.

Mr. Morrison, in referring to the Government policy of encouraging the establishment of research associations and the assurance given three years ago that Government support would not be withdrawn after an initial stage, said that the Government had been very much impressed by the results being obtained by some of the research associations. Last year, their total expenditure was close on £2 millions, as against £470,000 in 1938, and the total estimated for next year is £2·5 millions. Even allowing for the general rise in costs, the effort has more than doubled, and there are now thirty-eight research associations as against twenty-one in 1938 ; while the formation of others is expected in the near future. He hoped that the Conference would lead to even bigger developments.

Through all the examples of the work of the research associations which Mr. Morrison cited as having particularly impressed the Government runs the thread of increased productivity, or the increase of industrial efficiency by the saving of fuel and of labour. The Lord President seems to regard the research associations primarily as valuable contributors to the increased industrial productivity by which alone Great Britain can hold its place in competitive world industry. Further, his speech indicates approval for greater encouragement of the study of man in relation to the machines he has to operate—a matter in which, as Sir Henry Tizard pointed out in his presidential address at Brighton to the British Association, industry has lagged far behind the Services. It might, indeed, be inferred from his speech and from the increased attention being given by the research associations to what is known as 'operational research', as judged by examples recently quoted, that an increasing proportion of their effort will be directed to the study of the human aspects of production and economic and sociological problems, as distinct from those physical problems to which their original effort was almost exclusively devoted.

It is not disputed that the particular technique developed in war-time under the name of 'operational research' and long since employed in progressive industry in its technical service to customers may have large potentialities. Both the need and the opportunity for such methods might possibly diminish, however, if we could secure the more effective utilization by industry—and by the State—of existing knowledge. Mr. Morrison frankly recognized that a large part of the problem of increasing productivity and industrial efficiency lies in securing the utilization of the results of past research as well as of that at present proceeding, and he indicated the readiness of the Government to use whatever resources are at its disposal to see that proved processes and equipment developed by the research associations should not be left unutilized.

Nevertheless, although the Lord President stressed the importance of those engaged in research having full opportunity to know what are the problems of industry, and above all, the needs of users and consumers of industrial products—and, indeed, asked whether the opportunities in the research association movement for co-operation between all engaged in industry are being fully taken—he did not stay to discuss the fundamental question whether that was or was not due to any inherent defect in the research association idea itself. He did inquire whether there is enough in industry of the approach and interchange which characterized the development of equipment for the Armed Forces, and he also asked whether there are enough scientific workers employed in industry helping to get the best of the scientific results which are already available. He also dwelt at some length on the importance of scientific interpreters and liaison officers, and of encouraging, in every way possible, contacts and exchange of visits between scientific men and industry.

There is, indeed, a large field for co-operative effort where the research association, as Mr. Morrison indicated, may pay handsome dividends in terms of productivity and the saving of materials and labour. It is by no means established, however, that the research associations can compare with the research departments of industrial firms in the development of those new products and processes which place British industry ahead and not just abreast of its rivals in the world markets, and which, as Sir Henry Tizard reminded us, are the product of the work of very few men.

What needs to be considered much more closely is how best that spirit of enterprise and inventiveness can be fostered. Mr. Morrison touched on many important factors and indicated some of the means by which industry in Great Britain could recover some of the ground lost in the development stage to such countries as the United States. He said little, however, to show that he appreciated the importance of the really fundamental research in which Britain excels, and on which in the long run industrial advance is based.

Some of that work is being carried out by th research associations, and some of it in the laboratories of leading industrial firms. By far the greate part of it, however, is proceeding in the universit laboratories; and the questions that have to b faced, before and not after any considerable expansion of the research associations, are: first, will suc expansion affect adversely the fundamental researc at the universities, now seeking to make up for th lost years of war? And secondly, will such expansio yield higher dividends in creative work as well a productivity than a corresponding expansion o industrial research laboratories themselves, or if not then some alternative form of co-operative research such as the Mellon Institute type? In the presen man-power situation we cannot expand all thre types indefinitely; we must attempt to establis some order of priority based on an impartial critica survey.

In this speech, for all the appreciation of the valu of scientific research which it shows, Mr. Morriso passes over the seriousness of the man-power situation. Research workers, he said, must have th resources and status they need to keep up the flo of new and improved products, and he welcomed th improvement in the status and conditions of Britis scientific workers. He also stated that the Government has now decided that a larger share of buildin resources must be made available for the equipmen of research and other institutions likely to contribut to raising the productivity of industry.

That will be welcome news to some firms, whos plans for expansion and development have bee restricted by lack of such facilities, and by the polic laid down in the White Paper last spring. It must b remembered, however, that the major difficult experienced by the larger and the smaller firms alik is the recruitment of first-class men for research an development; and particularly from the universit schools of chemistry. If in consequence some firm who have recently been imbued with the resear spirit are driven to recruiting men of inadequa standing for their new research departments, the ne enthusiasm of those firms is likely to be damped, ar still more as the results may well fall short expectation.

Such factors may well lie outside the field of su a conference as that addressed by Mr. Morrison, b they should not be overlooked by one who carries large a share of responsibility for determining t distribution of the scientific effort of Britain at time when expansion in any one direction of necessi involves curtailment elsewhere. Nor can he w afford to disregard those factors which, like co ditions of service, may influence as profoundly Government policy the distribution of scienti workers in particular occupations. Quite apart fr the distribution of, say, the available chemists, b chemists and physicists between industry, academ research, the research associations and Governme departments, has any real thought been given, fr the national point of view, to the effect of unbalanc expansion of university departments of medicine comparison with their other scientific departmen or of the wide disparity in the inducements offered to the graduate in medicine as compared with those received by the chemist, biochemist or physicist ?

It is true that industry itself might well do something to redress that balance by the evolution of financial incentives, possibly of the invention-bonus type ; but those responsible for the scientific and industrial policy of the Government can no more ignore such considerations in determining the future of the research associations than they can the effect on the universities themselves of the conflicting and unco-ordinated pressures for expansion, on which the recent statement from Nuffield College on "The Problem facing British Universities" commented so pointedly. Dr. C. J. T. Cronshaw's remarks on this ubject to the Society of Dyers and Colourists in Bradford on October 7 should be noted in this onnexion, as should those of Sir Ian Heilbron at the nnual dinner of the Association of British Chemical Manufacturers on October 13.

A short-term policy which concentrates on securing the more effective utilization of existing knowledge may, as Sir Henry Tizard suggested in his presidential address to the British Association, be our immediate need from the point of view of increasing productivity and restoring the industrial health of Great Britain. In that policy the research associations have clearly a part to play, and the policy will simultaneously encourage the continuous application of science to ndustrial practice. That, however, does not mean utting research into the second place ; and such a hort-term policy must not be pursued at the expense f a long-term policy designed to ensure the nation a ufficient supply of scientific men and technologists in every sphere and to provide them with the equipment and resources they require. A long-term policy f that type can only be evolved as a result of the pen-minded study of the effectiveness of particular nstruments for our purpose, such as the research ssociations, in comparison with other methods. A esolute attempt must be made to decide where and ow creativeness and inventiveness are best fostered, and an impartial and continuing appraisal made of he demands of industry, the universities and the overnment services, and the interactions of those emands.

To achieve a reasonable balance is no easy task, ut no more urgent task awaits the Advisory Council n Scientific Policy than such a fundamental and mparative inquiry into the research association ovement in relation to other forms of co-operative d industrial research. Sir Henry Tizard, it would pear from his presidential address to the British ssociation, is ready to make that attempt ; the rd President of the Council might well support ch a task, for no other way seems so likely to tablish the best means by which during the next w critical years our limited resources in scientific an-power and equipment may be deployed so as to eld the quickest and largest return in productivity d in new and improved products. The inquiry uld not be an easy one ; and the evolution of a licy on the basis of its results could be undertaken ly at the highest levels.

ANTI-CANCER DRUGS

Approaches to Tumor Chemotherapy

A symposium of Papers and Discussions on various Aspects of Tumor Chemotherapy, developed from the Summer Meetings of the Section on Chemistry (C) of the American Association for the Advancement of Science at Gibson Island, Maryland, 1945–1946. Edited by Forest Ray Moulton. Pp. x + 442. (Washington, D.C.: American Association for the Advancement of Science, 1947.) n.p.

THE historical introduction to this series of papers is by the *doyen* of American cancer research, W. H. Woglom, who with brilliant lucidity and charming modesty of style describes the use of the innumerable agents of mineral, plant, animal or synthetic origin which have figured in the untiring attack on malignant disease by chemotherapy. He believes that hormone therapy has given the first hopes of ultimate success.

Algire discusses the method that he has developed of introducing a transparent chamber into a skin flap of the mouse, enabling the vascularization of transplanted tumours, or the regression of a tumour undergoing treatment with bacterial polysaccharide, to be observed. No doubt the method is a triumph of technique; but the photomicrographs are not very informative to the uninitiated and there is nothing startling about the discovery that the blood vessels rapidly develop to cope with the new growth ; further, is it really necessary, to-day, to introduce an illustration of a photomicrographic camera ?

Kopac's article is on "Cellular and Surface Chemical Aspects of Tumor Chemotherapy" ; it is no easy task to find one's way through the thirty pages of complicated laboratory data and question-begging hypotheses. His thesis seems to be that one group of chemotherapeutic agents acts by selective nucleoprotein dissociation. Although there are references to selective destruction of neoplastic cells *in vitro* by these compounds, no mention is made of the results of tests *in vivo*. It is to be feared that some hiatus was discovered between physico-chemical hypothesis and biological facts.

Aptekman uses an alcoholic extract of transplantable rat tumour to destroy grafted tumours in other rats; but his extract contained about 20 per cent alcohol which alone, apart from tissue constituents, could scarcely have been encouraging for the growth of the tumour.

Turner and Miller's paper on "The Chemistry of Substances Specific for the Stimulation of Lymphopoiesis and Myelopoiesis" describes the investigation of agents present in the urine of patients with myeloid leukæmia which produce myeloid metaplasia in the organs of experimental animals. Heinle, Hirschmann and Wearn also write on the myeloid metaplasia factor in human urine; but their work is obviously unfinished, for they state : "This issue obviously is not decided by the fact that the protein fractions prepared from various urines show great differences in biological activity. These observations, however, could suggest that the active principle in these fractions may possess the degree of structural specificity that one expects to find in a regulatory hormone." These two papers deal largely with the biochemistry of the substances from urine which influence the myeloid tissue ; on the other hand, the discussion which followed the papers centred around the interpretation of the pathological changes in the injected animals.

Tannenbaum, in his paper "Role of Nutrition in the Origin and Growth of Tumors", puts forward the evidence for his thesis that, in mice, a 60 per cent calorific restriction inhibits the development and reduces the incidence of spontaneous mammary cancer, and also retards the formation of induced skin, subcutaneous and lung tumours by hydrocarbons. Such experimental results are supported by statistical data from insurance companies which indicate that overweight human subjects are particularly liable to cancer.

Opie, in "Influence of Diet on the Production of Hepatic Tumors induced by *p*-Dimethylaminoazobenzene", states that a rice diet facilitates tumour formation, and that kidney and liver in the diet inhibit it, as do also riboflavin and nicotinic acid. A low-protein or high-fat diet was favourable to tumour production, whereas a high-protein or low-fat diet effected some retardation. Diets that protect against cirrhosis also protect against neoplasia; but tumours can arise in the absence of cirrhotic changes.

A group of papers by Lewisohn, Laszlo, and C. and R. Lenchtenberger, taking up, with discussion, sixty-eight pages, on "Chemotherapeutic Regressions of Transplanted and Spontaneous Cancers in Mice", deals with the use of the *L. casei* factor (folic acid) as inhibitor. Their results are severely criticized in papers by Sugiura and by Zahl and Hunter, who find no convincing evidence that this substance does, in fact, inhibit tumour growth.

A historical account is given by two descendants of William B. Coley of his treatment of malignancy by bacterial toxins. There follows a series of papers (45 pages) by a large group headed by Shear, bearing the resounding title of "Some Aspects of a Joint Institutional Research Program on Chemotherapy of Cancer: Current Laboratory and Clinical Experiments with Bacterial Polysaccharides and with Synthetic Organic Compounds". Unfortunately, this monument of organisation and industry has not as yet yielded chemotherapeutic results of proportional significance. One is tempted to ask whether it is really necessary to reproduce a photograph of a small bottle bearing the legend, "Sterile solution of polysaccharide prepared for clinical use. Sterile cotton plugged needle, inserted through the outer region of the rubber stopper, extends into the bottle."

More than a hundred pages are devoted to a number of papers on nitrogen mustards (chloro-ethylamines) for the treatment of lymphomas, leukæmia and allied conditions. The energy expended in these investigations and in the preparation for publication must have been immense; nevertheless, the opinion has been expressed by some authorities that the mustards are not superior to X-rays in the treatment of these types of malignancy.

Huggins, in an admirable paper of four and a half pages, describes the "Antiandrogenic Treatment of Prostatic Carcinoma in Man"; more space might have been given to an account of this valuable contribution to tumour chemotherapy. Reinhard and Womach describe the application of radioactive phosphorus to the treatment of leukæmia, Hodgkin's disease and polycythæmia, of which only polycythæmia is benefited by this agent.

The two papers by British investigators, Haddow and co-workers, and Parry and Innes, dealing with the use of urethane in the treatment of lymphatic and myeloid leukæmia, lead to the conclusion that the drug certainly has a temporary ameliorative effect on the disease; but unfortunately the improvement is not maintained.

Engelbreth-Holm and Stamer's paper is on the somewhat heroic treatment of leukæmia with the most powerful carcinogen (9 : 10-dimethyl-1 : 2-benzanthracene); one of the patients was still alive eighteen months after treatment.

Geschickter and Reid contribute an account of the use of oil-soluble organo-metallic compounds in malignancy; iron, cobalt, copper, manganese and nickel were given in the form of fatty-acid–phthalate derivatives. Leukæmias responded favourably to these substances, as they do indeed to other drugs and radiations.

Much of this book, or rather collection of papers, makes tedious reading, for a large part consists of detailed technicalities somewhat distantly related to the aim expressed in the title. It is doubtful if the verbose accounts of laboratory or clinical findings will interest any but the pure specialists, which may help to explain why the verbatim reports of the discussions which followed the papers are nearly always more interesting than the papers themselves.

I. Hieger

TESTING PETROLEUM HYDROCARBONS

Standard Methods for Testing Petroleum and Its Products

Ninth edition. Pp. xlviii + 616. (London: Institut of Petroleum, 1948.) 31*s*.

THE first edition of "Standard Methods" appeared in 1924, initially at the instigation of Sir Boverton Redwood and following labours of the pionee committee under Prof. Brame. During the ensuing twenty-four years the volume has steadily grown i stature and authority; once again, in this ninth edition we recognize a mandate for laboratory procedure which for long past has commanded international respect. As is the case with preparation o other 'standards', whether governing quality o materials or guiding methods by which that quality is assessed, few realize the enormous amount of wor put in voluntarily by specialists representing every possible angle of the subject concerned. Standardization committees are notoriously time-consuming bodies, and this particular case has clearly been n exception; apart from the main committee, no les than sixty-two sub-committees, panels and working groups, involving some two hundred and sevent experts, contributed to this considerable task, an it may be said at once that it has been worthil discharged.

Naturally the technician familiar with previous issues of this volume will want to know wherein differs from its predecessors. Only two method have been withdrawn, namely, acetate content o solvents and halogen content in lubricating oil. Th new methods comprise determination of chlorine i lubricating oil, knock-rating of aviation fuels (ric mixture), lead, copper and iron in lubricating oil, oil separation on storage of grease and spectrograph analysis of inorganic constituents of ashes; this la is a welcome inclusion of a technique now so free employed in inorganic analysis.

Revision of existing methods affects the corrosi test for lubricating greases, diluent content of cran case oils (Diesel fuel diluent), distillation of cut-ba bitumen and road oil, ignition quality of Diesel fuel, knock-rating of aviation fuels (weak mixture), knock-rating of motor fuel, penetration of greases and petroleum, saponifiable matter, smoke-point and unsaponifiable matter in drying oils. Some minor alterations concern thermometers employed in determination of specific gravity ('I.P. 46W. Gravity Balance') and specific refractivity ('I.P. 45W. Refractometer').

The format of this volume follows much the same pattern as the eighth edition. Both arrangement and indexing reflect great credit on the editorial sub-committee and permanent officers of the Institution concerned. No one involved in routine investigation of petroleum and its products can afford to be without this latest "Standard". H. B. MILNER

CHEMISTRY OF ACETYLENE

The Chemistry of Acetylene and related Compounds

By Ernst David Bergmann. (Polytechnic Institute of Brooklyn: Lectures on Progress in Chemistry.) Pp. vii + 108. (New York and London: Interscience Publishers, Inc., 1948.) 18*s*.

THIS book is the latest representative of a series of short lecture-monographs. The title would seem to be rather grandiloquent for a work of this type; but, in fact, the author has managed to consider, albeit superficially, most of the reactions and transformations of this important class of organic compounds.

The first lecture enumerates the thermodynamical and physical data connected with the triple bond and also deals with addition to acetylenes, the 'iso-acetylene' hypothesis and the reactions exhibited by compounds containing the ethynyl group. The second discusses the addition of nitrogen compounds to acetylenes and then proceeds to give an admirable précis of the researches of Reppe. The work of the Weizmann school is described a little over-enthusiastically; but this is perhaps natural in a publication by one of its members. This latter section serves a useful purpose in making available the results of this school in a form for easy reference; hitherto they have been scattered throughout the patent literature. Many tantalizing references to unpublished work are mentioned; in particular, one awaits with coniderable interest the details of the vapour-phase somerization of dimethylethynylcarbinol to β-methylrotonaldehyde. The last lecture describes the nature of the condensation catalyst employed by the Weizmann school and continues with a discussion of cetylenic polymers, including vinylacetylene and *yclo*octatetraene; the book ends with a brief account of naturally occurring triply-bonded compounds. References are amply provided throughout.

The book is written in a highly personal manner, nd many of the mechanisms accepted by the author must be considered to be still *sub judice*. The style on the whole clear and concise, although irritating edantries occasionally occur (for example, the use of 'analogon' for the far more usual 'analogue'). Over-compression has rendered one sentence (p. 88) completely beyond comprehension. The author ucceeds in conveying the spectacular synthetic possibilities of the acetylenic compounds and the imulating experience of working in this field.

R. A. RAPHAEL

THE ANODIZING OF ALUMINIUM

Werkstoff Aluminium und seine anodische Oxydation

Ein Handbuch und Ratgeber für den Praktiker. Von Dr. Max Schenk. Pp. 1042. (Bern: A. Francke A.-G., 1948.) 138 Swiss francs.

ALTHOUGH information on the technical reinforcement of the oxide film on aluminium and its alloys is to be found in papers in scientific publications, articles in trade journals, and patent specifications, it is often difficult to trace, and books on the subject are not numerous. The issue of Dr. Max Schenk's book, dealing with the subject comprehensively and critically, and written by an author having a wide knowledge of the processes involved, is therefore to be welcomed. It is primarily intended for the practical man, but is no mere compendium of technical processes and applications. Dr. Schenk holds the view that to understand the processes involved, to operate them successfully, and to make full use of the product, requires considerable knowledge of the chemistry and physics of aluminium and its compounds, coupled with some acquaintance with the various processes of fabrication to which the metal may have been subjected. The book accordingly comprises two sections, approximately equal in length, the first dealing with the structure, properties, and fabrication of the metal, and the second with the chemical and electro-chemical processes used to produce coherent oxide films and with the properties and applications of the product.

The first quarter of the book is devoted to the metallography and fabrication of aluminium and its alloys, and covers constitution, casting, rolling, heat-treatment, forming and methods of jointing. The descriptions of the processes are short but adequate, and the treatment is essentially practical. Thus figures and diagrams are given showing the effect of alloying and of processes such as cold working and heat treatment on the structure and properties of the product, while current theories on these subjects are given in outline but are not discussed at length. Stress is laid throughout on the behaviour of the product during anodizing, special attention being given to the effects of variations in processing conditions and of faults during fabrication. Useful tables are included giving the compositions and properties of commercial cast and wrought alloys, though so far as British alloys are concerned the list is by no means complete. Recommendations are also made for optimum working and annealing conditions, and for solution and precipitation treatments in the case of the heat-treatable alloys.

The next part of the book is devoted to general chemical theory, particularly electrochemistry, and is followed by an account of the chemistry of aluminium and its compounds. This section is comprehensive, clearly written, and well illustrated; and the chapters on the formation and properties of the oxide film should lead to a clear understanding of the technical processes and applications of anodizing. The section dealing with the chemical behaviour of aluminium and aluminium alloys towards various reagents includes no less than sixty-three pages of tables. The chapters on corrosion are detailed and lucid; but their value is lessened by the fact that research by other than German workers has been largely ignored.

The next section of the book, dealing with technical methods of forming the oxide film, opens with a short but excellent account of the purely chemical processes, followed by a description of the nature and properties of films formed in various electrolytes under the application of direct or alternating electric current. The treatment is lucid and comprehensive, covering both theory and practice, and serves as an excellent introduction to a very detailed account of the commercial anodizing processes. This covers pretreatment, plant installation, operating conditions for various electrolytes, and after-treatments such as sealing, dyeing, and impregnation with inorganic pigments. Practical difficulties, whether arising from faults in the material or from errors during anodizing, are dealt with at length, and information is given on plant and process control, and on the testing of the product. The sections on process control are excellent; but those on testing leave something to be desired. Physical tests on anodized material are adequately described; but for assessing liability to corrosion, only accelerated tests such as the Mylius are considered, and nothing is said about their reliability. For chemical control of the metal to be anodized, the reader may be led to infer that qualitative spot tests are generally sufficient and that full quantitative analyses are rarely needed.

Applications of anodized aluminium in household ware, architecture, instrument-making and chemical plant are critically described, with reasoned statements on the most suitable type of film for each purpose. The book concludes with a chapter on the cost of plant, operation and upkeep.

The printing, binding and quality of illustrations leave nothing to be desired, even by pre-war standards, and one can only regret that the book is not in English and that the price is so high.

H. W. L. PHILLIPS

TAXONOMY AND EVOLUTION OF COTTON

The Evolution of Gossypium

And the Differentiation of the Cultivated Cottons. By J. B. Hutchinson, R. A. Silow and S. G. Stephens. Being the Final Report of the Genetics Department, Cotton Research Station, Trinidad, B.W.I. Pp. xi + 160. (London, New York and Toronto: Oxford University Press, 1947.) 15*s*. net.

THE function of the Empire Cotton Growing Corporation is to assist in the promotion of cotton-growing in the various countries of the British Empire or Commonwealth. This aim is largely realized by close co-operation with the local governing authorities in the various territories, by carrying out a wide programme of research designed to maintain or improve the quality of the crops and to increase yield by selection and initial expansion of new seed stocks, by overcoming and circumventing pest and disease attack, and by effecting improvements in many aspects of tropical and sub-tropical crop husbandry. The Corporation started a main Cotton Research Station in Trinidad in 1926 and encouraged fundamental studies in botany, plant physiology and genetics so that cotton breeders would have firmer foundations for their work on the commercial cotton crops. The increasing complexity of many modern problems necessitates a considerable extension in this side of the work of the Corporation. The Trinidad Station has been closed and a new, larger station is being established in Uganda, where closer contac with the field-workers in Africa may be made.

The transfer of activities from Trinidad to Ugand has caused a temporary but unavoidable halt i many activities. The joint authors of the book unde notice have therefore taken this opportunity t review the progress made while they were working a a team in the Genetics Department in Trinidad, an to survey many lines along which future researc could be usefully directed. Many of the authors detailed investigations have been published separatel from time to time. The present work reviews th genus *Gossypium* as a whole by covering its classification, evolution and present position on a basi broadened by critical use of much published work o other workers. For convenience, the book is divide into four main sections.

"The Wild and Cultivated Cotton Plants of th World" (1907), by Sir George Watt, is the almos classical monograph on the taxonomy of cotton. I the light of more recent advances in the field o genetics and cytology, coupled with morphologica considerations, Hutchinson has revised the classification of the genus on a simplified basis, dividing i into eight sections, of which two contain the cultivated commercial cottons and six embrace the wil species.

The evolution of cotton is covered by Hutchinso and Stephens. Consideration is given to the identification of the major factors which governed th evolution of true 'commercial' cottons from the wild and often virtually lintless, species. The origi of first the Old World cottons, with the basic chromosome number in the genus of $n = 13$, and then th New World cottons, with $n = 26$ chromosomes comprising a set of thirteen homologous with th genom of the cultivated Old World species and a se of thirteen homologous with that of the wild America species, will prove of interest to many ethnologist as well as to biologists.

These evolutionary studies are pursued further b Hutchinson and Silow in the third section, which covers the differentiation of cotton, as the spinne knows it, into the complex of major and minor type by man.

In the last section, Hutchinson and Stephens consider how new characters arise and the part playe by polyploidy. Brief consideration is given to th nature of genetic variability and to the question o its often desirable conservation when it may ai adaptation to varied local conditions. Many of th views expressed should be of both practical an general interest to breeders working on the presen commercial types.

No doubt individual workers in the genetics c cotton may disagree in part with particular view held by the authors; but agreement will be gener that a work of this type was long overdue, and tha it will facilitate adequate interpretation of the man contributions made in this field in recent year From the angle of the textile technologist, the basi groundwork of cotton genetics may seem to be matter of academic rather than of practical interes Nevertheless, only fundamental studies in the fiel mentioned above will make it possible to effec major improvements in the present cottons of commerce by the formation or transference of desirab fibre characteristics, by inducing immunity to diseas or resistance to pest attack, or by obtaining increase yields through greater adaptability to varied growt conditions.

E. LORD

Physics

For Students of Science and Engineering. By Asst. Prof. William H. Michener. Pp. x+646. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 25*s.* 6*d.* net.

THIS is a text-book, of about intermediate standard, in which physical principles are illustrated more fully than usual by examples from everyday life. The author claims that he has tried to encourage the student to think for himself, and o this end has used the device of mentioning phenomena without explaining them. It is doubtful whether this device is successful. For example, the problem of a ping-pong ball supported on a jet of air (p. 135) is not one that the student should be expected to work out for himself; nor is that of the oncentration of the scattering by a diffraction rating into one particular order (p. 353). Topics such as these are best omitted completely in an ntermediate text-book.

Some of the diagrams are rather poorly drawn. On p. 343, for example, a lens system is shown with ll the deviations produced at a single surface of each lens. On p. 364 a ray of light is shown being dispersed into three representative rays at one surface of a prism, these three then emerging from the other surface *parallel to each other*. Further, these parallel rays are caused to diverge by a converging lens! Such diagrams place the serious tudent at a disadvantage with respect to the casual eader.

In short, this text-book has some serious faults and does not appear to have any particular points to ommend it in competition with the many others that exist.

Soilless Growth of Plants

y Carleton Ellis and M. W. Swaney. Second lition, revised and enlarged by Tom Eastwood. p. x+277. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 28*s.* 6*d.* net.

HYDROPONICS, or soil-less culture, has made considerable progress during the last ten years, specially in America and in areas where heat and rought make it difficult to produce vegetables under rdinary conditions of soil cultivation. While the rst edition of Ellis and Swaney's book catered ainly for the amateur or general reader, Eastwood's vision deals largely with the commercial side. This vision has been so drastic that little of the original xt remains; but there is no indication of this in he foreword or elsewhere, thus failing to give due redit to the original authors.

Many types of equipment have been developed for ub-irrigation and gravel culture methods, and in scribing these, Eastwood indicates the weak, as ell as the strong, points of the outfits, with the robable causes of failure where initial success has ot been followed up in later work. Specially valuable e the practical working details for procuring the ecessary chemicals, making up and analysing the utrient solutions and the care of the apparatus eded. Plants grown in soil-less culture are not mmune to many of the common pests and diseases, is too often believed, and precautionary methods gainst them are suggested.

With the growing interest in soil-less cultures, this vision should be of much value to scientific workers, mmercial growers and amateurs alike, as its insistence on practical details should help to overcome many of the difficulties inherent in the method. As a work of reference it should also play its part in the considerable advances that may be expected in hydroponics in the course of time. W. E. B.

The Ventilation of Bee-Hives

By E. B. Wedmore. Pp. 116. (Petts Wood: Bee Craft, Bracken Dene, Manor Way, 1947.) 7*s.* net.

MR. WEDMORE has done a further service to beekeepers by bringing together, discussing and criticizing in his latest book the available data on the subject of hive ventilation. This is a subject to which Mr. Wedmore has devoted considerable time and on which he speaks with authority. It is, of course, of the very greatest importance to a proper understanding of those conditions which are necessary to ensure satisfactory living conditions for colonies of hive-bees both in winter and summer.

The reader will be left in no doubt that the conclusions reached from analysis of the data on hive ventilation, which have so far been obtained, clearly support the application of the relatively spartan methods of wintering bees which are to-day advocated almost unanimously by the leading authorities both in Europe and in North America. It is of interest to students of beekeeping practice to note that these methods, which are still regarded with suspicion by some beekeepers, were employed and recommended by leading beekeepers so long as fifty years ago.

Besides discussing such matters as the form of the winter cluster, air currents within the hive, the disposal of water and carbon dioxide, and temperature control, the author also discusses such a practical matter as hive design.

This is a most stimulating book not only on account of the interesting analysis of the data presented but perhaps even more because of the gaps in our knowledge which such analysis discloses.

C. G. BUTLER

Genetics

By Dr. H. Kalmus, in collaboration with Lettice M. Crump. (Pelican Books, A.179.) Pp. 171. (Harmondsworth: Penguin Books, Ltd., 1948.) 1*s.* 6*d.*

GENETICS is one of the youngest, yet also one of the most actively developing, branches of biology. At present neither its own theoretical structure and internal consistency nor its importance for general biology and human affairs is widely appreciated outside the immediate circle of geneticists themselves. This is in a great measure due to the lack of books giving simple accounts of the subject, particularly in its broader connexions.

Dr. Kalmus' 'Pelican' should therefore command a wide audience. It is a formidable task to compress even an outline of genetics into 171 pages, and there are inevitably omissions and over-simplifications. The author is, however, to be congratulated on his attempt to include consideration of the wider implications as well as the narrower basis, even though in places his discussion may not commend itself to all his fellow geneticists. Care is taken to explain the genetical terms used, and a short glossary is given as well as suggestions for further reading. It has, however, proved impossible to explain all the more general biological terms which are used. The book, therefore, may well prove to be of greatest value to those who already have some biological background.

MOVEMENTS OF POPULATION IN THE BRITISH COMMONWEALTH

AT the Brighton meeting of the British Association, a symposium was arranged by Section E (Geography) on population movements in the British Commonwealth. Prof. C. B. Fawcett contributed a paper on the geographical aspects of the subject; Prof. Brinley Thomas (Section F: Economics) dealt with it from the point of view of an economist; and Mr. R. R. Rawson analysed the particular problem of White settlement on inter-tropical highlands, with special reference to Kenya and Rhodesia.

Prof. Fawcett introduced his analysis with the main facts about the distribution of population in the Commonwealth. He described it as the least densely peopled of the major political units of the world. More than half the total area consists of the arctic or sub-arctic regions of Canada, or the arid and semi-arid zones of Australia and South Africa. The Dominions, the total area of which covers about one-seventh of all the inhabited land, contain not more than one-fifteenth of the good agricultural land of the world. England, with its 40 million people on 50,000 square miles of land, that is to say, about 800 persons a square mile, is the most densely settled country in the world. The striking unevenness of the distribution of the population of the Commonwealth raises the question whether the younger Dominions are under-peopled.

In considering this very topical problem, Prof. Fawcett saw reason to approve measures such as the 'White Australia' policy. He stressed that any 'foreign' minorities which remain distinct communities in the population tend to lessen its social and political unity, and that the acute colour problems in South Africa and the United States are an object-lesson which justify Australians in their determination to keep out races difficult to assimilate. Prof. Fawcett doubted whether the economic effects of immigration are the most significant ones. To quote his words, "the colour problems of the United States and the communal differences of India are sufficient evidence that the world has not yet reached the level of civilization in which a plural society, with wide cultural or racial difference between its component communities, can form a satisfactory social or political unit of free people".

Prof. Fawcett cited with approval the following estimates of the probable populations which the Dominions could support at the present standards of living: Australia, 30–50 million; Canada, 60–100 million. In Australia the increase could be brought about in three ways: by closer rural settlement in the well-watered areas, expansion of tropical agriculture in the east coastal areas of Queensland, and industrial development based on mineral resources, especially coal. Britain could not be expected to supply agricultural migrants, in view of the drive to grow more food at home. Similarly, while full employment continues, there would be little chance of a large-scale transfer of industrial workers. After referring to the effect of social security and the demographic consequences of the pre-war fall in the birth-rate, Prof. Fawcett concluded that any considerable migration would accentuate the change in the balance between the lower and upper age-groups.

The next paper, "The Economics of Commonwealth Migration", was read by the present writer. The argument may be summarized as follows. Despite all the efforts made to people the Dominions wit migrants from Britain, there was a net overflow o population from the British Empire to the rest o the world amounting to 5·9 million in the year 1836–1900 and 250,000 in the period 1901–36. O the ten million British people who crossed the sea in the half-century 1845–1894, 68 per cent went t the United States, 16 per cent to Australia and New Zealand, and 12 per cent to Canada.

What were the main determinants of thes migration movements ? First, there was a shar difference between the relative quantities of factor of production in the Old World and in new countries the marginal productivity of labour overseas wa much higher than it was in Europe. Secondly capital exports tended to be accompanied by migration of labour. The last great burst of emigration from Britain coincided with the absorption of considerable volume of capital by Canada, when th Prairie Provinces were being opened up in the earl years of this century. Thirdly, the *direction* of th flow of British emigrants was strongly influenced b the contrast between the high degree of equality o opportunity in the United States and the clas barriers in Great Britain. Under the influence of th ideas of Edward Gibbon Wakefield, British colonization policy was designed to reproduce in the overse dependencies the social structure of the homelan It met with little success because the facts in th Colonies were too strong for it. It was the discover of gold, not the colonization theories of Whitehal which gave a real impetus to the growth of Australia

The inter-war period was dominated by the drasti immigration restrictions introduced by the Unite States in 1924. The consequences were far-reachin Agricultural protectionism was stimulated in Europ and capital from the United States was encourage to flow to the Old World, since population wa prevented from migrating to America. In these ne circumstances the Empire settlement policy launche by the British Government led to disappointin results. The net amount of British emigration to th Empire fell from 113,000 in 1922 to 63,000 in 1929 and during the thirties the stream actually turne the other way, Britain receiving an *inward* balan of 126,000 migrants from the Dominions.

A cardinal weakness of the ideas underlying th policy of peopling the Empire was the failure realize that Britain was no longer able to expo capital on the appropriate scale. Moreover, a sign ficant change was taking place in the econom relationship between agricultural and industri countries. As the Western world became richer, greater proportion of income was being devoted amenities, and a smaller proportion to necessitie hence the growth of employment in personal service distribution, entertainment, etc. Despite this tren Empire migration policy continued to be based extensive land settlement in the Dominions. Th objective was not consistent with the new directi which was being given to the productive forces the Western world by the rising level of affluence.

Against this background, the paper proceeded an analysis of the bearing of migration on the curre economic crisis, the hypothesis of a planned trans of population for strategic reasons being left out account. Large-scale emigration would weaken t lower age-groups which contain the most producti labour. It would be accompanied by an export capital which would accentuate Great Britai difficulties. In 1947, a year of severe crisis in t balance of payments, no less than a third of the toll on British reserves was caused by export of capital, a good proportion of which consisted of emigrants' funds and money invested in Dominion securities. Moreover, by accentuating the scarcity of man-power in industries where the shortage is already keen, emigration tends to promote inflationary pressure.

The policy best calculated to help Britain overcome the crisis is one which would welcome appropriate grades of immigrants from the continent of Europe. A high rate of immigration makes up for a low degree of internal mobility. The argument that these newcomers would be a strain on the British economy since they have to be fed and housed does not bear analysis. They are prepared to work in industries producing the most essential output—coal, textiles, food—and they are accommodated in existing premises. The value of the marginal product of immigrant labour of this kind much exceeds the cost of the imports and capital equipment needed for its employment.

Finally, there is the long-run question whether Britain can hope to sustain a population of fifty million at anything like the old standard of living when outside help is no longer available. Much will depend on the future course of the terms of trade. There are strong reasons for taking a pessimistic view. The industrializing of agricultural countries will tend to reduce exports of food from these countries. A study of the stages through which the United States has passed is instructive. In poor countries like India, the peasants may sell less of their crops on the market as the price improves; they will wish to consume more themselves. Then, the principle of 'fair shares' in the allocation of food as between rich and poor nations augurs ill for the highly industrialized countries like Britain. These tendencies operating unchecked mean a continuance of dear food for the British people: whether this can be masked indefinitely by a policy of internal subsidies is questionable.

On the other hand, it may be that the world is on the eve of a great advance in the application of science to crop production. Moreover, the long-term trend in consumption habits noted in the inter-war period may yet reassert itself. The most reasonable expectation is that the terms of trade for Britain will fall somewhat from their present level, but will never again reach the favourable ratio experienced between the two World Wars. If the people respond to this stern challenge by increasing and rearranging their productive power, there is no reason why a tolerable equilibrium cannot be found for a population of fifty million. There need be no mass emigration.

In the third paper in the symposium, Mr. R. R. Rawson considered in detail the factors determining White settlement in Kenya and Rhodesia. Looking to the future, he saw signs of a more considerable White settlement in East Africa for strategic reasons; but in view of the lack of mineral resources in Kenya, such a plan would entail linking Kenya with the coal and iron deposits of Rhodesia.

The open discussion ranged widely over the ground covered by the three papers. One of the questions treated in detail was the future of the terms on which Britain can expect to purchase imported food. Reference was made to the views of authorities in other Sections of the British Association, who had pointed out that the effective supply of food could be greatly increased if the heavy loss due to destruction by vermin could be partly eliminated. It was significant to observe the attention devoted to the food problem in this symposium, as in other sessions during the British Association meeting at Brighton. On the question of the White Australia policy, a representative of Section H (Anthropology) disagreed with Prof. Fawcett and argued that the difficulties of assimilating coloured peoples must not be shirked. Finally, I had the feeling that Prof. Fawcett's suggestion that Australia could increase her population to 30–50 million, and Canada to 60–100 million, was much too optimistic. A careful assessment of the probable economic trends seems to be necessary before such estimates can be put forward with any confidence.

BRINLEY THOMAS

PHYSICAL CHEMISTRY OF PROCESS METALLURGY

THE discussion on "The Physical Chemistry of Process Metallurgy", which the Faraday Society held at Ashorne Hill, Warwickshire, during September 23–25, showed plainly that process metallurgy is now as much the province of the physical chemist as the metallurgist. Attention at this meeting was devoted almost entirely to the high-temperature processes involved in the winning and refining of metals, and here in particular it seems that advances will come mainly from the application of physical chemistry. Indeed, speaking as a steelmaker, Sir Andrew McCance (Colvilles, Ltd.) confirmed, in his introductory remarks, that the advances in the open-hearth process over the past twenty years have come almost entirely from the physico-chemical approach to open-hearth reactions. In this article it is intended to touch only upon the main topics of physico-chemical interest. In so short a space it is impossible to consider all the problems discussed, and reference will not be made to those papers concerned with industrial applications.

After an opening paper by Sir Charles Goodeve (British Iron and Steel Research Association), outlining the physico-chemical principles of special importance in this field, the subject was considered in three main sections: metallic solutions; roasting and reduction processes; and slags and refining processes. In addition, a number of papers dealt with the problems associated with experimental work in the important temperature-range between 1,000° C. and 2,000° C. The main difficulty in handling substances at these high temperatures is finding refractory containers which will not react with them. Almost all substances become chemically reactive in such extreme conditions, since high activation energies for molecular processes are no longer seriously restrictive. Another less obvious problem, which has caused large errors in the results of many equilibrium studies between gas mixtures and metals or slags, is thermal diffusion. This is caused by the large temperature gradients which are generally unavoidable in any apparatus operating under these conditions. The heavier components in the gas mixtures used diffuse away from the hot zone, and so set up concentration differences in the apparatus which may be maintained even under steady flow conditions. These differences can be avoided by combining adequate preheating of the incoming gas with a flow-rate sufficient to prevent any significant concentration gradients from becoming established. They can also be greatly reduced, as shown by Mr. M. N. Dastur and Prof. J. Chipman (Massachusetts Institute of Technology) in a paper dealing specifically with the problem, by the addition of a heavy inactive gas, such as argon, to the mixture.

The present state of our knowledge of solid metallic solutions is rather different from that of liquid solutions. For solid solutions we frequently have a structure which has been determined precisely by X-rays, and an exact knowledge of the conditions under which one structure becomes unstable relative to another. As pointed out by Dr. R. M. Barrer (Bedford College, London), simple spatial considerations, such as the ratio of the radius of the interstitial atom to that of the metal atom, lead to a reasonably clear understanding of the type of structure which will be assumed. In contrast, our knowledge of the chemical potentials of solutes in such solid solutions is fragmentary, to say the least. In the liquid state the reverse is the case; for, as Prof. Chipman showed, there are now a reasonable number of such solutions for which the thermodynamic data are satisfactory. On the other hand, we have no exact model for our liquid solution, and can only suppose that it differs from the solid mainly due to the relaxation of spatial restrictions, brought about by melting. This accounts, of course, for the marked increase on melting in the solubility of substances present as interstitial atoms; but this very relaxation makes it difficult to interpret the marked effect of one solute on the activity of another, as described in the papers by Prof. Chipman and by Dr. J. A. Kitchener, Dr. J. O'M. Bockris and Mr. A. Liberman (Imperial College, London).

From the point of view of process metallurgy, kinetic aspects are mainly of interest at low temperatures in the solid state. At high temperatures, diffusion usually controls the rate for processes involving solids, and convection for those involving liquids. This can readily be appreciated when it is remembered that at 1,600° C., for example, no less than one collision in 10^6 is energetically suitable for an activation energy of 50 kilocalories, as compared with one in 10^{14} at 500° C. The most commonly investigated property of solid solutions is the diffusion of solute atoms in the metal lattice. The property most frequently measured, however, is the movement of the solute through a thin sheet of metal; but this, as Dr. Barrer stressed, is often governed more by surface processes than by lattice diffusion. A good example was provided by Sir Charles Goodeve and Mr. K. H. Jack (British Iron and Steel Research Association), who reported that the slowest step in the evolution of nitrogen from an iron–nitrogen alloy (the ε phase of the iron–nitrogen system) is the combination of pairs of nitrogen atoms at the surface. In the presence of hydrogen gas, which appears to render this combination process unnecessary, the evolution is 10^4 times faster, and lattice diffusion becomes rate-determining to some extent.

The value of thermodynamics in the design of metallurgical processes was brought out strongly in the section on roasting and reduction. Its application is particularly important in the reduction of refractory oxides for winning such metals as magnesium, titanium and vanadium. A good example was provided by Prof. L. M. Pidgeon and Dr. J. A. King (Toronto), who reported their studies of the equilibrium:

$$2MgO + 2CaO + Si\,(Fe) = Ca_2SiO_4 + 2Mg_{(g)} + (Fe).$$

This is the basic reaction for the Pidgeon process, which was used in Canada during the War for making magnesium from dolomite and ferrosilicon. The pressure of magnesium developed by this reaction at 1,200° C. is 19 mm., as compared with 1·9 mm. for the reaction,

$$4MgO + Si = 2Mg_{(v)} + Mg_2SiO_4,$$

which was investigated in Germany in 1940. The reason for the difference lies, of course, in the far more negative free energy of formation of the calcium than the magnesium silicate.

The method of representation of free energy data is important for those concerned with the extractive processes. Two methods were discussed at the meeting; one the plot of ΔG° against T, which was illustrated by Prof. C. W. Dannatt (Royal School of Mines, London) and Dr. H. J. T. Ellingham (Royal Institute of Chemistry, London) in their introductory paper to this section, and the other the plot of $\log K$ against I/T, which was used by Dr. M. J. N. Pourbaix and Madame C. Rorive-Boute (Brussels) in describing a series of oxide systems. Although each method has its merits, it would seem desirable to select one as standard, since the graphical representation of collected data is certain to become of increasing importance. In the light of the discussion, the ΔG°, T plot would seem to be of more general application, since it can include data for a wide variety of systems in one diagram. With complex processes this makes it possible to distinguish at a glance the important equilibria from the unimportant, and to see how the systems change as temperature and pressure are altered.

Dr. P. Gross and Messrs. C. S. Campbell, D. L. Levi and P. J. C. Kent (Fulmer Research Institute) reported some interesting work on the thermodynamics of aluminium halides by measurements of the reaction pressures set up by equilibria of the type:

$$NaCl_{(solid)} + Al_{(liquid)} = Na_{(vapour)} + AlCl_{(gas)}.$$

Direct measurements of the pressure are not possible on account of the reactive character of the halides, so they had to adopt an unusual experimental technique. The unknown gas–solid equilibrium, together with a known one which does not interfere with it, was allowed to establish itself in an evacuated vessel closed except for a capillary outlet. This outlet served as a slow escape for the equilibrium gas mixture, which was collected in a suitable condenser on emerging from the capillary. The ratio of the unknown pressure to the known was determined by analysis of the condensate, the known pressure in this case being the vapour pressure of the alkali halide.

The primary reactions which occur in roasting and reduction processes were described by Dr. J. S. Anderson (Atomic Energy Research Establishment, Harwell) in terms of the lattice defects which can occur in ionic crystals, and particularly oxides and sulphides. For these materials the stoichiometric compound is a special case, and in general there is either a very small excess of oxygen in the lattice associated with cation holes, or excess of metal as interstitial metal atoms. In the light of this knowledge the reduction process may be considered as taking place in the following stages. First there is chemisorption of hydrogen or carbon monoxide at the surface as hydroxyl or carbonate ions, as proposed by Garner, the additional valence electrons being accommodated by lowering the valency of one or more cations and thus creating lattice defects in the surface. These defects now migrate into the lattice and increase in concentration until saturation is reached, and metal or lower oxide forms as a new phase. In roasting sulphides one would similarly expect that oxygen ions would first be formed on the surface, creating cation holes within the lattice. This would be followed by destruction of the positive holes as oxides of sulphur are eliminated, and the resultant building of oxygen into the lattice in place of sulphur. Studies of the roasting of copper sulphides by a new method reported by Prof. E. A. Peretti (Notre Dame, Indiana) are in line with his picture, for they show that the reaction proceeds directly from cupric to cuprous sulphide and finally o cuprous oxide, and not via the formation of sulphates as previously believed.

Our present understanding of liquid slags is far from adequate. This can be attributed partly to the fact that ionic melts in general have received little attention from the physical chemist, and partly to he great difficulties which arise in making controlled experiments with materials which attack containers of all types. As Dr. F. D. Richardson British Iron and Steel Research Association) pointed out, our ideas of liquid slag structures are based essentially on our knowledge of the structures of crystalline silicates, phosphates and aluminates, and the recognition that the liquid state differs from he solid mainly in lacking any long-range order. This picture is corroborated by X-ray work on silica lasses, which have been shown to consist of random networks of silicate tetrahedra with metallic cations located in the holes between them. The chemical potentials of the components of slags have in some cases been determined by slag-metal equilibrium measurements. For binary systems they can be obtained less directly from phase diagrams, and interesting results derived in this way were reported by Prof. M. Rey (École des Mines, Paris). The tandard states for some of the oxides and sulphides of importance in slags present a problem in cases uch as ferrous oxide (FeO) and iron sulphide (FeS), which can exist over wide ranges of composition depending on the equilibrium oxygen or sulphur pressures. Although failure to take account of such non-stoichiometric variations may not lead to large rrors in total free energy changes, it was stressed by Dr. G. M. Willis (Melbourne) that large errors may be caused in the partial molar free energies of components in slag melts. An ionic view of slags has been developing in recent years, and although, as Prof. E. A. Guggenheim (Reading) pointed out, it is irrelevant, so far as slag-metal equilibria are concerned, whether the various atoms or atom groupings are ionized or not, knowledge of the ionic constitution is helpful in developing a detailed model of slag melts, nd may, indeed, be of practical importance in arc furnaces. Dr. J. A. Kitchener, Dr. J. O'M. Bockris and Messrs. J. Tomlinson and S. Ignatowicz (Imperial ollege, London) reported measurements of the electrical conductivity of binary silicate melts, which indicate that the conduction is mainly ionic. It increases more than one-hundredfold at the melting point for calcium and manganese silicates, and shows temperature coefficient compatible with the view that the conductivities are due to the small, relatively mobile cations, and the viscosities to the large, relatively immobile anions.

All those concerned with the application of physical chemistry to process metallurgy owe a great debt to the Faraday Society for arranging this discussion. Apart from the stimulating effect of bringing together workers in this field from many laboratories and many different countries, it has brought the criticisms and ideas of physical chemists outside this field to those who are now working in it. It is to be hoped that the discussion will also stimulate physical chemists generally to take a new interest in the fundamentals of some of these interesting high-temperature systems.

F. D. RICHARDSON

VETERINARY EDUCATION: DEVELOPMENTS AT CAMBRIDGE

By DR. JAMES T. EDWARDS

THE address before us* breathes a freshness of outlook which bestirs the imagination of those who have watched a public awakening into the need for finding a healthy solution to a problem which, since the onset of the Industrial Revolution, and even before then, has been treated in Great Britain, to its sad discredit, with sore neglect.

This problem is concerned not only with the 'doctoring of animals', the pursuit which the ordinary member of our public associates with the designation 'vet.'. That in itself, it can never be too strongly emphasized, is an art which calls forth all the skill that is born of long and close experience, all the powers of keen and careful observation, and all the moral virtues of sympathy and kindliness which the human faculties can muster. It is an art which in the course of its long history has seen its periods of great triumph and of respect in the eyes of society, and its periods of utter debasement. Its triumphant periods have been within the histories of great empires at the height of their glory—the Buddhist, the Byzantine, and the Arab; and, let us hope, the British Commonwealth, as it is now marching to higher destiny, will be added to them. One of the worst, if not the worst and most infamous, of the periods in which the art suffered degradation was that in which the Church dominated thought and conduct in the Western world—the Dark Ages. Let us insist at once that this decline in respect for the art did not owe its origin to the Christian ethic, with its dominant note of 'charity'. Compounding for it a doctrine in which the ingredients were not incompatible with persisting Mediterranean cults and contained an infusion of neo-Platonism with some tincture of Christianity, the early Church Fathers, in their wisdom, shrewdly mindful of means of fostering moral uplift among peoples as they were at that time, founded a powerful hierarchy. This hierarchy increasingly in its interest played hard on the Platonic concept of the 'soul' as a higher state of being, which was immortal, and did not pertain to the 'beasts', which in their suffering were therefore denied both pity and mercy. (This theme has been well developed recently by the eminent French scholar and experienced veterinarian Emmanuel Leclainche in his book, "Histoire de la Médecine Vétérinaire" (Toulouse: Office du Livre, rue Alsace-Lorraine, 42; 1936).) The human physicians were hence eagerly absorbed into the Church, and their learning became that of the Church, disdaining craftsmanship and the knowledge which Plato's contemporary, Aristotle, had proved could be so richly garnered for the benefit of mankind from observation on the 'brute creation'. It was not until well into the eighteenth century that craftsmanship became elevated in esteem as a branch of the healing art with the rise of the surgeons from their lowly standing of barber-surgeons. Nothing of this sort had occurred in the older civilizations where, in the Arab Empire, for example, the arts of healing, both of man and animal, were taught side by side, with equal respect, in her great universities, from Baghdad to Salamanca.

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* Veterinary Education. An Inaugural Lecture. By Prof. W. I. B. Beveridge. Pp. 40. (Cambridge: At the University Press, 1948.) 1s. 6d. net.

After the fall of Rome, and the lapse into disuse of her magnificent road communications with the lethargy that then beset humanity, the Western world broke up into isolated communities, governed, or tyrannized, by baronial courts, the chief officials in each of which were the chamberlains, seneschals and marshals. It was to the marshals that was consigned the important office of charge of the cavalry, comprising both the management and treatment of the horses. From about the eighth century B.C., beginning in Babylonia, right up to the First World War, the use of cavalry in warfare, supplying as it did to this vital enterprise mobility and striking power, had been a main concern of rulers and States. Epidemic disease among horses, of which the chief was glanders, hampered campaigns and so encompassed gravely their existence. During the period of the Crusades, with the discovery of the art of horse-shoeing and the need for preserving cavalry on the march for long distances, a new class of menial assistants to the marshals arose who, besides acquiring proficiency in the craft of making and nailing-on (*ferrer*) iron horseshoes, were also entrusted by their masters with the more laborious duties in treatment, such as the dressing of wounds and drenching of potions. These farriers, as they came to be called, soon, in the way of human nature, supplanted their trusting, well-bred masters, the marshals, usurping as they did in France a title common to both—*maréchal-ferrant*. Doubtless among them there were to be found many observant and worthy practitioners; but, on the whole, throughout Western countries they came to be looked upon as an ignorant class recruited from the most depraved strata of the public such as the knackermen and hangmen. The brutality of their treatments, matched only by their exorbitant charges as fees, was such that, as has been well said (McFadyean, 1923), the most fortunate animals before the opening of the veterinary schools in Western Europe during the latter half of the eighteenth century were those which escaped notice by that class.

There was no dearth of good literature to be consulted, such as the remarkable symposium recorded in the "Hippiatrika" by the Byzantine hippiatrists, and emended and plagiarized in various ways throughout the Middle Ages by successive authors. Yet, strangely, the literature which was produced and obtained a large circulation, such as that of the notorious impostor, Gervase Markham (1568–1637), was of the vilest, all diseases being assigned meaningless names and little description; but, for all there was an 'infallible' cure that had been a long-guarded 'secret', and was a shameful polypharmacy calculated to assuage and exploit superstition and credulity.

An exception to this lamentable story of the West was to be seen in Spain during the days of her greatness as a world power, where the Catholic monarchs, after the expulsion of the Moors, were careful in their own interest to preserve what was best from the Arab civilization they had conquered. Among thi best was a well-educated and highly disciplined profession ministering to the domesticated animals in particular the horse, to the governing body o which profession (the *Protoalbeitariat*) they graciousl accorded their own patronage. It was not until 181 when the Spanish Cortes, meeting at Cadiz, decided in an excess of liberalism, to abolish all corporat institutions that this valuable profession becam disrupted, never again to recover its former dignit and usefulness.

Meanwhile, concern was being felt in another wa with the appallingly low state into which the healin art ministering to the animal world in the West had fallen. This concern was being felt not only by ruler and States but also by those whose interest it was t preserve the herds and flocks upon which the live and prosperity of peoples so largely depended. Fro time immemorial, recurrent waves of devastatin plagues among the domesticated animals had bee known, the most serious of these being cattle plagu (or rinderpest). As evidence of the concern of ruler may be cited that of Frederick the Great, who o return in 1767 from his Silesia campaign in the Seve Years War and fresh from witnessing the devastatio caused by cattle plague and the consequent horro suffered by the civil population, requested the Medica Faculty in Berlin to draw up plans for the openin of a veterinary school. This the professors of th Faculty did reluctantly, but added at once, almos reproachfully, that it was hoped it was not to b further expected of them to soil their hands in th carcases of beasts. The low ebb of affairs in thi respect in Britain was decried by the wise an observant physician, Sir Thomas Browne (1605-82) (Smith, F., "The Early History of Veterinar Literature and its British Development", 1, 311 1919), the author of "Religio Medici", who in hi book "Pseudodoxia Epidemica" bewailed the ignorance of the 'common farriers' to whom only recours could be had by stockowners at the time, and appeale for the raising of a new class whom he designated b a term new to the language, 'good veterinarians' Drawing on his massive classical scholarship, he ha introduced a word which was held in repute in th earlier history of Rome, signifying a cattle husbandman. The solid farming peoples from whom Rom then derived her man-power were much attached t their cattle, the older, more mature, of which (th *veterini*) they prized for their tillage, their respecte attendant being the *veterinarius*.

In Britain, concern was felt not so much by it rulers or its Government, as by the rising agricultura societies, one of which, the Odiham Agricultura Society of Hampshire, initiated the movement fo starting veterinary education in England, while, late in Scotland, the Highland and Agricultural Societ lent its powerful patronage to William Dick whe he started a school in Edinburgh in 1823.

A Board of General Officers, sitting in London i 1796, decided that the best term to use for th educated recruits drafted urgently from the Londo Veterinary College, that had been opened in 1791, fo care and treatment of cavalry and artillery horses i the Napoleonic War was 'veterinary surgeons', t distinguish them as a corps apart from the surgeon who until then had been displaying keen interest als in that work. The designation was afterward taken up enthusiastically by fellow practitione among the civil population. As the late Sir Frederic Smith (1857–1929), the meticulously accurate veter inary historian, rightly insisted, however, the designation is a misnomer, for the practitioner of the healing art among animals has ever been more of a 'physician' than a 'surgeon'. Prof. Beveridge in his address contends that the name was not "a happy choice". We may agree, to some extent, however, with Leclainche in concluding that the very lack of precise meaning in it commends it; and, further, it has a safe position in language inasmuch as most countries have introduced it into their language and so it has gained the sanction of widespread usage. The powerful sanction of usage need not, however, we can now better realize, compel ultimately refusal o employ some more explicit name when that is really needed. In Britain, for example, what was long called the Veterinary Branch of the Board (now he Ministry) of Agriculture has come to be known as the Division of Animal Health. From its foundaion in 1884, a similar great organisation in the United States has been known as the Federal Bureau of Animal Industry.

The Charter of Incorporation of Veterinary Surgeons, 1844, which gave legal recognition to the title of 'Veterinary Surgeons' as the exclusive designation of those who qualified from the veterinary colleges after passing an examination held by an elected Council of their body, was not confirmed by Statute until the passing of the Veterinary Surgeons Act, 881, when in protecting the title 'veterinary', the xclusive right to use which had been allowed to apse, a considerable body of unqualified people were brought on the register as 'Existing Practitioners'. The Act did not debar anyone, however, from undertaking veterinary practice so long as he did not use the title. In some progressive countries for a long time the veterinary profession has enjoyed the privileges of a 'closed shop', and it is one of the aims f the Veterinary Surgeons Act which has just become aw to secure the same privileges for the veterinary profession in Great Britain.

To revert to the low ebb of affairs generally preailing in Europe until well into the eighteenth century: there was, as we have seen, a widespread and periodically deeply felt need for the supply of enlightened and skilled men to control pestilence mong animals; and, as the late Sir George Newman rightly said in regard to his own calling, "pestilence as always been the opportunity of medicine". It is an opportunity, as all who have had intimate experience of the subject well know, that has to be quickly eized, for the public soon forgets once the danger is over. It has to be remembered, too, that in human medicine matters were little better, for until 1745 here was no formal medical education in England, nd thenceforward until 1782 what little that was given was imparted at private schools. Now and gain, there were forthcoming highly gifted men, without special training for the purpose, who as if by intuition divined and applied wholly appropriate measures for controlling disease. For example, in 714, Thomas Bates, surgeon to the King, by esolutely applying the model system of 'stamping-ut' contagion outlined by the Papal physician, ancisi, in 1711, succeeded in eradicating quickly attle plague from England. When about thirty ears later the disease reappeared, recurring afterwards until near the close of the century, when war revented importations of live cattle, Bates's successful experience had been forgotten or overlooked. The natural disappearance of important cattle pidemics, it may be stressed here, from Great Britain during the last part of the eighteenth century and until the beginning of the fifth decade in the nineteenth century was largely responsible for Government and organised societies losing interest for a long time in veterinary education and for its consequent falling after its inception in England in 1791 into unworthy and incompetent hands, a setback from which it never fully recovered, even to this day. James Clark, of Edinburgh, 'Farrier' to the King for Scotland, who, according to Sir Frederick Smith, may "well and truly be described as the father of Veterinary Hygiene, not only in this country but in Europe", published, in 1788, a work on the "Prevention of Disease" which is a revelation. It was doubtless the application later of the principles of ventilation to stables advocated by Clark which brought about the rapid decline of glanders and other respiratory infections in Army horses.

What is important so far as we are concerned in criticizing the work under review is—what is not emphasized in it or, for that matter, in any recent document—that the universities throughout Christendom themselves took no heed whatever of this prevailing deplorable state of affairs, for which learning and inquiry of the highest order were sorely needed. They were, on the whole, not only apathetic, but disdainful, even hostile. Several examples could be readily given if space permitted.

It was not until the twentieth century had opened that the universities awakened, and then almost everywhere in the world, to a realization that the pursuit was worthy of the exercise to the fullest of such powers as were possessed by men and women of first-rate intelligence and general education, and that they must no longer keep aloof. Of all the larger territories, Australia, at Sydney and Melbourne (though this latter school is now closed), has shown outstanding willingness to aid advance of the pursuit by its universities. But already there is much to record in the experiences of several other countries upon the association of the universities with veterinary teaching. Britain has lagged; but there have been peculiar difficulties.

How, in the meantime, veterinary education developed has been well touched upon in the address under review, and it would exceed the compass of a short article even to give a bare summary of the complicated story. The time was doubtless ripe during the latter half of the eighteenth century for it to begin, as it did, with the opening of a veterinary school at Lyons in France in 1761, and the historian can now well discern that elsewhere it made many very bad beginnings. The paramountcy of the horse, which came about with the improvement of road communications early in the nineteenth century, when the Industrial Revolution got into full swing, followed later by decline of the horse which came about early in the present century with the mechanization of road transport, have been major phenomena that have strongly impressed themselves on the trend of developments. The Agricultural Revolution, which coincided with the Industrial Revolution and largely resulted from it, is another phenomenon, the importance of which had been largely masked and ignored in veterinary developments by deflexion of interest, often entirely, to the former one of the ascendancy of the horse. What this Revolution brought in its train was a complete change in the livestock husbandry of Britain and, indeed, of almost all countries, the exceptions being those countries like India and Egypt which still employ cattle mainly as a source of motive power in agricultural operations. Otherwise, with the aggregation of large masses of people in towns which needed feeding, and with the enclosure of the commons and the abandonment of the open field system of farming, and, again, with provision for winter feeding of stock, consequent on storage of fodder and introduction of root crops, no less than the temporary absence, as already indicated, of major plagues, the cattle became transformed, largely through the genius of breeders like Robert Bakewell (1725–95) into types that were destined to meet the clamour of the towns for food, namely, meat and milk. England from being a wool- and wheat-exporting country for centuries had now new assets and new outlets, a prime asset being no longer her sheep, and wheat had to become an imported commodity of first magnitude. The invention of refrigeration, which enabled meat supplies to come from abroad, and the improvement of internal transport, so that milch cows need no longer be kept in cities, have again changed the problem confronting the veterinarian, who, paradoxically, with each succeeding change that seemed to foredoom his calling to extinction, has found himself confronted with a transformed yet ever-expanding field for enterprise.

Great triumphs lie already to his credit: in Britain, cattle plague was eradicated, after it was again introduced after a long lapse in 1865, when heed was paid at last to his counsel, so that when in 1870 it reappeared it was promptly eradicated. The legislation introduced at that time laid the foundation for State veterinary control of animal disease in Great Britain. Glanders again was eradicated in 1913; besides, nearly all the other major plagues, like bovine pleuropneumonia, rabies and sheep-pox, had by then been eliminated. Foot-and-mouth disease has been several times eradicated; but difficulties lie in preventing re-introduction with imported animal products. There remains, however, a mass of insidious disease which is very seriously limiting productivity and is sometimes a grave direct danger to man himself. Tuberculosis has become rampant among our cattle herds; but there seems no reason, particularly in the light of experience gained abroad, in the United States of America, Finland and Norway, why it should not be eradicated in time, effective legislation to bring about that result having been introduced only in 1935. Besides tuberculosis, other serious diseases affecting our dairy herds are sterility, contagious abortion, mastitis and Johne's disease, and much has been achieved already in better understanding of them and devising control. Great success has followed proper investigation, within the last three decades, of the diseases of sheep. Pig diseases are, for the most part, well in hand. In countries abroad, there have been magnificent achievements. Striking examples which may be cited are, first, in the United States, besides the suppression of tuberculosis in cattle, still earlier, following brilliant research, the eradication of Texas fever, a disease which afflicted the southern States to such an extent that economic cattle-raising had become impossible; secondly, wisely guided by the statesmanship of Botha and Smuts after the Boer War, the abundant financial resources available from the Rand were deflected without stint towards ridding the country of animal diseases which were playing havoc with its development as an agricultural country; and, in this endeavour, the successes which attended the labours of the late Sir Arnold Theiler and his disciples exceeded all anticipation.

Knowledge in nearly all departments has so far advanced within the last few decades that we can discern more clearly wherein skill of the kind that is to be derived from a sound veterinary education can be placed at the service of humanity. First, advances in nutritional science have been enormous, and they indicate plainly that a large proportion of the human race lacks adequate and proper feeding without which there must be physical deterioration inescapably predetermining mental and moral enfeeblement. The stage at which this must be rectified is at the earliest, from conception, the pregnant and nursing mother and young offspring being highly vulnerable towards inadequacy of dietary constituents comprising especially first-class protein and several other substances the richest source of which are milk, eggs, butter, cheese and other products of animal origin. A standard of living needs to be attained, therefore, at which there shall be no lack of these ingredients, and animal life consequently needs to be safely and economically propagated to meet all requirements. At present animal life in the world falls very far short of being safe or fully economic to the producers.

Secondly, what to the anthropologist or archæologist has been a minute span of human history, namely the period since the Industrial Revolution, has been fraught with enormous changes in the relationship of man to his environment, and ecologically it is a grav question whether the powers of any species, including the human species, for readjustment can withstand the strain of such a drastic change. Symptomatic probably of the strain in adjustment is a phenomenon that has come prominently into veterinary experience and, incidentally, proved pecuniarily remunerative namely, the craving of the urban classes, from the humblest to the richest, for professional attention upon their household pets—dogs and cats. This source of revenue has more than compensated the professio in England for the disappearance of the horse, and during the interval between the two world wars when Government allowed agriculture to lapse almost into a state of insolvency so that farmer could not easily pay for veterinary attention, th newly opened source must have saved the veterinar profession itself, as to a very fair proportion of it members, from dire financial straits. Some soci historians have emphasized that the migration o the rural population of England into the town after the Industrial Revolution was an unmitigate evil, in so far as childhood experience then was no passed, as it had been immemorially, in clos relationship with the numbers of other species whic the ecologist finds essential for the continuance o any species. All that, of course, awaits inquiry b workers in the several branches of the social science One cannot but be impressed in a country like Egypt where the great masses of the people—the *fellahee* —persist still in a state akin to that of pre-Industri England, with the serenity of countenance tha generally characterizes those masses, compared wit the strained, almost tormented, expressions of thos inhabitants in the few large cities who are emulatin the present urban luxury standards of the Wes The maintenance of a numerous and healthy rur population everywhere may therefore prove on prop investigation to be the highest achievement of gov statesmanship in the present troubled state of th world; and, interspersed among that population guide it, will be needed numerous veterinarian Countries like Holland, Switzerland, Hungary an the Scandinavian countries generally have perceived things already in that way and made provision for veterinary education at, State expense, out of all proportion to what was expended on the "starved and neglected" (to quote departmental committee reports) veterinary colleges in Great Britain in the past.

If one proceeds to make a proper 'job-analysis', then it will be found that to turn out veterinarians to meet the transformed and expanding situation the final objective of the necessary training is three-fold, being concerned with, first, clinical practice ('the doctoring of animals'); secondly, preventive medicine (or public control of the pestilences, grave or insidious, of the kind already mentioned); and thirdly, livestock husbandry and economy (of no less public significance than the former divisions and essential to neet the social circumstances as they are unfolding hemselves). A whole array of sciences, many of which have only just emerged as sciences in their own right, such as animal nutrition, genetics, comparative psychology, endocrinology, need to have heir proper place in the curriculum of teaching leading to the vocational objectives. Mere minor eadjustments in the traditional curriculum are out of place; but what is called for is rather a complete resetting, bearing always in mind the time in he trainee's life that ought not to be exceeded and he expense and the important question of his or her natural aptitude.

Prof. Beveridge in his address has very well pereived many of the implications of the changed ituation. The Veterinary Surgeons Act which has just been passed will give him ample freedom within the jurisdiction of a great university to develop his plans; and in all that endeavour he may be well ssured of the good wishes and goodwill of his British colleagues. That that university should have thought it to appoint a countryman of the daughter Dominion f Australia to launch its plans for a complete eterinary education on securing at last full legal anction to do so is a gesture that will appeal both o the good sense and to the finer sentiments of everyone in Great Britain. Even if space allowed, digression upon the recent history of the several ansactions which have ultimately led to the establishment of this teaching at Cambridge would be odious. However, finally, even in the shortest notice, to omit paying respectful homage to the memory of the late Sir Clifford Allbutt, regius professor of physic at Cambridge, who worked hard during his long life to achieve this end, would be ungracious, now that that end he strove so hard for has come in sight.

OBITUARIES

Prof. Ruth Benedict

The death on September 17 of Ruth Fulton Bene-ct at the comparatively early age of sixty-one deprives social anthropology of one of its most imulating writers and thinkers. Ruth Benedict was ne of the many American anthropologists who took eir early training at Columbia University under he late Franz Boas, and she remained attached to at University all her life, ending her days as the lder of a chair in the Anthropological Department. Ruth Benedict was a vigorous teacher as well as a oman of distinction and charm. In her youth she id field-work among the Zuni of New Mexico and wrote a series of monographs on them. She will, however, be chiefly remembered for her original and provocative book "Patterns of Culture", published in 1934; "Race and Racism", published during the War; and "The Chrysanthemum and the Sword", an analysis of Japanese character which appeared last year.

The fashion of her day was the conventional type of ethnographic monograph; but she early cut away from these and marched boldly out on to the frontier between psychology and anthropology. She was interested from the first in the infinite diversity of values and behaviour patterns which are found in cultures of different types. She believed that these ideals and attitudes formed a coherent whole to which she gave the title 'culture pattern'. She suggested that cultures could be grouped into types on the basis of these patterns. Cultures might be described as Apolonian, Dyonisac or Paranoiac, for example, or they could be classified as 'shame' or 'guilt' societies. The individual brought up in such societies was shaped to their dominant pattern.

Ruth Benedict never developed a systematic typology on this basis. Systematic sociology was not the bent of her mind, and her culture pattern concept could not be sufficiently rigorously defined for comparative work of this kind. On the other hand, her imaginative insight and originality suggested a new field of problems for a younger generation of anthropologists and psychologists, and her literary gifts made her work available to the general public and very much influenced educationists. She must certainly be reckoned as one of the originators of the study of culture and personality which is such a dominant trend in American anthropology to-day.

Ruth Benedict was deeply interested in contemporary problems. During the War she used her methods and concepts to provide a study of the culture patterns of the Japanese for the American Office of War Information. At the time of her death she was engaged in a study of contemporary European cultures, and particularly of their methods of child education. She visited Europe during the past summer and was present at the International Ethnological Congress at Brussels, where she impressed her fellow workers by her vigour and charm. Her death in the middle of an important piece of work will certainly be deeply regretted by anthropologists everywhere.

AUDREY I. RICHARDS

Sir George Hill, K.C.B.

GEORGE FRANCIS HILL, numismatist, and director of the British Museum during 1931–36, youngest son of Samuel John Hill and grandson of Micaiah Hill, both missionaries in India, was born at Berhampur on December 22, 1867, and educated at Blackheath School, University College School, University College, London, and Merton College, Oxford, where he obtained first classes in Classical Moderations and Literæ Humaniores, and under the influence of Prof. Percy Gardner devoted himself to the study of Greek coins. He entered the British Museum in 1893, where Barclay Head had recently published his "Historia Numorum", still the standard text-book in that subject; and edited no less than six volumes of the "Catalogue of Greek Coins". The first of these, on the "Coins of Cyprus" (1897), was followed many years later by a general history of that island, the third volume of which, published in the present year, brings the story to the Turkish conquest in 1571. Meanwhile, he did valuable service as editor of the *Journal of Hellenic Studies* and of the *Numismatic Chronicle*, edited a handbook of "Sources for Greek History", and extended his special studies to Italian coins and medals, and the practical art of die-engraving. His great "Corpus of Italian Medals before Cellini" is his monument in this field.

In 1931, Hill succeeded Sir Frederic Kenyon as director and principal librarian of the British Museum, for which he acquired the biblical "Codex Sinaiticus" from the Soviet Government, and the Eumorphopoulos collection of Oriental antiquities, and where he planted the almond trees in the forecourt. He was created K.C.B. in 1933 and retired in 1936. He took an active interest in the British Academy, the Society of Antiquaries, the Royal Commission on Historical Monuments, the Joint Archæological Committee, and the Hellenic and Numismatic Societies; and published a standard treatise on "Treasure Trove".

Hill died in London on October 18, while a memorial volume of the *Hellenic Journal* and a bibliography, compiled by his many friends, were still with the printers. JOHN L. MYRES

Mr. O. H. Latter

THE death of O. H. Latter on October 11 has removed not only a pioneer in science-teaching in schools but also one who, at the age of eighty-four, was as keen in sight and in mind and as ardent a correspondent as men sixty years his junior. His last letter in the *School Science Review*—characteristically both recalling a lecture of his Oxford days and insisting on accuracy to-day—appeared in June this year; and only two days before his death, while gardening, he shot one of his chief enemies, a grey squirrel.

Latter went as a boy to Charterhouse in 1878 and found there two science masters and no laboratory. In 1887 he took a first class in natural science at Oxford and became Berkeley fellow of Owens College, Manchester; he returned to Oxford in the following year as senior demonstrator to the Linacre professor. Next year he returned also to Keble as tutor. It was largely by chance—a very fortunate chance for science teaching—that in 1890 he returned to Charterhouse as senior science master. There he remained for thirty-six years, during ten of which he was a housemaster.

Latter's special interest was in Lepidoptera, Diptera and most particularly Hymenoptera. His paper in the *Cornhill* on wasps is typical of his gifts for observation and sympathetic exposition. But no branch of natural history escaped him. He contributed to various scientific journals papers on shell-fish, the rabbit, puss-moth, cuckoo's eggs, an odd contortion in dog's mercury, and as a 'holiday task in his seventieth year (with H. Eltringham) on the scent mechanism of the male *Euplœa*. No living thing seemed to him to have been so well studied that nothing new could be observed about it, as witness his papers on the breathing of tadpoles (1923) and the dispersal of burdock (1941).

But Latter was far more than an observer, a writer of broad and lucid text-books and a teacher, great as is the debt his pupils owe to him and continue to acknowledge. He was a founder of what was then the 'Public Schools' Science Masters' Association' and his profound belief in the value of science (and especially biology) as an essential, and not merely a vocational, element in education has had an influence far beyond the public schools. Addresses of his exis on this, his favourite, subject to the British Association, the Association of Preparatory Schoolmasters and the Rotary Club of Colombo; and apart from this wider appeal his public spirit made him for many years the most valued chairman of Godalming Higher Education and Corporation Museum Committees and of the governors of Godalming County School. Fifty-eight years of meteorological observations have ended with his passing: his immense contribution to education remains. J. C. THOMSON

WE regret to announce the following deaths:

Prof. Johan Hjort, For.Mem.R.S., known for his sea-fisheries investigations, on October 7, aged seventy-nine.

Prof. Gustave Roussy, *académicien libre* of the Paris Academy of Sciences, formerly rector of the Sorbonne and director of the Cancer Institute of the Faculty of Medicine, Paris, on September 30, aged seventy-three.

Dr. J. H. M. Wedderburn, F.R.S., professor of mathematics in Princeton University, aged sixty-six.

Dr. C. M. Wenyon, C.M.G., F.R.S., formerl director-in-chief, Wellcome Research Institution, o October 24.

NEWS and VIEWS

Dr. Lise Meitner

WHEN, on November 7, Dr. Lise Meitner celebrates her seventieth birthday, her many friends will offer her their warmest congratulations and respectful admiration on a life of great activity, during which she has maintained the highest reputation for experimental discoveries in radioactivity and nuclear physics. Dr. Meitner studied under Boltzmann in Vienna. Moving to Berlin, she was for a time '*Assistent*' to Planck. She then joined Otto Hahn and thus began a long and rich collaboration, ended only by her flight from the Nazi regime. Her investigations during this period of about thirty years are so many and so varied that only a few can be mentioned here. An early joint paper on the absorption of β-rays was followed by the discovery, wit von Baeyer, of homogeneous groups in the β-ra emission from radioactive bodies. This opened up new field, to which she returned again and again i subsequent years, taking a leading part in th elucidation of β- and γ-ray spectra and in the stud of the properties of β- and γ-rays. To the earlie period of collaboration belongs also the discovery protoactinium in 1918. In later years she worke with Hahn, and also with Strassmann, on th neutron-induced radioactivity of uranium. Aft Hahn and Strassmann had discovered the presence active barium in irradiated uranium, and thereb established the division of the uranium nucleus, D Meitner and her nephew O. R. Frisch gave, in letter in *Nature* in March 1939, the first physic picture of the fission process, introducing the term 'fission' and making an estimate of the energy liberation. Using the method of recoil, which she and Hahn had applied so effectively in the early days of radioactivity, she was later able to show that the bodies previously called 'transuranic' did, in fact, originate by fission. Since 1939, Dr. Meitner has worked in Stockholm, where she now directs a small but active laboratory. Enjoying good health and abundant energy she can, while looking back on a life full of high achievement, also look forward to further years of happiness and success.

Nobel Prize for Medicine : Dr. Paul Müller

The award of the Nobel Prize for Medicine for 1948 has been made to Dr. Paul Müller for his discovery of the effects as an insecticide of D.D.T. Drs. P. Läuger, P. Müller and H. Martin were the leaders of an intensive research for insecticidal chemicals in the Basle laboratories of J. R. Geigy, S.A., which extended more than twenty years. The researches were directed originally towards the discovery of moth-proofing agents to be incorporated in fabrics. It was in the section of research entrusted to Paul Müller that D.D.T. was actually synthesized and its contact insecticidal properties discovered. It seems to have been in the course of field trials that its remarkable effectiveness against the Colorado beetle was noticed. It was soon found to be equally toxic to the louse and the mosquito. The material was brought to the notice of medical entomologists in Great Britain and the United States at a critical moment in the War when the supplies of pyrethrum were rapidly falling short of the demand. Soon it was being produced in very large quantities on both sides of the Atlantic. It proved of enormous value in combating typhus and malaria during the War, and now it is being employed with success in campaigns for the complete eradication of malaria from island areas. It is an equally valuable weapon in agricultural entomology and has provided a great stimulus to the search for yet other insecticides.

Dr. G. M. Vevers

Dr. G. M. Vevers, superintendent of the Zoological Society of London, will be retiring for medical reasons at the end of the year. He received his medical education at St. Thomas's Hospital, London, and served in the First World War as a captain in the R.A.M.C. After demobilization he became assistant o Prof. R. T. Leiper, in the Department of Helminthology of the London School of Tropical Medicine, and was awarded a Beit Medical Fellowship for Medical Research in parasitology. The same year he was also appointed honorary parasitologist to the Zoological Society and spent much of his time in the Society's prosectorium. In 1921 he went to British Guiana on a Colonial Office inquiry into filariasis. In 1923 Dr. Vevers was appointed superintendent of the Zoological Society in succession to the late R. I. Pocock. He introduced the application of the general principles of hygiene to wild animals in captivity, paying particular attention to the helminthic infections which used to be such a frequent ause of death in newly imported animals. He also introduced improvements in diet and housing, resulting in a reduction of the incidence of dietetic diseases and epidemics such as tuberculosis. He was also responsible for carrying out the extensive building programme at the Zoological Gardens, Regent's Park, following the First World War.

Dr. Vevers was closely associated with the late Sir Peter Chalmers Mitchell in the formation and development of Whipsnade Zoological Park, in which he took a very special interest. He also designed the layout of the Dudley Zoological Gardens, and since the Second World War has been engaged in the reconstruction and rehabilitation of the Zoo at Regent's Park. He is the author of numerous papers on helminthology and the keeping and breeding of animals in captivity; also children's books and other books on general natural history, and has been a regular broadcaster in the B.B.C. Children's Hour and other programmes. He was elected an honorary fellow of the Royal College of Surgeons in 1946; and has been awarded the Silver Medal of the Zoological Society of London, and the Gold Medal of the Zoological Society of Glasgow and West of Scotland. After his retirement Dr. Vevers will continue to reside at Whipsnade, and will be available for consultation by the Society in an advisory capacity.

Botany at Rothamsted : Dr. Winifred E. Brenchley

On her retirement from the post of head of the Botany Department, Rothamsted Experimental Station, on October 1, Dr. Winifred E. Brenchley had completed forty-two years of service there. She went to Rothamsted in 1906 as the holder of a Gilchrist Studentship of the University of London, and in the following year was appointed to the permanent staff. Dr. Brenchley was the first woman member of the staff, and it says much for her personality and for the quality of her work that the appointment was an immediate success and paved the way for many other women to undertake research in agricultural science at Rothamsted. Dr. Brenchley was a pioneer in the study of the effects of micronutrient elements on plant growth, and is an acknowledged authority in this field. Before the importance of elements such as boron, copper and manganese in plant nutrition was fully appreciated, she began a long series of solution-culture studies on elements other than the ten known to be essential. Her monograph "Inorganic Plant Poisons and Stimulants", published in 1914, described her own results and provided a valuable critical summary of the scattered information then existing on the subject. The investigation of the effects of boron made afterwards is perhaps the best-known work from her laboratory. Dr. Brenchley's other chief interests have been in the ecology of weeds, and in the changes with time in the flora of the permanent Park Grass plots at Rothamsted. The results of her earlier studies on these plots provided material for her book "Manuring of Grassland for Hay", published in 1924. Dr. Brenchley has played a very active part in the social life of Rothamsted, and in recognition of her long-continued interest in the welfare of all members of the staff, a presentation was made to her at a party held on October 22, attended by many of her past and present colleagues. Dr. Brenchley is to continue her research work at Rothamsted on a part-time basis. Her successor as head of the Botany Department is Dr. D. J. Watson, formerly in charge of the Crop Physiology Section, which has now been merged with the Botany Department.

Indian Archæology at the University of London

On October 28, at the Institute of Archæology, London, Prof. K. deB. Codrington, the newly appointed professor of Indian archæology, gave an inaugural lecture entitled "The Place of Archæology in Indian Studies". The High Commissioner for India, Mr. Krishna Menon, who took the chair, said that the creation of such a chair was very welcome and he hoped that it would lead to exchanges of scholars on both sides. He welcomed the appointment of Prof. Codrington, whose second home was India. In his lecture, Prof. Codrington stressed the educational value of the study of archæology, and the need of close collaboration between all who are interested in the study of India. Outlining the relations of the earliest city culture in India with north and south Persia, he went on to describe the intrusion of the neolithic tanged-adze culture of South-East Asia with reference to the first appearance of the Aryans in India. The chair of Indian archæology in the University of London is held jointly at the Institute of Archæology and the School of Oriental Studies.

Food and Agriculture Organisation

The fourth annual conference of the Food and Agriculture Organisation of the United Nations will open in Washington on November 15. The conference will review the world food situation and the technical activities of the Food and Agriculture Organisation. It will also consider major constitutional, administrative and financial issues, particularly the budget for the next financial year. The United Kingdom delegation will be led by Mr. Tom Williams, Minister of Agriculture and Fisheries; the alternate leader is Mr. R. H. Franklin, deputy secretary in the Ministry of Agriculture and Fisheries. Among other members of the delegation will be Sir Ralph Enfield (chief economic adviser) and Mr. A. T. A. Dobson (fisheries adviser), both of the Ministry of Agriculture and Fisheries; Dr. N. C. Wright (chief scientific adviser), of the Ministry of Food; Sir Gerard Clauson, assistant under-secretary of State in the Colonial Office; Mr. P. N. R. Butcher, assistant secretary in the Ministry of Health; Mr. A. N. Duckham, agricultural attaché to the British Embassy; and Mr. G. R. Oake, head of the British Supply Office (Food) in Washington. In addition, Mr. James Turner, president of the National Farmers Union, and Mr. E. G. Gooch, president of the National Union of Agricultural Workers, will serve as advisers to the delegation.

Biological Service in Great Britain

Mr. Herbert Morrison, Lord President of the Council, announced in the House of Commons on November 1 that Capt. Cyril Diver has been appointed head of the biological service which is to be formed for the conservation of the fauna and flora of Great Britain, including Nature reserves. The London office of the service is at Thorney House, Smith Square, S.W.1.

Society of Chemical Industry: Fine Chemicals Group

The Fine Chemicals Group of the Society of Chemical Industry has for its objects "The discussion of fine chemicals especially such as are of therapeutic or biological interest". The Group held its inaugural meeting at the Royal Institution on October 5, with Sir Jack Drummond, chairman of the Group, presiding. Prof. J. H. Burn, professor of pharmacology, University of Oxford, delivered the inaugural address and reviewed much of the important work that has been done in the production of fine chemicals for medicinal use. He recalled the lapse of time between the discovery of penicillin in 1929 and its use in 1941, and suggested that, but for the recognition of the curative value of sulphonamides, it is possible that the use of penicillin might have been held up indefinitely owing to the false notion that "an antibacterial agent for use in man is an impossibility". Prof. Burn referred particularly to the work in the fields of tuberculosis and cancerous growths, of which the latter is still, in his opinion, the outstanding unsolved problem; it is one thing to deal with bacteria in the blood and extracellular fluid, but quite another thing when the bacterial agents are inside the cell or even in the nucleus. Much knowledge is to be gained from the classical work of Dale and Laidlaw with Carr, Barger and Ewins on adrenaline (and sympathomimetic amines), histamine and acetylcholine. It is increasingly obvious that the effect of chemical substances in the body is to modify or interfere with the action of these three compounds. This matter is of great importance in the study of anæsthetics, and it would be worth while to promote research in this direction. In the general problems of research, Prof. Burn felt that the university worker ought to pass on more of his knowledge to the industrial laboratories, and the industrial men of science must take 'refresher' courses in the academic laboratories to keep abreast of new techniques. The crying need of to-day is not for more fundamental knowledge but more application of the present existing knowledge. In conjunction with this, Prof. Burn expressed the opinion that the value of elaborating quantitative methods for the estimation of biological properties is indisputable. This work has been criticized as not leading to any fundamental discovery; but since 1926 chemical work has been much facilitated by the introduction of biological standards, and the Pharmaceutical Society has made a wise decision in establishing a laboratory for the study of biological standardization.

Cultural Geography of the Tarascan Area, Mexico

Pub. No. 7 of the Institute of Social Anthropology, Smithsonian Institution, Washington, by Robert C. West, may be specially welcomed because it deals with a population in its environment in western Mexico, and takes note of physical features, climate, agriculture, handicrafts, houses and settlements and material culture generally. The geognostic map is an interesting key to the environment and so are the maps, admittedly based on inadequate data none too reliable, of climatic features, especially the frequency of frost on the highlands. Tarascan was an indigenous language of pre-Spanish days; the conquerors misused the natives in mines and elsewhere, missionarie and others 'hispanized' large numbers of the remainde on great *estancias* (stock-raising farms) and *hacienda* (crop farms); so the old language lingers only in th poorer areas which Europeans did not wish to occupy The recession of Tarascan speech is traced in map for different periods. Wheat and barley were cultivated soon after the Spanish Conquest in order to pa the tribute demanded by the authorities, and Arabi modes of irrigation also came in. Each community had owned surrounding lands in which the chie apportioned the right of user among the villagers Since the mid-nineteenth century, individual ownership has developed; but vestiges remain, and in som pueblos a head-of-family may have 2–4 hectare allotted *sine die* provided he does not leave th land untilled for more than two successive years He may sell his right-of-user, but only to anothe member of the pueblo. The woodland is, at least in theory, communal property. The gradations from indigenous to more or less European tradition give pages of special interest to this book.

High-Vacuum Equipment

PARTICULARS have recently been received from Messrs. W. Edwards and Co. (London), Ltd., Kangley Bridge Road, London, S.E.26, of several new devices which they manufacture for use with pumps and vacuum equipment. These include controllable leaks for the continuous admission of small quantities of gas to a vacuum system. A dial allows any particular setting of the valve to be noted and repeated. The other equipment consists of various combinations of bellows and micro-switches to form pressure-controlled relays capable of operating a half-horse-power A.C. motor. One version can be used to switch off power supplies, or start a motor, when the pressure in a vacuum system reaches any pre-determined value between 15 and 500 mm. of mercury. Another application is as a safety device which comes into play when the rate of flow of liquid in a tube falls outside chosen limits. This instrument is also supplied in a form which indicates the rate of flow on a dial. No doubt many applications of these units will be found in apparatus which has to run for long periods without attention.

Colonial Services: Recent Appointments

THE following appointments in the Colonial Services have been announced: J. S. Campbell, agricultural officer, Nigeria; H. D. Matheson, agricultural officer, Federation of Malaya; D. J. Parsons, agricultural officer, Uganda; J. B. D. Robinson, chemist, Department of Science and Agriculture, Barbados; J. W. F. Chapman, assistant conservator of forests, Nigeria; D. A. Francis, assistant conservator of forests, Gold Coast; F. W. Binge, geologist, Kenya; T. C. James, geologist, Tanganyika; D. L. Searle, geologist, Kenya; R. B. Smith, agricultural officer, Trinidad; M. E. R. Taylor, assistant conservator of forests, British Guiana; J. H. Wheelan, assistant conservator of forests, Gold Coast; H. Gillman (agricultural officer, Tanganyika), senior agricultural officer, Tanganyika; R. Johns (agricultural adviser to the comptroller of development and welfare, West Indies), deputy director of agriculture (regional), Nigeria; R. W. R. Miller (agricultural officer, Federation of Malaya), director of agriculture, Sarawak; A. Smith (rural education officer, Gold Coast), principal agricultural education officer, Gold Coast; F. E. Hughes (senior assistant conservator of forests, Gold Coast), conervator of forests, Gold Coast.

University of London

THE title of professor emeritus in the University of London has been conferred on the following: Sir Alexander Fleming, professor of bacteriology in St. Mary's Hospital Medical School since 1928; Sir Francis Fraser, professor of medicine and physician n St. Bartholomew's Hospital Medical College during 920–34 and professor of medicine in the British Postgraduate Medical School during 1934–46; Prof. H. Gordon Jackson, professor of zoology in Birkbeck College since 1928, and master of the College; and Prof. C. H. Lobban, formerly head of the Department f Civil and Mechanical Engineering and professor of civil engineering in King's College during 1935–46.

The following doctorates have been conferred: D.Sc. on Elsie M. Widdowson (Imperial College); D.Sc.(Eng.) on Hugh Ford (Imperial College), H. C. H. Gurney and Harry Walker (external students).

Royal Society of Edinburgh: Officers for 1948–49

AT a statutory meeting of the Royal Society of Edinburgh, held on October 25, the following officers and members of council were elected: *President:* Sir William Wright Smith; *Vice-Presidents:* Prof. W. M. H. Greaves, Prof. James P. Kendall, Sir Ernest Wedderburn, Prof. A. C. Aitken, Prof. E. P. Cathcart, Sir Alexander Gray; *General Secretary:* Dr. J. E. Richey; *Secretaries to Ordinary Meetings:* Prof. E. T. Copson, Prof. Arthur Holmes; *Treasurer:* Mr. Andrew White Young; *Curator of Library and Museum:* Dr. John E. Mackenzie; *Ordinary Members of Council:* Prof. A. D. Hobson, Prof. W. O. Kermack, Dr. John Weir, Prof. J. H. Gaddum, Prof. G. D. Preston, Prof. S. J. Watson, Mr. R. Ll. Gwilt, Prof. J. N. Davidson, Mr. Edmund G. Dymond, Mr. Charles W. Parsons, Prof. R. W. Wheldon, Prof. E. M. Wright.

Institute for the Study of Animal Behaviour

AT the annual general meeting of the Institute for the Study of Animal Behaviour, held on October 10 in the rooms of the Linnean Society, Dr. W. H. Thorpe, of the Department of Zoology, Cambridge, was elected president in succession to Prof. Edward Hindle. Dr. Thorpe, who is a leading British worker in the field of animal behaviour, is a member of the editorial board of *Behaviour*, the new international journal devoted to this subject. Dr. P. H. T. Hartley, of the Edward Grey Institute, Oxford, was elected joint honorary secretary with Prof. Alastair N. Worden, while Mr. James Fisher, a former honorary secretary, was elected honorary treasurer. The following were elected to serve as members of Council: Mr. R. J. Bartlett (London), Dr. J. T. Edwards (London), Dr. John Hammond (Cambridge), Prof. A. C. Hardy (Oxford), Prof. Edward Hindle (London), Prof. Julian Huxley (Unesco), Dr. E. S. Russell (Hastings), Dr. Arthur Walton (Cambridge) and Dr. C. W. M. Whitty (Oxford).

Announcements

A DISCUSSION on "The Theory and Practice of New Techniques in Separation and Purification", to be held by the Chemical Society on November 25, has been arranged by Dr. R. P. Linstead. There will be two sessions: "Chromatography and Partition Chromatography", at 2.30; "Ion Exchange", at 7.

A COMPLIMENTARY dinner was given on October 22 to Prof. John Read by the members of the Chemical Society of the University of St. Andrews to mark the celebration of his silver jubilee as professor of chemistry in the University, to which he came in 1923 from the chair of organic chemistry at the University of Sydney. Mr. A. R. Battersby, president of the Society, presided over a representative gathering, which included Sir James Irvine, principal of the University and a former occupant of the chair of chemistry.

ERRATUM.—In *Nature* of October 30, p. 690, under "The Night Sky in November", line 8, for "easterly" read "westerly".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Life-Span of Red and White Blood Corpuscles of the Hen

In a former communication[1], a method of determining the life-cycle of nucleated erythrocytes was described. The method is based on the fact that radiophosphorus incorporated into desoxyribosenucleic acid molecules during the formation of the red corpuscles in the marrow of the hen remains in the erythrocytes throughout their life-time. If labelled sodium phosphate is administered repeatedly to a hen with the aim of keeping the plasma activity at a constant level, the specific activity of the desoxyribosenucleic acid phosphorus extracted from the erythrocytes is found to increase with time according to a linear curve and to reach the level of the specific activity of the inorganic phosphorus of the blood plasma after the lapse of 33 days. Thus, after that date, we find only such red corpuscles in the circulation as were formed during the experiment. As, according to these experiments, about five days elapse before the labelled corpuscles are released into the circulation, the life-span of the red corpuscles works out to be $33 - 5 = 28$ days.

An alternative method of the determination of the life-span of the red corpuscles is the following (cf. Shemin and Rittenberg's[2] experiments, in which glycine containing nitrogen-15 was administered). Phosphorus-32 is injected only at the start of the experiment. During the first day, when the activity-level of the marrow is very high, strongly active erythrocytes are formed. During the days after the injection, the activity of the plasma, and correspondingly that of the marrow, is rapidly declining, and the erythrocytes formed at later dates show a much smaller activity. The specific activity of desoxyribosenucleic acid phosphorus isolated from erythrocytes is nil during the first two days; but it rapidly increases during the fourth and even the fifth day after the injection. This indicates that the main part of the strongly active corpuscles is released into the circulation at that date. Later, the activity increases, but only slightly, as erythrocytes formed with smaller activity reach the circulation. This increase continues until the strongly active corpuscles formed during the first day of the experiment reach their life-span and are removed from the circulation. From this point onwards, the activity rapidly decreases so long as these cells are being broken down.

From the data obtained for the specific activities of plasma inorganic phosphorus and desoxyribosenucleic acid phosphorus of the corpuscles, and by making use of the considerations put forward by Shemin and Rittenberg[2], it is possible to calculate the percentage of the corpuscles present in the circulation which is formed during the first day of the experiment. (Details of such a calculation will be published shortly elsewhere.) Fig. 1 shows the results of an experiment aiming at the determination of the life-cycle of the red corpuscles. The horizontal part of the curve between 6 and 32 days indicates clearly that the number of labelled atoms, and hence the number of labelled corpuscles, present in the circulation does not change within that interval of time. The sudden decrease in the number of labelled corpuscles at about 35 days is thus to be interpreted as due to the disappearance not of the labelled phosphorus atoms alone, but of the total corpuscles. In this experiment, the release of the labelled corpuscles into the circulation was found to take place after the lapse of three days, in contrast to five days in the first method described, mainly due to a more refined method of measurement. Correspondingly, the mean life-span of the erythrocytes is about $35 - 3 = 32$ days.

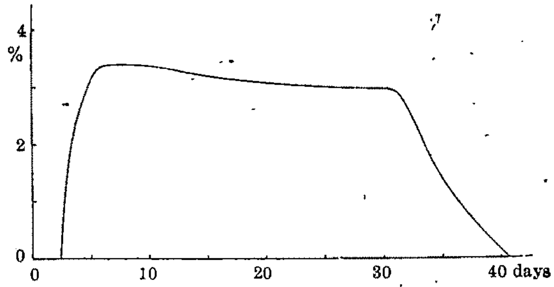

Fig. 1. Percentage of hen *red* cells formed during the first day of the experiment which is present in the blood stream at the time indicated on the x-axis

Though the white corpuscles are a mixture of different corpuscle types, it seemed to be of interest to determine the life-span of this mixture, making use of the second method. 60 μC. radioactive sodium phosphate was injected into a hen and blood samples were secured at suitable intervals. The leucocytes were isolated by the method of Butler and Cushman[3] and their desoxyribosenucleic acid phosphorus was extracted by Schmidt and Thannhauser's method[4]. The percentage of the white corpuscles formed during the first day and present in the circulation at subsequent dates is seen in Fig. 2. Should white corpuscles show a similar behaviour with respect to their life-cycle as do red corpuscles, we might expect the curve to have a horizontal part. This, however, is not the case. This fact is due partly to the inhomogeneity of the mixture of white corpuscles and partly to the comparatively short life-time of the corpuscles; furthermore, there is a large statistical variation in the life-times of single white corpuscles. The curve indicates that at the most 10 per cent of the white corpuscles have a life-span of more than eight days.

Objections may be raised to this explanation and one might be tempted to interpret the results obtained by assuming that the white corpuscles do not preserve their 'label', and that we are confronted not with a change in the number of labelled white corpuscles, but with a turnover phenomenon. This can be shown, however, not to be the case. It is found that if the formation of new white corpuscles is stopped by irradiating the hen with 2,000 r., and phosphorus-32 is then administered, no labelled desoxyribosenucleic

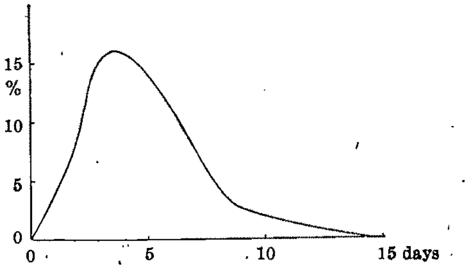

Fig. 2. Percentage of hen *white* cells formed during the first day of the experiment which is present in the blood stream at the time indicated on the x-axis

acid is formed in the leucocytes present in the circulation. This lack of formation of labelled nucleic acid can scarcely be a consequence of the effect of X-rays on the turnover rate, because a dose of 2,000 r. diminishes, but does not entirely stop, the renewal of desoxyribosenucleic acid in all types of tissue investigated[5]; it must be interpreted as a lack of formation of new white corpuscles. The turnover of desoxyribosenucleic acid, present in the white corpuscles is thus negligible.

I wish to express my most cordial thanks to Prof. N. Bohr for numerous facilities put at my disposal, and to Prof. G. Hevesy for his kind interest and many helpful suggestions throughout the work.

J. Ottesen

Institute for Theoretical Physics,
University, Copenhagen.

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Introduction of Radioactive Tracers into Antisera

It has been found possible to introduce radioiodine into the globulin molecule of an antiserum without seriously impairing the agglutinating power of the serum.

The globulin fraction of a *Proteus vulgaris* rabbit antiserum was prepared by two successive precipitations with a 22 per cent concentration of sodium sulphate, and dissolved in $M/15$ phosphate buffer of pH 7. It was then treated with an aqueous iodine solution (0·1 mgm/ml.) containing also some 8-day radioiodine. Reaction is complete in a few minutes, approximately 20 per cent of the iodine being substituted into the globulin. The remainder, now present as iodide, was removed by dialysis.

A solution containing 5 mgm. of the iodinated antiserum globulin in 70 ml. of pH 7 phosphate buffer was mixed with 5 ml. of normal serum and sufficient *Proteus* suspension to remove all the agglutinins. After standing for one hour at 56° C., the agglutinated bacteria were filtered out, washed, and their radioactivity determined. The accompanying table is typical of the results obtained.

Iodine atoms (n) per antiserum globulin molecule (mean), assuming mol. wt. globulin 156,000	Percentage of total activity precipitated
1·0	8·1
2·3	8·1
3·1	9·3
7·7	5·7

A control experiment with normal rabbit globulin gave only about one per cent of precipitable activity, which may have been due to naturally occurring agglutinins in the serum.

With increase of the iodine content above 10 atoms per molecule, the agglutinating titre and percentage of precipitable activity of the globulin showed a marked decrease. The iodine probably becomes substituted into the tyrosine residues, of which there are about 58 per molecule.

If the number of iodine atoms, n, as defined in the above table is small compared with 58, the probability of a globulin molecule containing m iodine atoms will be:

$$\frac{n^m}{m!} \cdot \exp - n.$$

Consequently, for $n = 1$, 36·8 per cent of the globulin molecules will contain no iodine; but for $n = 7·7$, only 0·05 per cent will contain no iodine. Since, however, over this range of n the agglutinating titre showed little alteration, it follows that slightly iodinated antiserum globulin has substantially the same agglutinating properties as the untreated antiserum globulin.

It should be possible to use this technique for the standardization of a considerable variety of antisera.

I wish to thank Drs. R. F. Menzies and H. Bensted, who prepared the antisera. Acknowledgment is made to the Director, Atomic Energy Research Establishment, for permission to publish these results.

F. D. S. Butement

Atomic Energy Research Establishment,
Harwell, Didcot,
Berks.

June 1.

Succinic Acid in the Blood of the Larva of *Gastrophilus intestinalis*

During the course of biochemical investigations on the parasitic larvæ of the fly *Gastrophilus intestinalis*, advantage was taken of the ease with which the hæmoglobin-containing 'tracheal organ' cells[1] and the hæmolymph which surrounds them could be obtained in order to study the interrelationship between the two *in vitro*. For this purpose an investigation of the respiratory metabolism of the tracheal organ was undertaken, employing standard manometric methods.

The oxygen uptake of tracheal cells in either phosphate buffer or a specially prepared '*Gastrophilus* Ringer' solution was small; but it was increased up to nine times in presence of the insect's own hæmolymph. Analyses of fructose, glucose, lactate, pyruvate, citrate and succinate having been made on the blood[2,3], the effect of these substances, and of fumarate and butyrate, on the oxygen consumption of the tracheal cells suspended in phosphate buffer was determined. Only with succinate was there an increase in oxygen uptake comparable with that found when the hæmolymph was the suspension medium. Evidence that the factor present in the hæmolymph responsible for this increase is indeed succinate was obtained as follows.

Preliminary experiments showed that the active material was dialysable and could be extracted by ether at an acid pH. Accordingly, the blood from some 1,200 third-instar *Gastrophilus* larvæ was dialysed against three changes of distilled water. The combined external fluid was acidified to pH 2, reduced in bulk by evaporation to 50 c.c., and continuously extracted with ether for ten hours. At this stage the aqueous phase was devoid of activity when tested with tracheal organ cells. The ether extract was then itself extracted three times with equal volumes of water, and the combined aqueous extract washed with a quarter of its volume of ether to remove easily ether-soluble substances. The aqueous solution was now evaporated to dryness, the solid residue taken up in 150 c.c. of ether and evaporated down to 5 c.c. The resulting crystals were filtered off, washed with ether and dried *in vacuo*. The yield was about 400 mgm. The crystals were monoclinic, and had a melting point (uncorrected) of 186–190° (m.p. of succinic acid, 184°). The silver salt of the acid, prepared according to Mrs. Needham's method[4], contained 62 per cent silver (theoretical : 65 per cent). When tested manometrically with a succinoxidase preparation from either pig heart or tracheal cells, the crystalline material was shown to be 91 per cent pure succinic acid.

By the same method succinate was also determined in *Gastrophilus* hæmolymph after deproteinization and ether extraction. The concentration varied from 128 to 404 mgm. per cent. The amount is already high in the half-grown second instar (the earliest stage at which it is practicable to collect hæmolymph), and appears to increase just prior to the second moult, to be followed by a decrease in the early third instar. These changes are summarized below.

Half-grown 2nd instar	2nd instar just prior to moulting	Early 3rd instar	Fully grown 3rd instar
279 mgm. %	351 mgm. %	203 mgm. %	242 mgm. %

To test whether succinic acid might have been formed during dialysis by continuous breakdown—enzymatic or otherwise—from some precursor, the hæmolymph was collected directly into 10 per cent metaphosphoric acid and the silver salt prepared. The yield from some 100 c.c. of blood was 230 mgm. of succinic acid, which shows that succinate is a normal constituent of the blood and not a breakdown product.

Pryor, Russell and Todd[5] reported that succinic acid was obtained from *Lucilia* pupæ, and this suggests that high concentrations of succinate may also be found in other species of insects. At present, however, any indication as to the origin or function of the succinate in the blood must await further study.

We should like to thank Prof. D. Keilin for suggesting this line of work, for his continued interest and advice, and the Agricultural Research Council for a research grant to one of us (L. L.).

L. Levenbook
Y. L. Wang

Molteno Institute,
University of Cambridge.
May 27.

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Staphylococcal Coagulation and Fibrinolysis

Smith and Hale[1] were the first to point out that coagulation by staphylococci takes place in two stages. First, the bacterial product is converted to a thrombin-like agent by an activator substance found in plasma. This thrombin-like agent then produces fibrin. Gerheim, Ferguson and Travis[2], and Kaplan and Spink[3] have pointed out that the activator substance is associated with the albumin fraction in ammonium sulphate fractionation, while the latter workers showed that in alcoholic fractionation the activator appears to be associated with the alpha and beta globulins. Kaplan and Spink also have made an important contribution in their studies on the inhibition of the staphylocoagulase reaction.

Staphylococcal fibrinolysis in the past has either been ignored or explained on the basis that staphylocoagulase is a proteolytic ferment[4]. Lack[5], working in Britain, and Gerheim *et al.*[6,7] in the United States, have shown that staphylococcal coagulation and fibrinolysis are distinct phenomena. They are in agreement that staphylococci produce a kinase for the proenzyme, plasminogen (profibrinolysin), just as streptococci do. This kinase has been designated staphylokinase.

Gerheim *et al.*[7], in a series of heat-lability studies, have shown that heating for two hours at 75° C. completely destroys the coagulation precursor (prostaphylocoagulase), while there is little change in the staphylokinase reactivity.

Earl B. Gerheim

Department of Physiology,
University of North Carolina.
June 2.

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Excretion of D-Pyrrolidone Carboxylic Acid by Rat and Dog Fed with Tumour Proteins

There has been much controversy about our claim[1] that D-glutamic acid is a constituent of tumour proteins. Many authors were unable to confirm our results, and in their opinion the D-form which we isolated from malignant tumours was formed by partial racemization *in vitro* during the hydrolysis with hydrochloric acid. An explanation of these contradictory results will be given in future publications. Here we wish to record further evidence for the correctness of our views.

In 1940 we reported[2] that the normal dog was unable to digest rabbit tumours (Brown – Pearce) in the same way as common meat. The Neuberg[3] precipitate of the urine contained a peptide fraction which on hydrolysis yielded glutamic acid with 17 per cent D-form. From the peptide fractions of the fæces we isolated glutamic acid with 53 and 57 per cent D-form respectively, that is, with a surplus of the unusual antipode. So far as we know, these experiments have never been repeated in other laboratories. In connexion with some new facts mentioned below, it was desirable to repeat the experiments in our laboratory for a third time. A dog was fed for four days with cooked rat tumours (benzpyrene). The isolation of the peptide fraction of the fæces was carried out in the same way as described previously. In the new case the isolated glutamic acid contained 33 per cent D-form ; the lower value is in good agreement with our general experience that the rat tumours (benzpyrene) produce on acid hydrolysis only about half as much D-glutamic acid as the very malignant Brown – Pearce tumours.

In 1944, S. Ratner[4] reported the isolation of optically pure D-pyrrolidone carboxylic acid from the urine of rats after feeding a normal stock diet with the addition of DL-glutamic acid. The conversion is probably enzymatic. It seemed to us that, in our feeding experiments with tumour proteins, a part of the D-glutamic acid might have been split off and converted to D-pyrrolidone carboxylic acid. As this cyclic derivative is not precipitated by Neuberg's reagent, we would not have found it in our earlier experiments. The collected urine of the dog was adjusted to *p*H 2 (with sulphuric acid), filtered and continuously extracted for forty-eight hours with ethyl acetate, the temperature of the aqueous layer being 15° C. throughout this period. The oily residue obtained after the evaporation of the ethyl acetate was treated in the same manner as described by S. Ratner[4]. We finally obtained a colourless crystalline product which was identified by the melting point (alone and in mixture), the optical rotation ($[\alpha]_D = + 11{\cdot}2°$) and the analyses as the pure D-form of pyrrolidone carboxylic acid. We estimate that about 10 per cent of the D-glutamic acid of the tumour originally present is excreted in this way.

As a control, the same dog was fed with beef and the urine extracted with ethyl acetate. In this case deuterio-D-pyrrolidone carboxylic acid (5·30 atomic per cent deuterium) was added to the extract. The recovered tracer substance showed no depression of the isotope contents. This is in complete agreement with the results of S. Ratner[4]; further, D. Shemin and D. Rittenberg[5] demonstrated, with deuterium and nitrogen-15 as tracers, that no D-glutamic acid is formed in the organism of the vitamin B_2-deficient rat, a conclusion which is reasonably applied also to the normal animal.

In another experiment, tumour proteins of rats (benzpyrene) were fed to normal male rats. Here again we isolated D-pyrrolidone carboxylic acid from the urine; in this case the final purification was carried out by chromatographic fractionation (Al_2O_3 Brockmann II–III; alcohol as solvent). The optical purity of the cyclic compound was demonstrated by the conversion to D-glutamic acid ($[\alpha]_D = - 31{\cdot}5°$).

The excretion of an optically pure derivative of D-glutamic acid after the enzymatic 'digestion' of tumour proteins is not compatible with the current view that the D-form which we isolate after acid hydrolysis of tumour proteins is an artefact. Moreover, an important consequence for future experiments may be pointed out. We know from experiments, mainly unpublished, with labelled amino-acids that a small part of fed or injected D-glutamic acid is incorporated in the tumour proteins. If the labelled molecules of D-glutamic acid are displacing the 'intrinsic' ones, a decrease of the isotope content of the excreted D-pyrrolidone carboxylic acid should be demonstrable. However, it is not yet clear whether the 'extrinsic' D-glutamic acid is really displacing intrinsic D-glutamic acid, or whether it is being additionally incorporated. Another premise is a favourable ratio between the 'extrinsic' and the intrinsic' D-glutamic acid. In any event, the effect will be rather small, and its demonstration will depend upon a very accurate isotope determination. Preliminary experiments with deuterio-D-glutamic acid emphasize the importance of these points. Presumably the use of radioactive D-glutamic acid would be more suitable; we hope to carry out a crucial experiment as soon as possible.

Further details of the investigations will be published elsewhere. Grateful acknowledgment is made to the Rockefeller Foundation for the support of our work.

F. KÖGL
T. J. BARENDREGT
A. J. KLEIN
Organisch-chemisch Laboratorium
der Rijksuniversiteit,
Utrecht.
June 17.

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Bacteriostatic Action of Oximes

THE action of numerous inorganic and organic substances on the growth of bacteria has been investigated in the hope of demonstrating properties useful either in the laboratory for selective and enrichment methods for isolation, or clinically for the treatment of the diseases which they cause. Record has not been found in bacteriological literature of the use of oximes in such an investigation.

The oximes and their derivatives used in the experiments described were kindly supplied by Dr. O. L. Brady, of University College, London. They included acetoxime, benzantialdoxime, N-methyl benzaldoxime, O-methyl benzaldoxime, salicylaldoxime and hydroxylamine hydrochloride. Each of these was tested against *Staphylococcus aureus*, β-hæmolytic streptococcus (Lancefield Group *A*), *Salmonella typhi*, *Bacterium coli*, *Proteus vulgaris* and *B. subtilis*.

Methods. For each test a series of nutrient agar plates was prepared, each plate containing a different concentration of the chemical to be tested. The concentrations were 1 : 400, 1 : 600, falling by 200 to 1 : 20,000. Suspensions in peptone water were made from well-grown 24-hr. agar cultures of the organisms. Small loopfuls of each suspension were inoculated on to the series of plates as well as on to control plates containing no oxime or derivative. After aerobic incubation at 37° C., readings of the amount of growth were taken at the end of 24 and 48 hours. In cases where all the organisms grew freely at the highest concentration of the compound, the experiments were repeated with still higher concentrations, namely, 1 : 100, 1 : 200 and 1 : 300.

Results. Acetoxime at the concentration of 1 : 400 failed to inhibit the growth of any of the organisms. It was afterwards found that the staphylococci were inhibited at 1 : 300, the β-hæmolytic streptococci at 1 : 200, and *B. subtilis* at 1 : 100. *Salm. typhi*, *Bact. coli* and *Proteus* all grew freely at 1 : 100. For the sake of brevity, the results with the other compounds are tabulated. The figures indicate the lowest concentration inhibiting the various test organisms.

Discussion. It will be observed that there is no outstanding difference in resistance or susceptibility among the different organisms tested. The hope of discovering a compound which would inhibit *B. subtilis* or prevent the swarming of *Proteus*, and yet not interfere with the free growth of organisms the

	Staph. aureus	*β Hæm. strept*	*Salm. typhi*	*Bact. coli*	*Proteus*	*B. subtilis*
Benzantialdoxime	1,200	1,200	1,200	800	600	800
N-methylbenzaldoxime	800	2,000	1,600	1,200	800	800
O-methylbenzaldoxime	800	2,000	1,200	600	800	1,200
Salicylaldoxime	2,000	4,000	2,000	1,200	1,200	1,200
Hydroxylamine hydrochloride	12,000	8,000	8,000	8,000	8,000	12,000

isolation of which was desired, was not fulfilled, as the *B. subtilis* and the *Proteus* were among the more resistant organisms. Similarly, such organisms as the β-hæmolytic streptococci and the *Salm. typhi*, the abundant growth of which is desired for their isolation and subsequent study, were among the most susceptible. The lack of marked resistance of *B. subtilis* compared with that of *Bact. coli* and *Proteus* is not unexpected, as the experiments measured the bacteriostatic and not bactericidal effect of the substances.

J. D. ALLAN GRAY
R. A. LAMBERT

Central Middlesex County Hospital,
Park Royal, N.W.10.
June 3.

Aluminium Phosphate as Precipitant of Agglutinable and Non-Agglutinable Strains of *H. pertussis*

ALUMINA (hydrated aluminium oxide) is generally used to precipitate *H. pertussis* organisms from aqueous suspensions. With this adsorbent the preparation of alum-precipitated vaccines has never involved any difficulty in getting all the bacteria precipitated.

Some months ago a number of experimental vaccines were prepared with aluminium phosphate as precipitant. We noticed that a few *pertussis* strains were incompletely precipitated; this was unusual, having never occurred with alumina, and we thought it worth while to investigate the difference in behaviour of the various strains.

The strains were subjected to the customary test for agglutinability, using a phase I immune rabbit serum. It was found that the strains which had become incompletely precipitable with aluminium phosphate had also lost their ability to be agglutinated by the immune serum. To elucidate this phenomenon further, an examination was made of the twelve strains kept as stock cultures in our laboratories, and of a further thirty-three strains, freshly isolated from whooping-cough cases and kindly supplied to us by Dr. R. Cruickshank, of the Central Public Health Laboratory, Colindale. All strains were tested for agglutinability, using a formol-killed suspension prepared from each at a concentration of 2,000 million organisms per ml. Precipitability with aluminium phosphate was tested by adding 0·3 ml. of 5 per cent solution of disodium phosphate and 1 ml. of a solution of 2 per cent potash alum to 4 ml. of bacterial suspension at a concentration of 20,000 million organisms per ml. This is approximately twice the minimum amount of aluminium phosphate needed completely to precipitate the average precipitable strain. An estimate of the proportion of organisms precipitated was made by opacity measurements of the supernatant fluid about thirty minutes after the floccules had begun to deposit.

The results are summarized in the accompanying table, which demonstrates that freshly isolated strains of *H. pertussis*, as well as old laboratory cultures having a satisfactory agglutination titre, were all completely precipitated with aluminium phosphate. Stained preparations of the suspensions of the two types of strains were examined under the microscope, and it appears that the non-agglutinable were shorter and smaller than the agglutinable strains. Stained with Giemsa, the former were rather basophil; but no morphological difference could be demonstrated.

Number of strains and origin

	5 laboratory stock cultures	7 laboratory stock cultures	33 Colindale
Agglutination titre	Less than 1 : 1,000	1 : 12,000 1 : 16,000	1 : 8,000 1 : 30,000
Behaviour with phosphate	Not precipitated	Completely precipitated	Completely precipitated

Various species of bacteria other than *H. pertussis* were tested for their precipitability with aluminium phosphate. It was found that the Gram-positive cocci (*Staph. aureus, Strept. hæmolyticus* and *pneumococcus*) are completely precipitated, as also is *C. diphtheriæ* (7 strains): *Ps. pyocyanea* and *Klebsiella pneumoniæ* were not precipitated, nor was *B. coli* or *B. paracolon*. Some strains of the *B. typhosum-paratyphosum* group were precipitated and some were not. The agglutinability of the strains could not be correlated with their precipitability. Three strains of *H. parapertussis* were found to be invariably precipitated: they could not be rendered non-agglutinable by *parapertussis* immune serum, despite repeated sub-culture (over two years).

H. pertussis suspensions stored after addition of phenol or ethyl alcohol slowly lose their agglutinability. It was found, however, that organisms rendered non-agglutinable by this means were still completely precipitated by aluminium phosphate. Moreover, we observed that agglutinable organisms after aluminium phosphate precipitation retain completely their ability to adsorb agglutinins from an immune serum.

Other adsorbents were studied, and we have found that cadmium phosphate behaves in the same manner as aluminium phosphate, whereas crystalline magnesium ammonium phosphate, although a relatively poor adsorbent, does adsorb agglutinable suspensions more readily. Acriflavine (1/2,000) precipitates all suspensions irrespective of agglutinability.

A *p*H optimum at which the organisms were most readily precipitated, analogous to an isoelectric point was not found; agglutinable organisms were precipitated with equal facility over the *p*H range 4·0–10·0. At *p*H values below 4·0 precipitation does not take place, owing to solution of the adsorbent. Non-agglutinable organisms are not precipitated at any *p*H between 4·0 and 10·0.

Further indications that the two types of organism differ in surface properties were given by the finding that the agglutinable organisms are completely soluble in 0·2 *N* sodium hydroxide, or in 2 per cent solution of sodium desoxycholate, whereas non-agglutinable organisms are unaffected. There would appear to be an analogy with the bile-soluble organisms of the *Streptococcus* group (pneumococcus), which have an antigenically active surface polysaccharide.

Agglutinability and precipitability of the two types of *pertussis* organisms were not influenced by treatment with salivary amylase or urinary diastase, and Molisch's test was positive for both types of suspension. Work on the relation between the biological properties of *H. pertussis* strains (agglutinability by immune serum, virulence to laboratory animals, endotoxin production, growth requirements on semi-synthetic media) and physical behaviour towards precipitants and solubilizing agents shows a close parallelism: it is hoped to publish our findings in fuller detail elsewhere.

J. UNGAR
P. MUGGLETON

Research Division,
Glaxo Laboratories, Ltd.,
Greenford, Middlesex.
June 1.

N. Acridyl-(5)-Alanines as Antibacterial Substances

THE occurrence of D amino-acids in several antibiotic polypeptides has stimulated interest in the correlation between the optical form of amino-acids and their effect on the antibacterial activity of certain molecules[1,2]. In furtherance of the investigation previously reported by Linnell and Smith[3], the synthesis and resolution of the ethyl ester of DL-N. acridyl-(5)-alanine has been accomplished.

Condensation of DL-alanine with 5-chloroacridine in phenol solution gave a 96 per cent yield of DL-N. acridyl-(5)-alanine as a yellow powder, m.p. 214° (found: C, 70·7; H, 5·48; N, 10·7; theory: C, 72·1; H, 5·26; N, 10·52 per cent). The monohydrate of this acid had been prepared, in 80 per cent yield, by the condensation of alanine and 5-methoxyacridine[4]. The acetate, hydrochloride and sodium salt of the above compound were prepared under anhydrous conditions; but bacteriological testing at this stage was not possible because the free acid was practically insoluble in water and aqueous solutions of the salts rapidly hydrolysed to the parent acid. A similar result has been reported for N. acridyl-(5)-glycine by Dupré and Robinson[5].

Esterification with ethyl alcohol in the presence of dry hydrochloric acid gas gave an 80 per cent yield of the racemic ester. This crystallized from aqueous alcohol as small yellow prisms, m.p. 75° (found: N, 9·25; H, 6·26; theory: N, 9·52; H, 6·12 per cent). The ester gave well-defined crystalline compounds with picric and picrolonic acids, and its diacetate and monohydrochloride were quite stable in aqueous media. A preliminary test showed that a 0·1 per cent aqueous solution of the diacetate possessed antibacterial activity against *Staphylococcus aureus* and *Streptococcus pyogenes*.

Resolution of the racemic ester was achieved by the use of (+) tartaric acid. An 87 per cent yield of the racemic ester (+) bitartrate was obtained by mixing hot absolute alcohol solutions containing equivalent quantities of the ester and (+) tartaric acid. This salt was a deep yellow powder, m.p. 165°, $[\alpha]_D^{20} = +18°$ (water, $C = 4·0$). Fractional crystallization from 80 per cent alcohol gave the (+) ester (+) tartrate as long yellow needles, m.p. 118°, $[\alpha]_D^{20} = +54·5°$ (water, $C = 4·0$). Evaporation of the mother liquors and repeated crystallization of the residue from absolute alcohol gave the (−) ester (+) tartrate as a yellow powder, $[\alpha]_D^{20} = -19·5°$ (water, $C = 4·0$).

The ester isomers were isolated by extracting aqueous solutions of their respective (+) tartrates, which had been made alkaline with ammonia, with benzene. They were obtained as viscous yellow oils, (+) N. acridyl-(5)-alanine ethyl ester, $[\alpha]_D^{20} = +128°$ (96 per cent alcohol, $C = 2$); (−) N. acridyl-(5)-alanine ethyl ester, $[\alpha]_D^{20} = -122°$ (96 per cent alcohol, $C = 2$).

Preliminary bacteriological tests on aqueous solutions of the (+) tartrate showed that these salts caused inhibition of growth in the following dilutions:

Organism	Racemic ester (+) bitartrate	(+) ester (+) tartrate	(−) ester (+) tartrate
(1) *Staphylococcus aureus*	1/6000	1/6000	1/3000
(2) *Streptococcus pyogenes*	1/4000	1/4000	<1/2000

A fuller account of this work is to be published elsewhere. The preparation and resolution of DL-β acridyl-(5)-alanine is now being investigated, and it is proposed to include other amino-acids in later work.

W. H. LINNELL
M. J. H. SMITH

Research Laboratories,
Chemistry Department,
College of the Pharmaceutical Society,
17 Bloomsbury Square,
London, W.C.1.
July 12.

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Genetic Transmission of Two Rare Blood-Group Genes

To date no data of families have been published which illustrate the genetic transmission of the rare gene r^y, and only but one or two families which illustrate the transmission of gene R^z.

Recently, four families were encountered which illustrate the genetic transmission of the genes r^y and R^z in striking fashion. Because of the rarity of such cases, it seems important to record them, and they are listed in the accompanying table.

Families illustrating genetic transmission of the rare genes R^z and r^y

Case number		Parents		Children		
		Father	Mother			
1	Phenotype	Rh_1Rh_2	rh	rh	Rh_1Rh_2	Rh_1Rh_2
	Genotype	R^zr	rr	rr	R^zr	R^zr
2	Phenotype	rh′rh″	rh	rh	rh′rh″	
	Genotype	r^yr	rr	rr	r^yr	
3	Phenotype	Rh_1Rh_2	rh	Rh_1Rh_2		
	Genotype	R^zr	rr	R^zr		
4	Phenotype	Rh_1Rh_z	rh	Rh_1rh	Rh_1Rh_2	
	Genotype	$R\,R^1$	rr	R^1r	R^zr	

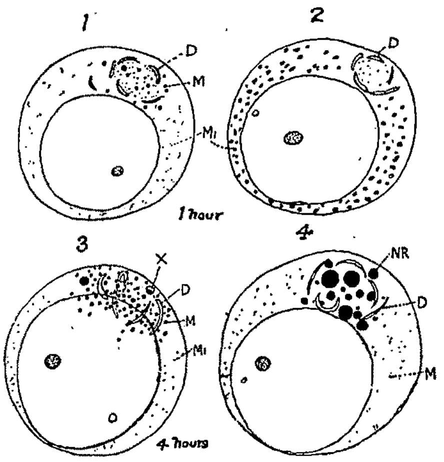
Incidentally, these more complicated cases serve to underline the importance of avoiding ambiguity between the designations for the phenotypes and genotypes.

A. S. Wiener

64 Rutland Road,
Brooklyn, N.Y.
Sept. 27.

Methylene Blue as a Vital Stain for the Golgi Apparatus

Experiments have been made with five specimens of methylene blue as a vital stain for the spermatocytes of *Helix aspersa.* The specimens were an old German 'polychrome methylene blue', and four others, 'pure methylene blue', and just 'methylene blue'.



In a suitable concentration all the specimens acted in the same way, being segregated into small droplets (M) inside and outside the Golgi apparatus (D), neither the mitochondria, M_1, nor the lenticular dicytosomes staining (Fig. 1). At a higher concentration of the dye (not the polychrome methylene blue) the mitochondria stained intensely, rivalling the best Janus green vitally stained cells (Fig. 2). In many of these cases the methylene blue granules associated with the Golgi apparatus (Fig. 1) did not appear. The polychrome methylene blue at these higher, perhaps lethal, concentrations tended to stain the mitochondria blue and rarely the dictyosomes of the Golgi apparatus a reddish colour. The main difference between methylene blue and neutral red as vital dyes for *Helix* spermatocytes is that the methylene blue can be made to stain mitochondria or to segregate into droplets in the region of the Golgi apparatus, whereas neutral red does not stain the mitochondria or Golgi dictyosomes, but easily segregates into droplets which grow in size according to the length of time the cells are exposed to the dye. In Fig. 3 is a cell which has been exposed to a weak methylene blue solution for four hours. The number of methylene blue segregation artefacts has increased very greatly, the dictyosomes are still unstained and in rare cases the methylene blue segregation cavities may be large (X). Generally speaking, these cavities do not become as large as the neutral red artefacts (Fig. 4, after four hours).

It is interesting to note that the methylene blue segregation artefacts shown in Fig. 3 are spread both inside and well outside the region of the Golgi apparatus. In more highly differentiated cells, such as nerve or salivary cells, the behaviour of the methylene blue dye will be more complicated.

It is hoped to publish the results of these and other experiments on methylene blue and Sudan Black B elsewhere in a fuller form.

J. Brontë Gatenby
Tohamy A. A. Moussa

Department of Zoology and
Comparative Anatomy,
Trinity College,
Dublin.

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Passage of Hæmoglobin from Blood into Eggs of *Daphnia*

It is known that the amount of hæmoglobin dissolved in the blood of *Daphnia* varies inversely with the oxygen content of the water in which the animals live. The changes in concentration of the hæmoglobin have been studied by a quantitative method which allows measurements to be made on a single *Daphnia*: the colour of the animal's blood is compared under the microscope with known dilutions of human blood[1]. In the course of further work involving the use of this method it was noticed that parthenogenetic females with eggs in the brood pouch have less hæmoglobin in their blood than those with embryos in the pouch. The difference is greatest in populations producing numerous young.

The parthenogenetic eggs of *Daphnia* contain hæmoglobin[2]. It can be seen under the microscope with reflected light that the ovaries become progressively pinker as they enlarge during the last few hours preceding egg-laying. The microspectroscope shows that this pink colour is that of oxyhæmoglobin. Moreover, at the same time as the pink colour is increasing in the ovaries, the blood becomes paler. This decrease in the hæmoglobin content of the blood may amount to one-third. The inference is that hæmoglobin passes from the blood into the eggs as they develop in the ovary. The course of the decrease during the six hours before the moult, which immediately precedes egg-laying, has been studied quantitatively in a number of individual *Daphnia.* It is at first gradual and then rapid. Part of the final decrease in the pink colour of the blood is due not to a loss of hæmoglobin but to a dilution of the blood resulting from the moult and the increase in body-size which is its consequence. This dilution, however, accounts only for a small proportion of the decrease in blood colour. After egg-laying, the hæmoglobin of the blood is gradually regenerated to its original level. The course of this regeneration has been followed quantitatively over the 2–3 days during which the embryos develop in the brood pouch and are finally liberated prior to the next moult.

The molecules of *Daphnia* hæmoglobin appear to be of two sizes, with weights respectively one-half and six times that of mammalian hæmoglobin; the larger molecules are the more abundant[3]. The passage of this protein from the blood into the ovary raises an interesting problem. Either the blood hæmoglobin must be rapidly broken down and the products rapidly resynthesized in the ovary, or else the hæmoglobin molecule as such crosses the cell membranes. This would not be the sole case where the passage of a protein molecule across a cell membrane is suspected. Other examples are found in the secretion of hormones and enzymes, virus penetration and the particularly relevant case of the acquisition of passive immunity in birds' eggs. Here the antitoxin passes from the blood serum of the bird into the eggs[4,5].

A full account of this work will be published elsewhere. I wish to express my sincere thanks to Prof. H. Munro Fox for his interest and advice.

ELISABETH I. B. DRESEL
Bedford College,
University of London.
Oct. 7.

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Effect of Carbon Dioxide on Availability of Manganese in Soil Producing Manganese Deficiency

A SERIES of experiments, extending over several years, in which potato plants were grown both in pots and in the field, in soil producing manganese deficiency, from the recently drained lake-bed at East Malling Research Station, has led us to suspect the presence of some hitherto unexplained factor influencing manganese availability. The soil in question is an alluvial deposit containing a large amount of calcium carbonate and organic matter and has a *p*H of 8·0–8·5. The soil contains ample manganese, as simple extractions in Morgan's solution yield considerably more than 50 p.p.m. of manganese on a dry soil basis. This, however, is only a small fraction of the total, as is shown by extractions with strong acid. The amount of manganese available to the plant is, on the other hand, very small, since plants containing less than 1 p.p.m. on a fresh weight basis and showing acute deficiency symptoms are of common occurrence in certain areas of the lake-bed. Attempts to reproduce these conditions using the same soil in pot culture never succeeded in producing plants showing such marked symptoms or low manganese contents, although the soil *p*H was maintained between 8·0 and 8·5 by irrigating with water saturated with calcium carbonate. Water extracts of soil taken either from pots or the lake-bed itself showed negligible amounts of extractable manganese, although the plants grown in pot culture in the summer of 1948 showed no manganese deficiency, while those grown in 1947 were much less deficient than those growing on the lake-bed.

Consideration of these facts led to the hypothesis that local accumulations of carbon dioxide within the root-masses might render manganese available without producing perceptible changes on the *p*H of the soil as a whole. The following experiment was therefore carried out. Some uniformly mixed soil (water content 9·0 per cent) was collected and finely ground. Portions of 250 mgm. each were weighed out into 150 ml. conical hard-glass flasks, well corked, and were left in contact for forty-eight hours with high-grade water re-distilled in quartz. The water used was divided into two parts, one of which was saturated with acid-free carbon dioxide at 20° C. and the other boiled. Mixtures in varying proportions were used, keeping the total volume at 25 ml. A flask was also set up in which the water was kept saturated with carbon dioxide during the extraction. After extraction the liquid was centrifuged to remove soil particles, and the *p*H and amount of manganese extracted determined. The results are given in the accompanying table.

ml. boiled water	ml. water saturated with CO_2	p.p.m. of Mn extracted calc. on dry soil	*p*H of extract
25	—	<0·1	8·0–8·5
24	1	<0·1	8·0–8·5
23	2	<0·1	8·0–8·5
21	4	<0·1	8·0–8·5
17	8	0·4	8·0
9	16	2·6	7·5
—	25	5·6	7·5
—	25 kept sat. with CO_2	22·0	6·0

Owing to the extremely localized accumulation of carbon dioxide likely to occur in the soil, and the large excess of calcium carbonate present, no general changes in *p*H have been detected in the pot cultures, which remained uniformly above *p*H 8·0.

The liberation of manganese by these local accumulations of carbon dioxide would go far to account for the patchy distribution of symptoms found in the field and the higher manganese contents of pot plants with a more compacted root system. Owing to the rain early in the summer of 1948 the soil of the pots was saturated with water for several weeks, while in 1947 these conditions did not occur, which may explain the observed differences in manganese uptake.

B. D. BOLAS
G. B. PORTSMOUTH
Research Institute of Plant Physiology,
Imperial College of Science,
London, S.W.7.
Sept. 17.

Protection of Grain against Weevils

TO-DAY, the losses of foodstuffs caused by insects, principally weevils, often disregarded in pre-war days, cannot be overlooked. A conservative estimate has been made that on the average losses of ten per cent of all stored food are caused by insects[1]. In the tropics the life-cycle of weevils and other insect pests is accelerated as the temperatures are close to the optimum and, furthermore, breeding is continuous throughout the year, so that the losses can attain appalling proportions—samples of grain offered for sale have been seen in which more than 50 per cent of the individual grains have been seriously damaged. In such infested grain there is a further attack by the flour beetle, *Tribolium castaneum*, which spoils the little good grain remaining by the taint.

During the last few years investigations have been in progress on inert dusts of local origin, some of which, notably diatomite, have been found to give fair protection. Jepson[2], in Tanganyika, has most successfully employed a 'Gammexane' dust diluted with diatomite, at a rate to provide 1 p.p.m. of the gamma isomer. The Ministry of Food has objected to this very small concentration on the grounds of possible poisonous effects; true, there is a danger of applications of the dust being made by each successive handler. Pyrethrum powder, a local product, has often been suggested as a protectant; but on account of its supposed short life has not been used. In September last an experiment was started in which diatomite, diatomite–pyrethrum dusts and pure pyrethrum powder were used. Four types of grain were included: clean maize, weevily maize, clean wheat and weevily wheat; unfortunately the 'clean' maize became infested *en route* and should be placed in the category of 'slightly weevily'. Six treatments were included, namely: untreated; diatomite alone, at the rate of 2 lb. per 200-lb. bag; three diatomite–pyrethrum dusts of increasing pyrethrum concentration, also at the rate of 2 lb. per 200-lb. bag; and, finally, pyrethrum powder, fairly finely ground, at the rate of 1 lb. per bag. Each treatment was replicated four times, and the bags were stacked in a randomized block, which ensured continuous infestation of the whole stack from the untreated weevily bags.

At the end of a week, counts made on random samples drawn from all the bags in the stack revealed that all the treatments had reduced the numbers of living weevils to a highly significant degree. Complete protection was given by all pyrethrum treatments over three months, though in the diatomite lot a few live weevils were found. At the end of six months, the infestation in the bags treated with the weakest pyrethrum–diatomite dust (20/80) had become mild. Complete protection has been afforded by the other two dusts and the pyrethrum powder for eight and a half months when, for the first time, random samples revealed living weevils in significant numbers. At the end of this period the untreated 'clean' wheat contained 57·3 per cent of damaged grains; the grain treated with diatomite alone 12·5 per cent; that with the weakest dust 3·5 per cent; while only a fraction of 1 per cent was damaged in those protected with the two stronger dusts and pyrethrum powder. There is evidence that an application of less than 1 lb. a bag will provide adequate protection, especially if the powder be more finely ground[3].

Perhaps the most interesting point established in these experiments is the unexpectedly long life of pyrethrum powder in bagged grain. Since the effect is very rapid, there would be no chance of stray weevils entering bags of grain treated with pyrethrum powder being able to lay eggs. The long protection given would also tend to destroy weevils emerging from grain lying on the floor of the warehouse; thus, complete protection for a much longer period than eight months may be confidently expected.

The detailed results of these experiments will be published elsewhere.

V. A. BECKLEY

Pyrethrum Board of Kenya,
Department of Agriculture,
Nairobi, Kenya.

June 14.

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Fast Neutron–Proton Scattering and the Law of Interaction between Nucleons

IN order to use the results of experiments on the scattering of high-energy neutrons by protons to obtain information about nuclear interactions, it is necessary to calculate the expected angular distribution of the scattered neutrons and the total collision cross-section for a large variety of different possible types of nuclear interaction.

Until now, practically all calculations of the scattering which have taken account of non-central forces have assumed a spherical well, radius $2 \cdot 80 \times 10^{-13}$ cm., as the shape of the interaction. Recently Hu and Massey, in a paper to appear shortly in the *Proceedings of the Royal Society*, have calculated the appropriate interaction constants for a number of different shapes of interaction. Following Rarita and Schwinger[1], they investigated three types of the n—p interaction with exchange properties suggested by the symmetrical, charged and neutral meson theories, which we shall call interactions I, II and III respectively. For states of even parity the interactions were taken as the same for each type of force, namely,

$${}^1V_{\text{even}} = -\frac{\hbar^2}{Mr_0^2}\, gV\left(\frac{r}{r_0}\right),$$

$${}^3V_{\text{even}} = -\frac{\hbar^2}{Mr_0^2}\, a\,(1+\gamma S_{12})\, V\left(\frac{r}{r_0}\right),$$

r being the range of the interaction, S_{12} the tensor force operator, and g, a, γ dimensionless constants; this g is not the same as the g used by Rarita and Schwinger.

The interaction functions $V\left(\frac{r}{r_0}\right)$ investigated were of the following forms:

(1) Spherical well $V\left(\frac{r}{r_0}\right) = 1$ for $r < r_0$
$\phantom{V\left(\frac{r}{r_0}\right)} = 0$ for $r > r_0$

(2) Yukawa potential $V\left(\frac{r}{r_0}\right) = \left(\frac{r_0}{r}\right)\exp\left(-\frac{r}{r_0}\right)$

(3) Exponential potential $V\left(\frac{r}{r_0}\right) = \exp\left(-\frac{r}{r_0}\right)$

(4) Gaussian potential $V\left(\frac{r}{r_0}\right) = \exp\left\{-\left(\frac{r}{r_0}\right)^2\right\}$

For a variety of ranges, r_0, Hu and Massey determined a, g and γ to give correctly the binding energy, the energy of the virtual singlet state, and the quadrupole moment of the deuteron.

A knowledge of these interaction constants has made possible a systematic investigation of the dependence of the total cross-section and angular distribution in high-energy n—p scattering on the range and shape of the assumed interaction. Accurate calculations of this type are at present being carried out in this Department for incident neutron energies in the range 100–250 MeV. These calculations are very lengthy, however, and in the meantime we have used the Born approximation to calculate the scattering in this energy range.

Ashkin and Wu[2] have investigated the validity of this approximation in the case of the spherical well of range $2 \cdot 80 \times 10^{-13}$ cm. They found that, although it is not very good at neutron energies of 100 MeV., it gives fairly good agreement with exact calculations for neutron energies of 200 MeV., the agreement being poorest in the case of interactions of type II.

In general, the Born approximation appears to give rather too large a value of the total cross-section. This is shown, for example, in Table 1, which compares the total cross-section as calculated by the Born approximation in the present work with exact values obtained previously by Massey, Burhop and Hu[3]. These values refer to a spherical well interaction of range $2{\cdot}80 \times 10^{-13}$ cm., and incident neutrons of energy 83 MeV.

Table 1

	Total cross-section ($\times 10^{26}$ cm.^{2})			Ratio $\sigma_{180°}/\sigma_{90°}$		
	Inter. I	Inter. II	Inter. III	Inter. I	Inter. II	Inter. III
Exact theory	14·10	15·77	23·38	10·2	3·67	0·58
Born approximation	19·05	23·32	28·32	11·3	3·56	0·53

Table 1 shows also that the ratio $\sigma_{180°}/\sigma_{90°}$ of the differential cross-section at 180° to that at 90° in the c.m. system is given fairly well by the Born approximation.

For other forms of interaction one would expect the Born approximation to give better results than in the case of the spherical well. Thus, for a purely central type of Yukawa interaction of range $1{\cdot}18 \times 10^{-13}$ cm. and symmetrical forces, Chew and Goldberger[4] found that the Born approximation gives a total cross-section about 7 per cent too large at 100 MeV.

(4) The decrease of total cross-section with increase of neutron energy is more rapid with the longer range interactions.

(5) The spherical well shape of interaction tends to give a larger total cross-section and a smaller ratio of $\sigma_{180°}/\sigma_{90°}$ than the other shapes. This, however, could arise partly from the poorer accuracy of the Born approximation in the case of the spherical well.

The Berkeley measurements of the total cross-section gave the value $8{\cdot}3 \pm 0{\cdot}4 \times 10^{-26}$ cm.^{2} for 90 ± 13 MeV. neutrons[5]. Of all the interactions investigated, the only one that gives a value approaching this is the Yukawa potential of range $1{\cdot}18 \times 10^{-13}$ cm. for type I interaction, which gives a value of $9{\cdot}1 \times 10^{-26}$ cm.^{2}. According to the interaction constants given by Chew and Goldberger[4] and used for this range, the triplet interaction in this case is almost wholly non-central.

The provisional experimental value[6] of $\sigma_{180°}/\sigma_{90°}$ is about 3. This seems to rule out any kind of type III interaction. The Yukawa symmetrical case of range $1{\cdot}18 \times 10^{-13}$ cm. gives about 6·2 for this ratio. It seems to be a feature of the angular distribution in the case of the Yukawa potential with type I interaction, however, that there is a sharp increase in differential cross-section at scattering angles near 180°. In such a case an experimental measurement might be expected to give a value of $\sigma_{180°}/\sigma_{90°}$ somewhat too small.

A full account of these calculations will be published elsewhere.

Table 2

Shape of Interaction	Range $\times 10^{13}$ cm.	Total cross-section ($\times 10^{26}$ cm.^{2}) Inter. I		Inter. II and III		Ratio $\sigma_{180°}/\sigma_{90°}$ Inter. I		Inter. II		Inter. III	
Neutron energy in laboratory system (MeV.)		100	250	100	250	100	250	100	250	100	250
Spherical well	3·49	19·0	7·5	22·1	8·5	75	1240	37	757	0·12	0·68
	3·05	17·6	7·4	20·3	8·1	25·8	2190	8·9	942	0·26	0·40
	2·80	17·0	7·7	20·7	8·7	12·9	136	3·7	48·2	0·30	0·05
	2·62	16·8	8·0	22·2	10·0	7·6	36·5	1·5	8·7	0·44	0·04
	2·18	25·5	15·3	48·9	30·8	2·4	3·1	0·44	0·62	0·98	0·01
Yukawa potential	2·18	14·1	6·0	16·6	6·6	90	397	64·8	269	0·34	0·31
	1·74	11·9	5·5	13·8	6·4	38	152	18·9	64·4	0·40	0·35
	1·18*	9·1	5·9	16·5	10·4	6·2	14·3	0·61	1·29	0·59	0·43
Exponential potential	1·09	15·3	6·2	17·6	7·0	99·5	562	43·0	237	0·28	0·20
	0·87	12·6	5·9	15·3	7·1	22·7	102	8·5	31·9	0·39	0·25
Gaussian potential	2·18	14·9	6·5	17·7	7·5	32·9	266	12·3	91·9	0·25	0·13

* The constants used for this range are approximate ones given by Chew and Goldberger[4].

Table 2 shows the results of the present calculations. Some general conclusions to be drawn from this able are as follow:

(1) The total cross-section for interaction types I and III is always larger than for type I.

(2) The ratio $\sigma_{180°}/\sigma_{90°}$ is greatest for interaction I nd always less than 1 for interaction III.

(3) As the range of interaction decreases, the total ross-section passes through a minimum and then tarts to increase again while the ratio $\sigma_{180°}/\sigma_{90°}$ coninually diminishes. The increase of the total cross-ection at very short ranges is associated with the ncreasing importance of the tensor force. In the xtreme case of a spherical well of range 2·18 × 0^{-13} cm., the non-central interaction is so large that he central interaction has to be made repulsive to ive the correct deuteron binding energy.

We are greatly indebted to Prof. H. S. W. Massey and Dr. Tsi-Ming Hu for allowing us to use, prior to publication, the interaction constants calculated by them, and for valuable discussions during the course of the present work.

E. H. S. BURHOP
H. N. YADAV

Mathematics Department,
University College,
London, W.C.1.
July 28.

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Photo-Elastic Effect in Barium Nitrate

During the course of our investigations on photo-elasticity, we have found that single crystals of barium nitrate behave in many respects in an exceptional manner. Differences between the stress-optical constants as determined by a Babinet compensator are $(q_{11} - q_{12}) = -23 \cdot 81 \times 10^{-13}$, $(q_{11} - q_{13}) = -18 \cdot 06 \times 10^{-13}$ and $q_{44} = -1 \cdot 62 \times 10^{-13}$ C.G.S. units for the sodium *D* lines. $(q_{11} - q_{12})$ and $(q_{11} - q_{13})$ furnish a measure of the birefringence caused when pressure is applied along a cube axis.

Values given above for barium nitrate are the largest so far obtained for any cubic crystal. These values are not only larger than those hitherto reported for other cubic crystals, but are also larger than the corresponding value for most glasses, which does not generally exceed 10×10^{-13}. Barium nitrate crystals belong to the T_h class and we would expect $(q_{11} - q_{12})$ to be different from $(q_{11} - q_{13})$. It is an interesting feature that the difference in this case is nearly 27 per cent, and is much larger than that observed by us earlier in potassium and ammonium alums[1]. It is also to be noted that for this substance the birefringence produced by a pressure along a cube axis is nearly fifteen times that produced by an equal pressure along a cube diagonal. This should be regarded as a large anisotropy, as the corresponding figure for potassium alum, its nearest approach, is only eight times.

S. Bhagavantam
D. Suryanarayana

Department of Physics,
Andhra University,
Waltair, India.
May 28.

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Inclusions in Aluminium Crystals

It appears from various experiments that the ease with which a crystal can grow in a deformed matrix depends very much on the mutual orientation of growing and disappearing lattice domain. This is already obvious from the fact that, in a recrystallizing coarse-grained material, the new crystals show corrugated boundaries, demonstrating visibly that some of the original grains are consumed at a faster rate than others[1]. Recent experiments give a far more striking proof of this phenomenon.

It was observed by Carpenter and Elam[2] in their original paper on the preparation of aluminium crystals by the stress-strain method that the large crystals so obtained often contain small included domains with deviating orientation, which were obviously unabsorbed grains from the original fine-grained material. These inclusions proved to be very stable against prolonged heat treatment (see, for example, Seumel[3]).

It struck us that in a crystal with a number of inclusions, several of these domains reflected incident light at the same moment, thus pointing to a more or less identical orientation. It seemed worth while to determine this orientation, and to look for a relation between the orientation of the 'mother crystal' and the orientation of the included domains. As the dimensions of these domains depend on the grain size of the matrix, they can vary considerably, so that it is not always possible to determine the orientation of an inclusion by X-ray methods. In these cases the etch method, developed for aluminium by Lacombe and Beaujard[4], was used. By this method tiny cubic etch-pits are developed, and the boundary lines of the pits are therefore traces of (100) planes on the surface of the test piece. Starting from the orientation of the mother crystal (determined from a Laue transmission photograph), the (100) traces to be expected for the four spinel twin orientations were constructed by means of stereographic projection. It was found that the pits in the inclusions had orientations which coincided with the four twin possibilities within about 5°. Fig. 1 shows two different twins in the same mother crystal.

The orientation of larger inclusions (approximately 0·2 mm. diameter) could be obtained by X-ray methods (Laue transmission photographs). These photographs consisted of the superimposed Laue patterns of mother crystal and inclusion; as the pattern of the included domain showed a marked asterism as a result of the deformation before recrystallization (this proves at the same time that the included domain is no new crystal), it was not difficult to separate them. The photographs confirmed the relationship between the orientations already found by the etch method. Fig. 2 shows the Laue patterns of mother crystal and inclusion superimposed; the enclosed spots would have coincided for an exact twin relationship.

According to these experiments, it seems to be difficult for a growing crystal to consume those lattice blocks which occupy approximately a twin position. From this it might be deduced that in order to prepare large aluminium crystals by the stress-strain method without such inclusions, one has to start from fine-grained material of such 'narrow' texture that a growing crystal has no chance of meeting its (approximate) twin position. A second point is the striking difference in behaviour between grains in *approximate* twin position and lattice blocks which give rise to exact twins. As was found in earlier work[5], a growing crystal may induce ('stimulate') a block to become an active nucleus, which develops into an exact twin with regard to the stimulating crystal (for a more extensive account on exact twins in aluminium and the idea of 'stimulation' we refer to ref. 6).

At the moment, we have not yet been able to analyse the geometrical relationship between two

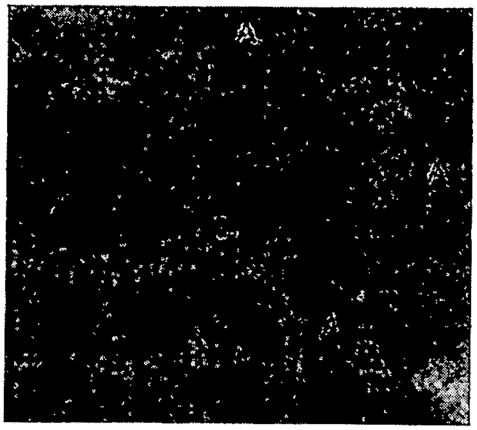

Fig. 1. Part of an aluminium crystal, *A*, containing an 'unconsumed' inclusion, *B*, with cubic etch pits. From the relative position of the etch pits it can be deduced that the inclusion *B* is approximately a spinel twin with regard to *A*. × 300

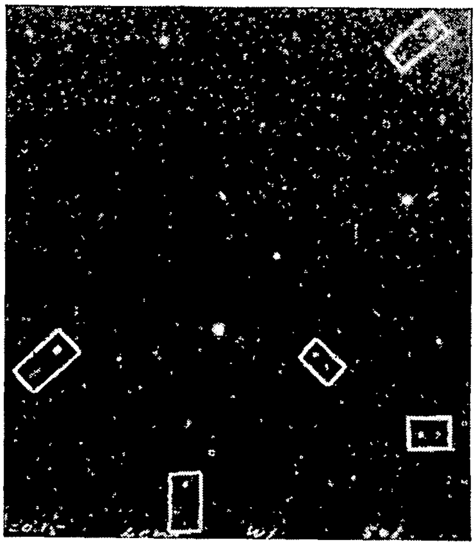

Fig. 2. Superimposed Laue patterns of a large aluminium crystal (sharp spots) and of an unconsumed inclusion of the original deformed matrix (slightly elongated spots). Pairs of spots enclosed by ▭ would coincide if the orientation relationship between crystal and inclusion was exactly that of a spinel twin

win orientations sufficiently to understand why con-umption of an approximate twin lattice is apparently o difficult.

Note added in proof. In recent work by P. A. eck, M. L. Holzworth and Ph. Sperry on grain rowth in Al–Mn alloys (1948) it was similarly found hat the large crystals, which develop on continued eating of special fine-grained recrystallized material y a process of 'exaggerated' or 'discontinuous' grain-rowth (also called 'secondary recrystallization'), eave unconsumed definite small grains of the original matrix: Prof. Beck kindly put some of his crystals t our disposal, and here also the same 'approximate win-relation' between large crystal and imbedded nclusion was found.

W. MAY
T. J. TIEDEMA
W. G. BURGERS

aboratory for Physical Chemistry,
Technical University,
Delft.
June 1.

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Electrokinetic Potentials of Aged Barium Sulphate Crystals

ELECTROKINETIC methods can be used with great dvantage in the study of the adsorption of electro-tes or potential-determining ions on crystalline bstances. One of us[1] determined the streaming otentials in diaphragms of precipitated and aged arium sulphate, as a function of the composition of e bathing electrolyte solution. Reyerson, Kolthoff d Kieth Coad[2] have recently confirmed in a general ay these results, with the exception that they found constant negative charge in hydro-alcoholic (50 per cent) solution of potassium chloride (10^{-5} *M*). Ruyssen[1] had found that by the replacement of the aqueous potassium chloride solution by a hydro-alcoholic one the initial negative charge was reversed.

We have re-investigated the point under discussion with the same samples of barium sulphate and the following experimental facts were definitely established: (1) The charge of the barium sulphate was negative in both aqueous and hydro-alcoholic potassium chloride (10^{-5} *M*) solution, provided these were the first solutions with which the crystals came in contact. (2) When the aqueous potassium chloride solution was displaced by a hydro-alcoholic one, the measured charge became positive. When the crystalline substance was taken out of the diaphragm and thoroughly washed and shaken with the same liquid, its charge was again reversed to negative. (3) When the hydro-alcoholic solution of the first experiment was displaced by pure water, the crystals were charged positively. (4) In a saturated barium sulphate solution, without other electrolytes, the crystals became again negatively charged.

We may conclude that the normal equilibrium charge of pure barium sulphate is negative in aqueous potassium chloride solution and saturated barium sulphate solution as well as in hydro-alcoholic potassium chloride solution. This is in agreement with Reyerson *et al.*[2], but not with the positive streaming potentials found by Buchanan and Heymann[3] of natural barytes and recrystallized barium sulphate. On the other hand, we confirmed the experimental fact of the reversal of the charge of the barium sulphate when the aqueous solution is displaced by a hydro-alcoholic one, although this seems not to be the equilibrium charge. It seems that in the hydro-alcoholic medium there is a precipitation of the barium sulphate out of the displaced saturated aqueous solution, followed by preferential adsorption of the Ba^{++} ions.

R. RUYSSEN
R. LOOS

Department of Medical Chemistry,
University of Ghent.

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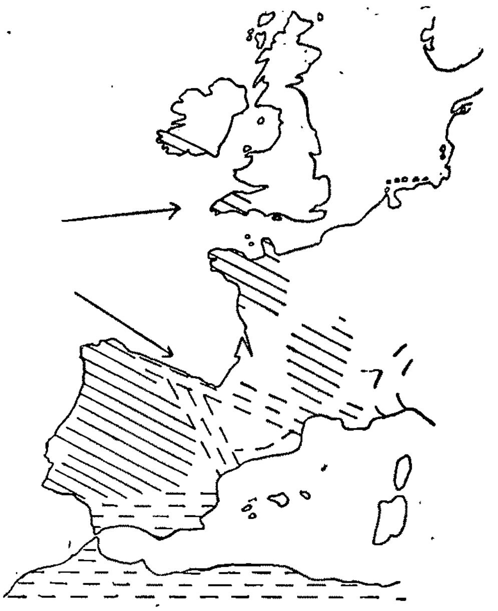
Factors Controlling the Atlantic Coastline of Europe

IN 1938, W. V. Lewis[1] pointed out that the general line of a shore tends to be at right angles to the direction of dominant wave-attack, and that as a bay becomes adjusted to this attack it tends to become asymmetrical, with the longer, smoother side facing the quarter from which the dominant waves approach. In 1940[2], I suggested that the theory applied by Mr. Lewis to beach material and easily eroded cliffs might be developed to explain the outline of the larger bays of south-west England. I showed that this would account for the fact that their eastern sides have been rendered comparatively smooth, with blunted headlands, while their western sides have been protected from dominant wave-attack, so that their indented minor bays have been preserved between angular promontories.

Various geologists have since suggested to me that this view of coastal development may be applicable to widely scattered parts of the world. In particular, I am indebted to Mr. E. E. S. Brown (now president of the Geologists' Association) for pointing out to me that both the west coast of Ireland and the Bay of Biscay are exposed to the full force of the Atlantic, while the coast of north Spain runs parallel to the line of wave-attack and is thus comparable with the coast of north Devon. These suggestions have led me to a further study of the map of western Europe from this point of view.

The outline of the Atlantic coast of France, Spain and Portugal is notable for its relative simplicity, the single northward-facing stretch turning at either end almost at a right angle into the westward-facing sectors. If wave-attack has been largely responsible for the smoothing of the westward-facing coasts, this is an illustration of the power exerted when the direction of prevailing winds happens to coincide with the direction of the greatest stretch of open ocean. In western Europe, the Westerly winds blow direct off the open Atlantic. The relation of the shore to wave-attack may possibly be very different on a coast such as that of eastern Canada, where the prevailing wind is offshore.



Sketch-map of Western Europe ; Armorican structure shown by continuous lines, Alpine structure by broken lines. Arrows indicate approximate direction of prevalent winds. (Bonne's projection)

Moreover, in western Europe the direction of the open ocean and prevailing winds happens to lie at right angles to the principal structural lines. The northern limit of Armorican, otherwise known as Hercynian, folding (originating in Permo-Carboniferous times) ran approximately east and west through south-west Ireland and southern England, resulting in the mountain ranges, now worn down to mere stumps, of Devon and Cornwall and of Brittany. Following the older Caledonian lines of weakness, running in a rather more north-east to south-west direction, granites were injected into Devon and Cornwall ; the granite of the Land's End protects the peninsula rather as the ferrule protects a walking-stick. A corresponding series of igneous and metamorphic rocks form the backbone of the Breton peninsula. The English Channel has eaten its way into the lower ground between Cornwall and Brittany, and, still farther south, the west of France is traversed by valleys where a submergence of about 600 ft. would unite the Bay of Biscay with the Gulf of Lions in a strait through the 'Gate of Carcassonne'.

The next rib in the skeleton of western Europe is the Pyrenees, which, although dating from the Alpine orogeny of Tertiary times, follow the same east and west axis as the earlier Armorican folds. Thus the general trend of the north coast of Spain runs straight from the Alpine Pyrenees into the Alpine and Armorican Cantabrians. The great block of the Iberian peninsula consists of the Meseta, which is lapped round in the south by the Betic Cordillera folded in the Alpine period. The structural control is continued in North Africa by the Alpine range o the Atlas Mountains, the sea having broken through between the Atlas and the Betic Cordillera to form the Strait of Gibraltar. Much of the Atlantic coast of Spain and Portugal lies in 'Mediterranean' latitudes south of the Westerly wind belt, but owing to the relation of land and sea it is not exposed to the North East Trades, and even in summer the winds have a westerly component. However, the Iberian coast presumably depends more for its form on structure and less on relation to winds and waves than does the coast north of the Cantabrians.

It is the east–west folds which, owing to the coincidence of the Armorican and Alpine axes, have acted as the supporting structure of western Europe holding out the land into the Atlantic Ocean, which has eaten its way back or broken right through wherever the protection of mountain or igneous rock was lacking. Thus the coast between the east–west mountain ribs has been worn back in a north–south direction under the attack of the waves. Thes waves are driven by the Westerly winds approaching over the open Atlantic approximately at right angle to the main structural lines of western Europe.

MURIEL A. ARBER

52 Huntingdon Road,
Cambridge.
Sept. 21.

[1] Lewis, W. V., *Proc. Geol. Assoc.*, **49**, 107 (1938).

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'Pins and Needles'

It is well known that the release of a constricting cuff, which is cutting off the blood-supply to a pa of a limb, may be followed by the complex sensatio known as 'pins and needles' ; but there has bee some controversy as to which part of the nerve or i branches is giving rise to the nerve impulses. Lew *et al.*[1] and Zotterman[2] believed that the region of th nerve lying under the cuff was mainly concerne whereas Weddell and Sinclair[3] argue that the sensation "is due to the stimulation of a proportion of th peripheral nerve endings in the area in which it felt". Some new experiments to be described gi results which appear incompatible with either these views.

The pricking sensation of 'pins and needles' wa produced by the release of a blood-pressure cu placed just above the elbow, which had cut off th blood-supply to the forearm and hand for twel minutes. The pricking sensation in the normal ar was compared with the sensation felt after blocking the ulnar nerve or its branches at various levels with procaine.

A block at the elbow, just below the cuff, entirely eliminates the sensation, which must mean that the 12-cm. stretch of nerve lying under the cuff cannot be the origin of all the impulses, or even of a majority of them, as Lewis *et al.*[1] suggested. A block of the ulnar nerve branches in the hand, however, which makes the whole or a part of the ulnar skin area anæsthetic, has only the effect of modifying the sensation, the pricks being fewer and less intense, but nevertheless clearly felt in the anæsthetic skin area. This argues against the conclusion of Weddell and Sinclair[3], since the peripheral endings are, in this case, taking no part in the production of the sensations which are perceived.

The effect of a block half-way between these extremes (that is, mid-forearm) is particularly interesting. The sensation is far less intense than with a block in the hand, although the same skin area is anæsthetized in either case: the pricks are now very few, and although clearly-felt as pricks, they are individually less intense than in normal unanæsthetized skin.

These experiments suggest that the intensity and number of the pricks depend on the length of nerve which is recovering from any fixed period of depressed blood-supply, and that no part of a nerve is particularly concerned in generating the impulses which give rise to this form of 'pins and needles'. This probably explains why the pricking of 'pins and needles' is less intense when produced by a cuff at the wrist, and very feeble indeed with a cuff around a finger.

The change in the physico-chemical circumstances governing the excitability of any one nerve fibre, which occurs as the circulation is restored (the removal of a 'substance'[3]), presumably offers to all parts of that fibre the opportunity of firing off impulses, and the chance of some low-threshold point or points becoming rhythmically active should be increased when a greater length of the fibre is exposed to the changed environment.

A fuller account and discussion of this work will be published elsewhere in due course.

G. GORDON

Department of Physiology,
University of Oxford.
June 7.

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[2] Zotterman, Y., *Acta Med. Scand.*, **80**, 185 (1933).
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Persistence of D.D.T. in the Soil

THE note by M. S. Smith[1] concerning the persistence of D.D.T. and 'Gammexane' in soil is in conformity with the results of experiments carried out in Australia on the use of D.D.T. as a control of the scarab *Aphodius howitti* Hope, the larvæ of which infest pastures on the tablelands of south-eastern Australia.

The species has a simple annual life-cycle, the adult flights occurring in February. D.D.T. was applied to the pasture as a 2 per cent dust in talc at the rate of 3·3 lb. of *pp*-isomer D.D.T. per acre in August 1946. At this time the larvæ had almost completed their active feeding stage. No significant mortality resulted from the treatment. However, in the winter of 1947, the treated areas were completely free from infestation, while adjacent untreated areas were again infested. Indirect evidence suggests that the D.D.T. had its effect on the very young larvæ of the 1947 generation, approximately eight months subsequent to the date of treatment.

On the basis of Smith's results, it may reasonably be expected that the D.D.T. will have persisted and exercised a control of the larvæ of the 1948 generation. At the time of writing, larvæ are as yet too small to enable effective population counts to be made.

The details of this work are being published elsewhere.

PHILLIP B. CARNE

Division of Economic Entomology,
Council for Scientific and Industrial Research,
Box 109, City,
Canberra.
June 22.

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[1] *Nature*, **161**, 246 (1948).

Entomological Aspects of 'Swollen Shoot' of Cacao

THE rapid spread of the deadly 'swollen shoot' disease of cacao first recorded by Steven[1] in 1936 justly gives cause for alarm. Now believed to be due to a virus transmitted by three species of insects of the family Pseudococcidæ, this malady of unknown origin bids fair to destroy the West African cacao industry. That this is realized by the people of West Africa is evident from the lively public interest in the problem.

It is not, therefore, too soon to pause and take stock of the problem. The good old-fashioned remedy of destroying affected trees and contacts, bearing as it does the stamp of common-sense, has won general support except, perhaps, from the unlettered farmer in whose egocentric view there is only one kind of dead cacao tree.

In this connexion it will be well to keep in mind the entomological aspect of the problem and see how the vectors may be controlled in the primitive conditions under which the crop is produced. One method which does not appear to have received the consideration it merits is that of biological control. In the welter of ideas about resistant varieties, immunization and cutting-out, this elementary aspect seems to have been forgotten. Yet the Pseudococcidæ are in some respects peculiarly amenable to this treatment in the tropics. In West Africa they are not heavily parasitized or preyed upon; and there is in other parts of the world a wide range of parasites and predaceous enemies which could be, possibly usefully, certainly with impunity, introduced into West Africa. I am not unaware of the provocative nature of this proposition. But those who would dismiss it untried should bear in mind the infinitesimal cost of effecting such introductions against the havoc wrought by the disease. No one can say whether the method will succeed. But it is a weapon that has proved itself elsewhere, and, in the present parlous state of the important West African cacao industry, it is one that should be tried without delay.

F. A. SQUIRE

Department of Agriculture,
Sierra Leone.

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[1] Steven, W. F., *Gold Coast Farmer*, **7**, 122 (1936).

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

THE Eighth General Assembly of the International Union of Geodesy and Geophysics, and of its seven constituent associations, was held at Oslo during August 19–28. The opening assembly, held in the large hall ('Aula') of the University of Oslo, was attended by the King of Norway and the Crown Prince. The Government of Norway and the municipality and the University of Oslo extended the most generous hospitality to the Union. A large amount of careful preparation had been done by the Norwegian Organising Committee under the chairmanship of Prof. H. Solberg, secretary of the Academy of Science and Letters.

Owing to the state of health of the president, Prof. Helland-Hansen, of Norway, the duties of president were carried out by the senior vice-president, Prof. N. E. Nörlund, of Denmark. The general secretary of the Union is Dr. J. M. Stagg, of the British Meteorological Office. The Council of the Union consists of one delegate from each country; the British member of the Council was Prof. J. Proudman. There were more than five hundred delegates and guests from about forty countries. The largest party was the British, numbering nearly eighty, of which about half were delegates appointed by the Royal Society; but the party from the United States exceeded seventy. This was the first ordinary General Assembly since the War; a small, purely administrative Assembly had been held at Cambridge in 1946, and this enabled the Oslo delegates to devote the maximum amount of time to scientific discussion. Evening lectures by Dr. M. A. Tuve, of Washington, and by Dr. S. Thorarinsson, of Iceland, the latter showing a remarkable colour film on the recent eruption of Mt. Hekla, were much appreciated. Prof. Vening Meinesz, of Holland, was elected president of the Union for the period 1948–51. An invitation from Belgium to hold the next General Assembly at Brussels in 1951 was gratefully accepted.

The Union expressed its gratitude for the very considerable financial assistance which it has received from Unesco. The major part of this has consisted of grants in aid of the permanent scientific services which are sponsored by the Union; the largest individual grant for 1948, £3,000, is in aid of the International Seismological Summary, the staff of which is housed at Kew Observatory. But many of the officers of the Union received Unesco grants in aid of their travelling expenses to and from Oslo.

A very valuable feature of the Assembly was the excursions, and it was on these that the warm-hearted hospitality of the Norwegians reached its height. It is the common experience of those attending international conferences that the personal contacts made on such excursions are, even from the point of view of the advancement of science, the most valuable part of the whole proceedings. Most delegates and guests accepted invitations to visit the district around Lillehammer on August 22. After the Assembly, forty delegates enjoyed a most entertaining and instructive visit to the hydro-electric works at Rjukan as the guests of Norsk Hydro. The meteorologists and oceanographers took part in excursions which met far up the Sogne Fjord, and from this point they were conveyed to Bergen in five research vessels, four of them Norwegian and one Scottish. The hospitality of the municipality of Bergen formed a fitting close to a memorable occasion.

Association of Geodesy. The work of the Association of Geodesy was distributed over five sections. In the Section on Triangulation there was much discussion on methods of measuring long distances, including triangulation between non-intervisible ground stations by radar and by the observation of flares dropped from aircraft. Consideration was also given to the proposal to extend the Central European Net to Western Europe. In the Section on Geodetic Levelling, deliberations were mainly devoted to refinements in the practice and theory of geodetic levelling and to the methods of research into those problems of tectonics on which levelling is capable of throwing light. The Section on Geodetic Astronomy gave consideration to co-operation with the International Unions of Astronomy and of Telecommunications. An interesting and important report on the activities of the Royal Observatory was received from the Astronomer Royal.

In the Section on Gravimetry it was noted that since 1939 the rapid development of static gravimeters has brought them into general use, not only for geodetic purposes but more especially for geological prospecting by oil companies. As a result, the quantity of gravity material accumulating in some areas is more than can be conveniently handled in geodetic work. It was decided that the Association should set up a Gravity Bureau. In the Section on the Geoid, attention was given to deviations of the vertical, to geoidal rise and deflexions, and to the application of methods of differential geometry to geoidal determination. There was a heated discussion on the 'co-geoid-fictitious level surface of the earth' after the removal of effects of compensated topography.

Both the president of the Association, Mr. W. D. Lambert, of Washington, and its secretary, Prof. P. Tardi, of Paris, were re-elected.

Association of Seismology. This Association benefited from the fact that a preliminary meeting had been held at Strasbourg in 1947. Without world-wide co-operation the progress of seismology would have been extremely slow. A notable example of such co-operation is the International Seismological Summary, for which the Association is responsible; significant measures for increasing the usefulness o the Summary were agreed upon at Oslo. A specia session of the Association was devoted to recent researches on the seismicity of the earth. One of the sessions was devoted to the study of the seismic results of the large explosions at Heligoland, Burton-on-Trent, Haslach and Soltau, and to the results o seismic prospecting in France, Spain and the United States.

The president, Dr. R. Stoneley, of Cambridge, and the secretary, Prof. J. Rothé, of Strasbourg, were re-elected.

Association of Meteorology. In his presidential address to the Association of Meteorology, Prof. S Chapman made a strong case for an Internationa Meteorological Research Organisation to link togethe the various meteorological research bodies throughou the world, and to serve as a clearing house for ideas. A strong impression was created by the discussion on rain-making by artificial means. Other important contributions included the following: a theory of selective unstable waves in an atmosphere described by the boundaries of the tropopause and the earth's surface, a subject which is connected with the formation of short-lived cyclones; fundamental problems in the study of radiation; the density of the high atmosphere as determined by the motion of meteorites; the need for more observations of water vapour and of helium in the high atmosphere; antarctic meteorology; jet streams; and the possibilities of statistical forecasting. Mr. A. W. Brewer exhibited an automatically controlled frost-point hygrometer, based on the design which he and Dr. Dobson had evolved, and gave an impressive account of the water vapour content above the tropopause. Prof. Byers showed a film exhibiting in slow motion the records of radar reflexion from rain during thunderstorms over Florida.

Prof. J. Bjerknes resigned the office of secretary and was elected president; Prof. J. van Mieghem was elected secretary.

Association of Terrestrial Magnetism and Electricity. The discussions of this Association included the following subjects: the influence of solar activity on terrestrial magnetism; air-borne magnetic surveys carried out in the United States and in Britain, which show great promise for the near future; the origin of the earth's magnetism; diurnal variation of the horizontal force near the magnetic equator; detection of rapidly moving ionic 'clouds', observed during ionospheric storms; and the use of $V2$ rockets for the exploration of the upper atmosphere.

Owing to the absence of the president, Dr. J. A. Fleming, of Washington, the chair at the early meetings was taken by Prof. J. Coulomb, of Paris; Prof. S. Chapman, of Oxford, was then elected president, and presided at the later meetings. The secretary, Dr. J. W. Joyce, of Washington, was re-elected.

Association of Physical Oceanography. A change of emphasis as compared with those at earlier Assemblies was shown in the meetings of the Association of Physical Oceanography. Previously, most attention was given to the distribution of temperature and salinity in the oceans and to the deductions regarding water-movements, etc., which could be drawn from such distributions. On this occasion, most attention was given to observations of oscillations in the sea, ncluding surface-waves; turbulence and storm-surges. The change reflects a result of the War, which prevented ocean-going expeditions and turned attention to problems associated with the landing of roops on beaches. For the first time, British oceanographers took a prominent part in the presentation of papers.

Most of the standing scientific committees of the Association, including those on mean sea-level, ocean bottom, weather ships and technical handbook, were reappointed, while a new one on bibliography was set up. The president, Prof. H. U. Sverdrup, of Oslo, was re-elected. Prof. J. Proudman, of Liverpool, esigned the secretaryship, and Prof. H. Mosby, of Bergen, was appointed to succeed him.

Association of Vulcanology. In the absence of the resident, Prof. Michel-Lévy, of Paris, owing to ill-health, the Association of Vulcanology met under the chairmanship of one of the vice-presidents, Prof. B. G. Escher, of Leyden. His address was on the symmetrical shape of the earth's surface and its fect upon the volcanism of the earth and the moon. Contributions included reports dealing with volcanic activity during the past decade, in Japan, Kamchatka, the East Indian archipelago, Guatemala, the West Indies, Africa, Iceland, Etna, Vesuvius, and elsewhere. Few vulcanologists attended the meeting, which is largely to be ascribed to the coincidence in time of the International Geological Congress in London.

Two new objects were brought forward, and to these particular attention was given. A commission was set up under the chairmanship of Prof. L. Glangeaud for the purpose of studying the extinct volcanoes of the world with special reference to the relations between geological time and the changing composition of the magmas concerned. A long-standing policy of the Association, for which funds have been accumulated over a number of years, is the publication of a catalogue of the active volcanoes of the world, and a conference was held on the scope of the catalogue, and its compilation and publication. Prof. B. G. Escher, of Holland, was elected president, and Prof. F. Signore, of Italy, was re-elected as secretary.

Association of Hydrology. The work of the Association of Hydrology was spread among the four commissions: limnology, potamology, underground water, snow and glaciers. The Limnology Commission dealt with the balance-sheet of a lake, with statistics of lake-level and with the movement of water in lakes; the Potamology Commission with evaporation, with precipitation-recording methods, and with transport of solid material in Nature and in the laboratory; and the Underground Water Commission with infiltration, with variations of level in springs, and with hot springs in general.

The Commission on Snow and Glaciers, in addition to the set themes, dealt, *inter alia*, with suggested classifications of snow, and with the alternative methods of observation and reporting which are now in use in the United States and Switzerland. The report on glacier variations was the first to be made by the new permanent committee which was established at Washington in 1939 to carry on the work of the long-established Commission Internationale des Glaciers. The statistical data up to now have dealt solely with the changes of position of the glacier snouts; but in future it is planned to include three-dimensional surveys of selected glaciers. There was an exhibition of glaciological films. It was decided to reduce the number of commissions to three: underground water, lakes and rivers, snow and ice.

The Association met under the chairmanship of Prof. G. Slettenmark, of Sweden, who had been appointed acting president after the death in 1947 of Prof. O. Lütschg, of Switzerland. The secretary, Prof. F. Diénert, of France, died shortly afterwards, and his place was filled by Prof. A. M. Vibert, of France, as acting secretary. At the close of the Assembly, Mr. Merrill Bernhard, of the United States, was appointed president, and Prof. L. Tison, of Belgium, was appointed secretary.

A joint meeting of the Associations of Seismology, Meteorology and Physical Oceanography was devoted almost entirely to thirteen papers on microseisms, recent developments in this subject showing how profitable has been co-operation between workers in the different sciences. The Union Committee on Continental and Oceanic Structure was replaced by a Joint Inter-Association Committee on the Physics of the Earth's Interior. J. PROUDMAN

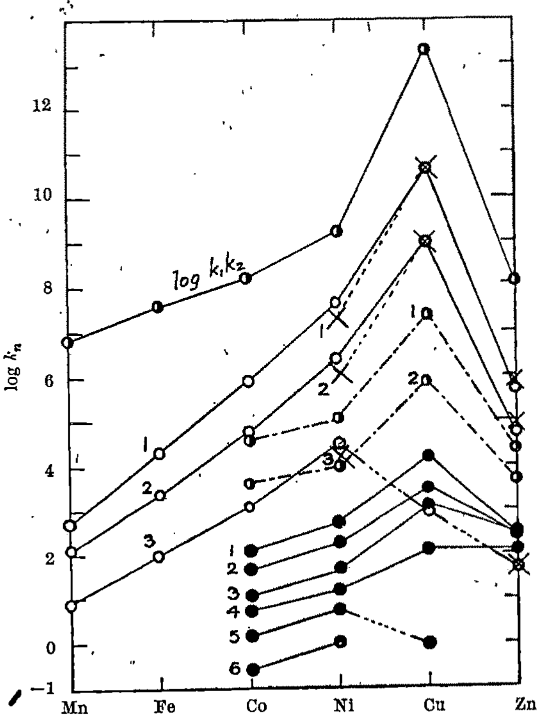
ORDER OF STABILITY OF METAL COMPLEXES

By DR. H. IRVING and R. J. P. WILLIAMS
Inorganic Chemistry Department, Oxford

MELLOR and Maley[1,2] have recently pointed out that the stability of complexes of bivalent metal ions follows the order

$$\mathrm{Pd} > \mathrm{Cu} > \mathrm{Ni} > \mathrm{Co} > \mathrm{Zn} > \mathrm{Cd} > \mathrm{Fe} > \mathrm{Mn} > \mathrm{Mg},$$

irrespective of the nature of the ligands involved, and remark that "although it is not clear what determines the order of metals in the series, it is worth noting that metals forming dsp_2 bonds ($\mathrm{Cu^{II}}$ and $\mathrm{Pd^{II}}$) head the list". Although our own programme of experimental work is incomplete, it appears desirable to indicate some of our conclusions in this field, since they extend the observations of Mellor and Maley and render to some extent more intelligible the order of decreasing stability found experimentally.



The numbers give the value of n in log k_n for: ●, ammonia; ○, ethylene diammine; ×, propylene diammine; ◐, salicylaldehyde.

If published data[2] on the successive stability constants of divalent ions of the first transition series are plotted against their atomic number (see graph), it is seen that the stability of complexes increases steadily to reach a maximum at copper whether the ligands be ammonia, ethylene diammine, propylene diammine or salicylaldehyde. The reluctance of copper to exceed a co-ordination number of 4 is shown by the low value of k_5 for the pentammino-, and k_3 for the tris-ethylenediammino-complexes. All zinc complexes are markedly less stable than those of $\mathrm{Cu^{II}}$, and it is perhaps significant that the M-shell is completely filled in $\mathrm{Zn^{II}}$, whereas the attachment of six groups through d_2sp_3 or dsp_2 orbitals (involving resonance) is possible throughout the sequence $\mathrm{Ca^{II}}$ to $\mathrm{Cu^{II}}$. A similar trend of stabilities can be noted in the second transition series with $\mathrm{Pd^{II}} > \mathrm{Cd^{II}}$, but the interposition of $\mathrm{Ag^{II}}$ (which forms complexes isomorphous with those of $\mathrm{Cu^{II}}$) can as yet be only inferred. In the third transition series, the order of stability is certainly $\mathrm{Pt^{II}} > \mathrm{Hg^{II}}$ and $\mathrm{Pb^{II}}$.

Published data on the *absolute* stability of complexes are limited so far to those already quoted. Yet it is obvious that the formation of an inner complex represented by the equation

$$M^{n+} + n\,\mathrm{H}R \rightleftharpoons MR_n + n\mathrm{H}^+$$

involves essentially a competition between (hydrated) protons and metal cations for the anion of the reagent forming the complex: the more stable the complex, the lower the pH at which it can persist, and *vice versa*. (It is, of course, implicit that any ligand displaces an equivalent number of water molecules from the hydrated cation; for example, ammonia or pyridine displace one; diammine salicylaldehyde or dithizone displace two, etc.) It can be shown that the pH for 50 per cent precipitation (or 50 per cent extraction of metal complexes for a constant excess of reagent) is a measure of their relative stability. Such data, with figures for the pH of incipient precipitation of metal quinaldinate and, for comparison, the stability constants of salicylaldehyde complexes are collected in the accompanying table and confirm the sequences of stability already noted.

Metal	'Oxine'; pH for 50% precipitation[3]	'Dithizone'; pH for 50% extraction with carbon tetrachloride[9]	Quinaldinic acid; pH for incipient precipitation[4]	Salicylaldehyde; log k_1k_2 in aqueous dioxane[1,2]
Mn	4·8	~9	—	6·8
Fe	—	5·6	—	7·6
Co	3·2	4·9	3·9	8·3
Ni	3·2	3·0	3·9	9·2
Cu	2·3	1·0	0·5	13·3
Zn	3·1	3·2	1·85	8·1
Pd	—	~−2·0	2·5	14·8
Cd	4·2	4·1	3·2	7·8
Pt	—	~−2·0	—	—
Hg	—	~−2·0	0·2	6·8
Pb	5·2	5·5	3·6	9·1

It is worth noting that among the divalent cations of the first transition series, copper alone is precipitated by 5:7-dibrom-8-hydroxyquinoline in normal acid[5], and similar examples of the outstanding stability of cupric complexes are commonplaces of analytical chemistry. H. Fischer[6] noted similar order of stability for complexes with α-nitroso β-naphthol, β-nitroso-α-naphthol and diphenyl carbazone, though the positions of cobalt and nickel were sometimes interchanged.

It must be emphasized that the order may be radically changed if the divalency of any of the participants is altered. Thus the selectivity of nitrosonaphthols as reagents for cobalt depends on their capacity to oxidize it and form a complex of trivalent cobalt far stabler than the corresponding complexes of divalent iron and nickel (or cobalt That divalent copper, palladium (and trivalent iron interfere with the cobalt test[7] shows that their complexes are comparable in stability, even with those of trivalent cobalt. Derangement of the 'natural' order of stability may also arise from steric and other factors. Thus, copper forms normal 1:2 complexes with M-methyl- and NN′-diethyl-ethylenediammine but cannot do so with N-methyl (or ethyl)-N′-diethyl ethylenediammine[8]; and trivalent gallium, indium and thallium, but not aluminium, will give insoluble 1 : 3 complexes with 2-methyl-8-hydroxyquinoline and similar rêagents[9]. We shall present elsewhere our observations with sterically hindered ligands such as α-methyl- and α : α′-dimethyl-*o*-phenanthroline.

The stability of complexes formed by any one ligand, for example, ammonia, with a series of metals may be expected to increase with the electronegativity of the metal concerned. Though reliable values for the transition elements are not yet available, it is of interest to record that a plot of instability constants (log k_n) against the second ionization potential (corresponding to the change $M \rightarrow M^{++} + 2e$ for the metal concerned) is approximately linear from manganese to copper, points for zinc lying somewhat off the curves. Thence, or less readily from the accompanying graph, it can be seen that the successive increments in stability in passing from manganese to copper complexes are of much the same order whether water is replaced by two molecules of ammonia, or one of salicylaldehyde or a diammine. When any one metal is considered, the gain in configurational entropy consequent upon ring formation is strikingly demonstrated by the high relative stability of the latter complexes.

Whereas it seems reasonably certain that the most stable complexes are always formed by elements erminating the transition series, and probable that he same 'natural' order of stability is preserved throughout each series, the acceptance of a unique order of stability operating throughout the Periodic Table must wait upon more extensive quantitative measurements with more varied types of ligands and upon a wider range of metals. Quantitative studies on chromous complexes should prove of particular interest.

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FIRST INTERNATIONAL CONGRESS ON RHEOLOGY

SOON after the end of the War, the Committee of the British Rheologists' Club approached rheoogists in the Netherlands about the possibility of holding an International Rheological Congress in Holland. Dutch rheologists welcomed the suggestion nd set up a Committee to organise the Congress (see *Nature* of January 17, 1948, p. 104).

Shortly afterwards, the International Council of Scientific Unions appointed a Joint Committee on Rheology which held its first meeting in London in September 1947. The honorary secretary, Prof. J. M. Burgers, was taking a leading part in the organisation of the Congress, and it was agreed that he plans for the Congress should be made in close o-operation with the Joint Committee, the second annual meeting of which would also be held at the same date and place as the Congress itself. The Congress was held at Scheveningen during September 0–25.

The technical business of the Congress was divided into two parts: (1) general lectures given by invitation of the Committee; (2) shorter communications submitted by members. The latter part was arranged to run in three concurrent programmes, though the subject-matter was grouped in four categories: (*a*) theoretical problems; (*b*) experimental methods; (*c*) rheological properties of various systems; (*d*) biological systems.

The official languages of the Conference were English and French, the Dutch members showing a remarkable proficiency in the English language.

There was also a general discussion on nomenclature introduced in a general lecture by Prof. J. M. Burgers, who also presented a communication from the International Joint Committee. The Joint Committee had instructed two of its members, Prof. J. M. Burgers and Dr. G. W. Scott Blair, to draw up a report on nomenclature based on the various wartime publications of the British Rheologists' Club and of Dutch rheological organisations. Although developed entirely independently of one another, these reports had been found to have very much in common.

Prof. Burgers also summarized in his address the general scope of the work which the Congress was about to undertake.

The general lectures covered a wide field of rheology. Prof. F. Eirich, of the Polytechnic Institute of Brooklyn, N.Y., dealt with experimental methods in rheology, discussing the relative merits of different types of viscometers and rheometers for industrial and academic problems. Prof. C. Sadron, of the University of Strasbourg, spoke on the viscosity of dilute solutions of macromolecules, with special reference to molecular shape and orientation. This lecture was particularly valuable in drawing together information from Dutch, American, British and French sources, and in presenting a composite picture of the complex problems of viscosity-concentration relations.

Dr. M. Reiner, of the Technical College, Haifa, spoke on rheological relations in complex systems, outlining first the applications of the classical theories of elasticity and hydrodynamics, and then proceeding to discuss how the classical rheological coefficients vary with structural changes in the material and how various groupings of elastic and viscous elements are linked together to account for the behaviour of complex systems. Dr. K. Weissenberg, of the British Rayon Research Association, Manchester, also spoke on rheology of abnormal systems, developing a comprehensive scheme by which all macroscopic aspects of rheological behaviour can be dealt with whether previously regarded as 'normal' (that is, conforming to some established theory or convention) or as 'abnormal'. The scheme is based on a general theory of transformation for defining invariant rheological parameters. The lecture was ably illustrated by experiments.

Dr. G. W. Scott Blair (University of Reading) discussed psychophysical aspects of rheology, and the relationship between physical measurements and subjective judgments of rheological conditions as made by craftsmen in industry, and explored the possibilities of applying multiple factorial analysis to data from batteries of empirical rheological tests. Prof. A. L. Copley (New York University) spoke on biological problems in rheology, dealing especially with rheological problems of protoplasm, of cellular coats and intercellular substances, and on the rheology of body fluids ('humoral rheology'). Dr. R. Houwink, of the Rubber-Stichting, Delft, who was also chief secretary of the Congress, spoke on rheology in industry, outlining the main rheological properties important for industry, with special reference to glass, asphaltic bitumen, thermoplastics, thermosetting plastics and paints.

In a short account of the Congress it is impossible to deal with all the contributions to the sectional meetings, numbering between thirty and forty papers; but it can be said that the ground covered was very wide.

There were a number of papers on thixotropy, including one by Sir Charles Goodeve, in which a novel model was described to represent thixotropic and plastic flow. Dr. H. Nitschmann, from the Harvard Medical School, Boston, described interesting experiments on thread-forming liquids, showing the relationship between this property and changes in viscosity with driving pressure. Dr. C. N. Davies, of the London School of Hygiene and Tropical Medicine, also discussed thread formation of liquids. It was somewhat unfortunate that, in an otherwise admirably arranged programme, Drs. Davies' and Nitschmann's papers were read in different sections almost simultaneously. M. M. Louis (Reuil, France) described a new type of viscometer for industrial use which should have a wide appeal on account of its simplicity of design; and a number of new rheometers were also described for the study of rubber, plastics, printing inks and other materials. Drs. H. de Bruijn and P. G. Meerman, of the Netherlands State Mines, discussed the use of a Stormer viscometer for settling suspensions, and Mr. W. Lethersich, of the Electrical Research Association, the relative merits of compression and rotation instruments for work on dielectrics.

On the theoretical side, turbulence phenomena received considerable attention; Dr. R. Schnurmann, of the Manchester Oil Refining Co., dealt with Reynolds' numbers in solutions of large molecules, and Dr. J. C. Oldroyd (Courtaulds, Ltd., Maidenhead) discussed wall-effects in turbulent flow through pipes. Prof. J. J. Hermans (University of Groningen) gave a summary of his well-known work and that of Prof. P. H. Hermans on swelling of gels, and Prof. W. T. Astbury (Leeds) gave an account of X-ray and electron microscope studies on myosin and actin.

Of the thirty-eight sectional papers, apart from general lectures, circulated in preprint form before the meeting, no less than twenty were from British rheologists, and, indeed, Great Britain was very well represented at the Congress.

An exhibition of rheological apparatus included instruments from Holland, Great Britain and France. The apparatus was classified in accordance with the way in which the stresses are applied, for example, direct, alternating, etc., whether the stress is distributed homogeneously throughout the material, or inhomogeneously, and whether the rates of shear are constant or variable. There were some sixty instruments grouped in this way. The exhibition was open during most of the Congress, and Dr. R. N. J. Saal gave a short informal address describing the exhibits and their classification.

On the evening of September 23 an informal dinner was held, Prof. H. R. Kruyt presiding. Prof. Kruyt proposed the health of the delegates, and replies were made on behalf of Great Britain by Dr. G. W. Scott Blair, of the Continental countries by Prof. C. Sadron and of the United States by Dr. A Voet.

Following the Congress, many delegates took par in a three-day trip by touring car to Arnhem an the State Mines in the Province of Limburg. O September 25 visits were paid to the General Rayo Union, to the Staple Fibre Factory of the A.K.U. to the Netherlands Shipbuilding Experimenta Station at Wageningen and to the Central Foo Products Research Station. On September 26 ther was a visit to the Arnhem Battlefield and on September 27 to the Central Experimental Station of Stat Mines at Treebeck.

The Congress was very well organised, although in spite of the quite remarkable recovery already made, conditions in Holland are at least as difficul as they are in Britain. The Dutch organising committee must have worked extremely hard in preparin the Congress, and the unfailing kindness and hel which we received from all our Netherlands colleagues, and especially from Prof. J. M. Burger (chairman), Dr. R. Houwink (first secretary) an Dr. G. E. Rotgans (organising secretary), will lon be remembered. (As Dr. Houwink said at the dinner Dr. Rotgans turned out to be "not a bad goose, bu a very good goose indeed !")

Although in existing circumstances it was felt t be unwise to fix a date and place for the Secon Congress, it was the general feeling both in th Congress itself and within the International Join Committee that congresses of this kind should b held about every four years, and the hope wa expressed that the Joint Committee should recommend the calling of a Second Congress in due course

The *Proceedings* of the First Congress will b published shortly and will be available at an approximate cost of £2 8s. G. W. SCOTT BLAIR

NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT

THE thirty-first annual report of the Nationa Research Council of Canada (Ottawa) covers th year ended March 31, 1948, and includes the repor of the president, Dr. C. J. Mackenzie, together wit the financial statement. The total expenditure durin the year amounted to just over 6·9 million dollars almost a further quarter of a million dollars wa expended on work carried out at the request o Government Departments and provided for by them apart from the 7·646 million dollars received in othe ways, including parliamentary appropriations o 6·351 million dollars. To cope with the expandin programme, facilities have been extended and th staff now total more than 2,300, of whom a thousand half of them scientific workers, are working a the atomic energy project at Chalk River. Th operating branch for the production and extractio of isotopes was organised during 1947, and branche of the project are concerned with the problems o operating the low-energy ZEEP and the higher powered experimental NRX piles and handling thei highly radioactive products safely and effectively Attempts are being made to spread the new techniques and knowledge to the universities and othe research institutions in Canada, and thus to foste research in these fields.

A new Division of Radio and Electrical Engineering has been established and substantial progress made in the applications of radar. In harbour control a nine-inch display with accurate ranging facilities has been added to the original installation at the Naval Signal Station at Camperdown, Nova Scotia, and procedures are being worked out for the use of shore-based radar in the identification and guidance of incoming ships that are not equipped with radar. Trials during the past season have shown that blind navigation of the entrances of Toronto Harbour and identification of every wharf within the Harbour is possible. The practical value of a direct-reading electronic instrument for locating hot joints on power ines has been demonstrated in field tests.

The Division of Physics carried out magnetometer surveys during the latter part of the year in co-operation with the Department of Mines and Resources and with the assistance of the Royal Canadian Air Force. A fundamental investigation has been started on the nature and source of cosmic rays, in particular their relation to other geophysical phenomena such as magnetic storms, and the ionosphere. A high-speed cine-camera capable of operating at a rate of 200,000 frames per second has been designed and built, and a method of geophysical prospecting has been tried in which measurements are made of the depth of overburden by vertical echo-ranging from the surface, and exploraion within the bed-rock, with a device which is dropped down a drill-bed. Architectural studies include a series of commercial sound-absorption tests, while equipment has been completed for producing high-intensity sound fields at frequencies from four kilocycles to about 600 kilocycles per second, and a new rod thermostat is being developed for use in railway refrigerator cars. A summer programme of panel-cooling investigations in two experimental houses was undertaken and continued through July and August 1947, while photographic research included work on the aerial camera, the dimensional tability of photographic film bases and the factors affecting the rendering of detail in contact printing.

The organisation of the Pure Chemistry Branch has been completed, and an infra-red spectrometer installed in the section on organic spectrochemistry. Among many problems investigated in the Applied Chemistry Branch of the Division of Chemistry are he lubrication of railway car journal bearings, the correlation of laboratory abrasion tests with actual oad tyre tests, the laundry application of dust-laying oils to cotton and wool hospital fabrics, corrosion inhibitors for use in various types of olution and the spreading of oil paints on certain repellent surfaces. A co-operative research with the Noranda Mines, Ltd., promises to develop a method of roasting pyrites for the recovery of elemental sulphur, and the investigation of silver alloys as catalysts for the oxidation of ethylene to ethylene oxide with air has led to the development of highly ctive stable catalysts. A method has been developed or the rapid determination of low concentrations of arbon monoxide in air.

Much of the work of the aeronautics section of the Division of Mechanical Engineering is devoted to wind-tunnel testing of new aircraft designs for Canadian firms; the low-temperature laboratory continued the flight investigation of aircraft icing, lectro-thermal de-icing for wings and propellers and he study of meteorological conditions associated with ice. A snow-cover survey was initiated, in co-operation with the Meteorological Service of the Department of Transport, to obtain data on the type and condition of snow encountered in different parts of Canada, in order to assist in developing snow-clearing equipment and in the study of such subjects as aircraft skis. Work continued on the improvement of fuels and lubricants for use at low temperatures, and research was initiated on fuels and combustion in jet engines.

In the Division of Applied Biology, substantial progress was made in research on food preservation and the industrial utilization of agricultural wastes and surpluses. Investigations on oiling, antiseptic and gas treatment of shell eggs have facilitated shipments to Britain, and transport temperatures have been established for a milder and more acceptable bacon. Extensive work has indicated that the Fritz machine for continuous butter production, as designed for German use, cannot consistently produce butter meeting the Canadian legal standard of not more than 16 per cent moisture content. Laboratory studies on new cooling mixtures to provide lower temperatures in refrigerated railways cars gave promising results, and a study has been commenced on the fermentation of cellulose wastes, while that on the fermentation of beet molasses has reached the pilot-plant stage. Work was also commenced on the utilization of straw.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 8

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. J. Bray: "The Possibilities of Super H.F. Radio and Wave-guide Systems for Telecommunications".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. G. H. J. Daysh: "Development Areas and the Location of Industry".

Tuesday, November 9

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. A. L. Armstrong and Prof. H. J. Fleure, F.R.S.: "Discovery of a Palæolithic Skull in a Rock Shelter at Whaley, near Creswell, Derbyshire".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. P. H. Flanders: "The Physical Properties of Very High Voltage X-Rays and Electrons and their Medical Benefit".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Continuation of the Discussion on "To What Extent does Distortion Really Matter in the Transmission of Speech and Music?" (to be opened by Mr. P. P. Eckersley).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. D. Davidson: "Heat Transfer".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. J. W. Mitchell: "High Speed Photography".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Rubber as a Stress-Carrying Material, and some Design Considerations" (to be opened by Mr. S. W. Marsh).

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Mr. R. F. Harrod: "The Atomic Age—The Economic Repercussions of Atomic Power".*

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Rev. Brian L. Gandon: "Through India to the Himalayas".

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Mr. W. H. Hillier: "The Treatment of Sewage containing Textile Effluent".

Wednesday, November 10

PHYSICAL SOCIETY, COLOUR GROUP (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Scientific Papers.

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. F. H. Garner and Mr. A. R. W. Baddeley: "Detergency of Carbon Black in Hydrocarbon Solution".

Institution of Electrical Engineers, Supply Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. M. Lacey: "The Lightning Protection of High-Voltage Transmission and Distribution Systems".

Royal Institute of Chemistry, Newcastle-upon-Tyne and North-East Coast Section (at King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. L. H. Lampitt: "Food Problems".

Thursday, November 11

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. Dingle: "What is Science?"*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. M. Goody: "Thermal Equilibrium at the Tropopause and the Temperature of the Lower Stratosphere"; Prof. S. Chapman, F.R.S., and Mr. K. K. Tschu: "The Lunar Atmospheric Tide at 27 Stations widely distributed over the Globe".

University of London (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. B. C. J. G. Knight: "Biosynthesis in Micro-Organisms".* (Further lectures on November 18 and 25.)

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. R. J. Smeed: "Some Statistical Aspects of Road Safety Research".

Illuminating Engineering Society, Manchester Centre (joint meeting with the Association of Public Lighting Engineers, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. W. D. Sinclair: "Fluorescent Street Lighting".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—M. Destival: "French Aircraft Gas Turbines".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7 p.m.—Prof. C. E. H. Bawn: "The Structure and Reactivity of Free Radicals" (Tilden Lecture). (To be repeated on Friday, November 19, at the University, Glasgow.)

Institute of Metals (at the Royal School of Mines, South Kensington, London, S.W.7), at 7 p.m.—Prof. W. R. Jones: "Resources of Strategic Metals".

Pharmaceutical Society, Manchester, Salford and District Branch (joint meeting with the National Association of Women Pharmacists, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Mr. D. G. Ardley: "Some Recent Advances in Drug Therapy".

Wednesday, November 10—Thursday, November 11

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1).—Autumn Meeting.

Friday, November 12

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mechanical Engineers, Applied Mechanics Group (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Some Properties of the Compression Shock as in Turbine and Compressor Blade Passages" (to be opened by Mr. I. M. Davidson).

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. R. G. Voysey: "Techniques of a Gas Turbine Vibration Laboratory".

Oil and Colour Chemists' Association, Manchester Centre (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. D. R. Duncan: "The Colour of Pigment Mixtures".

Saturday, November 13

British Psychological Society (at Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Discussion on "Current Professional Problems of Psychologists" (to be opened by Miss Grace Rawlings and Mr. Alec Rodger).

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Major Maxwell Knight: "The Habits and Lives of British Reptiles and Amphibia".*

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the University, Reading), at 3 p.m.—Symposium on "Radioactive Tracer Elements".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Educational Psychologist—The Director of Education, County Education Office, St. Mary's Gate, Derby (November 13).

Senior Research appointment to be made for the purpose of undertaking Government-sponsored research into problems of the location of industry—The Secretary, National Institute of Economic and Social Research, 2 Dean Trench Street, London, S.W.1 (November 13).

Head of the Science Department of the Technical College of Monmouthshire, Crumlin—The Director of Education, County Hall, Newport, Mon. (November 13).

Lecturer in Mathematics in the Physics and Mathematics Department—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (November 13).

Chief Laboratory Engineer to take charge of a recently established Highways Laboratory at Osset, near Wakefield—The County Engineer and Surveyor, County Hall, Wakefield (November 13).

Educational Psychologist—The Director of Education, Education Offices, Cobourg Street, Plymouth (November 15).

Lecturer in Pure Mathematics in the School of Science, Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (November 15).

Veterinary Surgeons (6), and a Field and Research Officer, in the Department of Veterinary Services, Southern Rhodesia—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (November 19).

Head of the School of Applied Chemistry, Melbourne Technical College—Mr. S. L. Martin, Mathematics Department, University College, Gower Street, London, W.C.1 (November 19).

Lecturer in the Department of Physics—The Registrar, University College, Hull (November 20).

Educational Psychologist—The Secretary for Education, County Buildings, Shrewsbury (November 22).

Officer-in-Charge of the Tests Division—The Director, National Foundation for Educational Research, 79 Wimpole Street, London, W.1 (November 22).

Lecturer or Assistant Lecturer in the Department of Biochemistry—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 24).

Lecturer in Physiology in University College, Dundee—The Secretary, The University, St. Andrews (November 30).

Leverhulme Studentship in Chemical Engineering—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (November 30).

Lecturer or Assistant Lecturer in the Department of Electrical Engineering—The Registrar, The University, Sheffield (December 1).

Meteorological Officer Cadets (5) in the Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 10).

Museums Assistant, primarily to supervise the collections in the Kirkstall Abbey House Museum (devoted to local history and antiquities)—The Director, City Museum, Park Row, Leeds (December 20).

Transvaal Chamber of Mines Chair of Wood Technology in the University of Stellenbosch—The Secretary, South Africa House, Trafalgar Square, London, W.C.2 (Stellenbosch, December 31).

Senior Assistant in Chemistry—The Registrar, College of Technology, The Newarke, Leicester.

Senior Geologist to the Government of the Gold Coast to undertake general geological work including geological mapping and prospecting—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in Biology, and a Lecturer in Chemistry—The Principal, Derby Technical College, Normanton Road, Derby.

Abstractors (part-time) for the *Veterinary Bulletin*—The Director Commonwealth Bureau of Animal Health, Veterinary Laboratory New Haw, Weybridge, Surrey.

Lecturer in the Department of Applied Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1

Deputy Executive Officer, and a Technical Officer in Seed Production—The Secretary, National Institute of Agricultural Botany Huntingdon Road, Cambridge.

Laboratory Technician in the Department of Pathology—The Pathologist, Royal Devon and Exeter Hospital, Exeter.

Scientific Officers (2) in the Biochemical Department for work on the separation and characterization of large molecules of biological origin—The Secretary, Rothamsted Experimental Station Harpenden, Herts.

Senior Technician (male) for training for maintenance of X-Ray Geiger counter and other equipment in the Medical Research Council's Field Research Station at Fajara, Gambia—The Director, Human Nutrition Research Unit, National Hospital, Queen Square, London W.C.1.

Senior Scientific Officers and Scientific Officers, and Experimental Officers and Assistant Experimental Officers, a Chemical Engineers in the Ministry of Supply research and development establishments in Lancashire, Essex, Kent and Buckinghamshire—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.884/48A.

Assistant Inspecting Officers (Scientific Supplies), and Assistant Chemists (Grade III)—The Director-General, India Store Department (Inspection Branch), 32–44 Edgware Road, London, W.2.

Physicist for fundamental work on the structure and propertie of fibrous materials, etc., and a Physicist for laboratory and service test of shoes and shoe materials, etc.—The Director, British Boot Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering.

Senior Trained Biochemical Technician in the Physiology Department—The Professor of Physiology, King's College, Newcastle upon-Tyne.

Senior Physics Laboratory Steward—The Principal, Acton Technical College, High Street, London, W.3, quoting F.41.N.

Demonstrator in Parasitology in the Department of Pathology and Laboratory Technicians for (*a*) the Department of Physiology (for biochemistry), and (*b*) the Division of Histology and Embryology—The Secretary, Royal Veterinary College and Hospital, Royal Colleg Street, London, N.W.1.

Chemist to take charge of the research work (at present being carried out at Leeds University)—The Secretary, British Brush Manufacturers' Research Association, 80 Coleman Street, London, E.C.2.

Technicians (2, Grade III) in the Department of Botany—The Secretary, University College, Gower Street, London, W.C.1, quoting Botany/1.

Senior Lecturer in Agriculture responsible for Extra-mural Teaching—The Principal, Kent Farm Institute, Sittingbourne.

Biochemist (man or woman) preferably with post-graduate experience in the field of enzymes or tissue-metabolism—The Secretary Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.

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PHYSICAL SCIENCE AND HUMAN VALUES

In 1946, Princeton University celebrated its bicentenary by a number of conferences at which leading figures in the world of learning met to discuss progress in their particular fields. One of the groups which met in this way consisted of physicists, and on the first and third days of this gathering the topic for discussion was the relationship of physical science and human values—a welcome recognition that both can influence profoundly the work of a university. The papers read at the conference have now been published in book form*.

The papers themselves, as Prof. E. P. Wigner points out in his preface, fall into two groups: those concerned broadly with the way in which the organisation of the society of which the man of science is a member can influence the growth and the trend of science, and those concerned with the influence of the man of science and his work and thought upon that society. The distinction is not sharply drawn, the field covered is very wide, and more than a title is needed to give unity between such diverse themes as Mr. F. T. Spaulding's discussion of scholarship in the secondary school, Dr. L. A. DuBridge on the large laboratory in nuclear research, Prof. F. S. C. Northrop on the physical sciences, philosophy and human values, and Prof. P. W. Bridgman on new vistas for intelligence.

The common bond is to be found rather in the evidence which the book provides that physical scientists are thinking, and thinking deeply, about all the interactions of science and society. The British reader will note that American thought runs on very similar lines to that of men of science in Britain; and the book, with Prof. H. N. Russell's approval, in the concluding paper, of the suggestion that a new Hippocratic code is needed to-day for all who deal with nuclear energy, and that the powers of life and death which are in our hands must be used soberly, and so far as in us lies, in the fear of God, supports the recent statement issued by the Committee on Science and its Social Relations set up by the International Council of Scientific Unions (see *Nature*, October 2, p. 507).

The papers in this volume, which cover subjects like the relation of research in universities to government and commercial laboratories, seldom contribute anything very novel; but points are stressed which are commonly overlooked or ignored in current debate in Britain. There is the same concern lest the university laboratories should be diverted from the advancement of science to the solving of commercial problems. In the United States, as in Britain, that would be regarded as a disaster of the first magnitude, and Dr. I. I. Rabi's suggestion that in the university research is to some extent secondary to, or parasitic on, teaching, at once drew the counter-attack that the advancement of knowledge is the first function of a university and that industry is really dependent upon the universities. Nevertheless, while industry's dependence not only upon new knowledge but also upon the development of new technologies was recognized, there was not in this discussion any tendency to exalt the divergent research typical of the university at the expense of the convergent research in industry. Both are required, and each would suffer if the other were cramped. The emphasis was rather on the need for co-operation, the way in which industry reacts on science, science on industry, and also one science on another, providing the means whereby advances are made in other fields.

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* Physical Science and Human Values. A Symposium by P. W. Bridgman, F. S. C. Northrop, H. Shapley, I. I. Rabi, H. N. Russell, M. Polanyi, F. T. Spaulding and L. A. DuBridge. With a Foreword by E. P. Wigner. Pp. vii+181. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1947.) 16*s*. net.

What stands out from the discussion is the recognition that the conditions favouring creative work are essentially the same in industry and in the universities, and that the spirit of freedom which enables an individual to work by his own method will become increasingly characteristic of the industrial research laboratory, as it already is of the university laboratory. Again, Dr. DuBridge stresses that the dominating factor in any research laboratory is the attitude of the workers themselves; and he points out rightly that without the tremendous emotional stimulus to co-operative effort which the War provided, any laboratory built along the lines of the large war laboratories is bound to collapse. The point is one to be kept in mind in considering the possibilities of applying what is known as the technique of operational research in peace-time. The question of incentives has as yet not received anything like the attention it merits where the man of science is concerned, and Dr. DuBridge's paper should stimulate further thought about the question and the psychological conditions conducive to collaboration in creative work. His confidence that the essential freedom of inquiry and time for thought can be secured even in the presence of great new techniques of physical science and organisation presents a challenge which the conference was not slow to meet, and Prof. M. Polanyi directed attention in this connexion to the importance of public opinion. Where public opinion respects the autonomy of science and the freedom of those charged with scientific work, he believes that the form of organisation matters little.

Another important factor is that to which Prof. Wigner directed attention, namely, the value of mobility and interchange of scientific staff, which is commonly recognized, but still rather the exception. Prof. Wigner suggested that in large institutions a reasonably rapid turnover of the personnel both at the top and at the bottom might well help to foster the sense of adventure and the lively atmosphere which is one of the big advantages of the university. Dr. Harlow Shapley's paper on the uses and hopes of scientific societies is of interest as indicating the way in which learned and professional societies could both counter the tendency to specialization and assist in the formulation of national policy. As an example of inter-science activity, he referred to the Society of the Sigma Xi; but he looked further to the Science Division of the United Nations Educational, Scientific and Cultural Organisation, urging especially th foundation by that body of great internation institutions for scientific exploration and develo ment in those fields where research is normally expensive that small institutions or even sma countries cannot easily undertake them on a nation basis, and also the establishment and operation travelling panels, each composed of specialists different nationalities and adjacent fields of specia ization.

When the conference entered upon the influence science on society, its thought was vaguer and le constructive. Prof. Northrop emphasized that if th atomic bomb was ever used to destroy civilizatio it would be because men could not get togeth sufficiently, on account of their ideologies, to agre upon the social controls that are necessary to me the situation. Although he argued that the ideologic conflicts between different conceptions of econom and political theory and human values are due t philosophical differences connected with scientif theory concerning Nature and the methods scientific verification in natural science, he did n entirely convince the conference as to the prob ability of a philosophical basis of agreement betwee the U.S.S.R. and the Western democracies; and suc scepticism will be encouraged by the recent fulsom adulation of 'Michurin science'. Science may we provide a rational basis for ethics; but it is the metho rather than the content which, as Prof. H. Margena suggests, forms the link; and in these latest man festations Russia appears to reject the values both science and of ethics, and to undermine the coheren which Polanyi regards as the real basis of freedom i science.

Doubtless greater precision in the choice of wor used to describe situations could remove so common and potent causes of conflict; but nothi in this symposium of papers warrants any optimis regarding the clash between the U.S.S.R. and t West. Admittedly it is imperative that other effecti controls shall be evolved in such fields as that nuclear energy before those imposed by milita security are relaxed, and these papers shatter a false ideas of absolute and irresponsible freedom work or communication for the individual scienti worker. Equally they make it manifest that t rejection by the U.S.S.R. of the tradition and di cipline of science at all points where they confli with a particular political ideology betokens difference in values which makes almost impossib at present her participation in the elaboration of t controls necessary to safeguard society. Where t transcendent character of scientific objective whi recognizes no limitations or national boundaries not admitted, there can be no such co-operatio Indeed, the dominant impression left by these pape is that the scientific workers of those countries which scientific values are respected must the selves elaborate the means by which the world c safeguard itself to-day, hoping that the task education and persuasion will secure the acceptan by others of those values in time to avoid catastrophe.

CYTOLOGICAL RESEARCH AND BIOPHYSICS

ubmicroscopic Morphology of Protoplasm and its Derivatives

y Prof. A. Frey-Wyssling. Translated by Prof. J. J. ermans and Miss M. Hollander. Pp. viii+255. ew York and Amsterdam: Elsevier Publishing o., Inc.; London: Cleaver-Hume Press, Ltd., 948.) 32*s*. 6*d*.

THE second edition of Prof. Frey-Wyssling's book is, as would be expected, a most stimulating ork. It comprises three sections. The first is conrned with methods for investigating submicroscopic orphology, such as X-radiation, polarized light, d electron microscope techniques. The second ters into numerous aspects of our knowledge of ll structure. The third covers structures such as llulose and keratin, and some of their relationships ith the cells which give rise to them. All this is ry much from Prof. Frey-Wyssling's own point of iew, expressed clearly and vigorously. It is much be regretted that the standard of translation from e German lacks literary quality: the sentence nstruction is awkward and the volume is lavishly attered with words not hitherto found in the nglish language. Although these defects never de the author's meaning completely, they do mper an appreciation of his clear flow of ought.

One of the main themes is the extent to which the operties of cells and their constituent parts are termined by elongated molecules and particles. is suggested that even the properties of the more id part of protoplasm are to be explained in terms the presence of such bodies, and the perpetual rmation and breakdown of junctions between em. This is a point of view which can scarcely be cepted with the scanty evidence we have availle; and on many, if not most, of the problems udied more views exist than are given in this ok. But it is a point of view worthy of its able ponent.

There is comparatively little discussion of the role long-range forces in the cell, though for the type system emphasized these forces are likely to be great importance. The forces acting between romosomes in meiosis and mitosis present one treme case, in which the distance over which the rces appear to act is of the order of micra, whereas tween small protein molecules the critical distances e of the order of millimicra. One of the major fficulties in advancing our knowledge of cells is our ck of understanding of the nature of the forces hich are important over distances of those orders magnitude. Thus the type of investigation which particularly suggested by this book is likely to be ought to a stop unless there are marked advances this branch of biophysics. The same is true of her branches of cytology: cell permeability awaits more adequate physical theory of diffusion; cell ctrophysiology depends upon a more detailed derstanding of thin films and membranes; cytoemistry waits upon advances in the field of optics, d so on.

The branches of physics which are involved are, the most part, those which are not of importance nuclear physics and electronics, which are attractg the lion's share of the interest and energies of physicists these days. It is thus more than ever necessary that departments of biophysics should be developed, which shall be sufficiently powerfully staffed to carry out fundamental research in those branches of physics and physical chemistry which are necessary for cytology. This policy has proved an outstanding success in the similar field of biochemistry; for example, the significance of phosphorylation and phosphorylation cycles, which ranks of the first importance in modern cell physiology, would never have been grasped had it not been for the existence of groups of biochemists capable of undertaking fundamental chemical investigations. One of the clearest conclusions to be drawn from Prof. Frey-Wyssling's book is that, without a rapid development of biophysics, a large part of cytological research must come to a halt, and much of biochemistry will be delayed in its application to cytology until the physical problems are solved.

J. DANIELLI

THE ENGINEER'S APPROACH TO ELECTRICITY AND MAGNETISM

Elements of Electrical Engineering

By Prof. Walter J. Creamer. Pp. ix+344. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 24*s*.

THIS is an interesting and somewhat unusual type of introductory text-book to the study of electrical engineering. Its express purpose is to introduce the engineering approach to the study of electricity and magnetism to students already possessing an elementary knowledge of the mathematical and physical principles, and the scope of the book has been determined quite rigorously by this consideration. With one or two minor exceptions, only D.C. phenomena are treated; but the student is presumed to be aware of some of the general features of alternating current systems.

It is noteworthy that, as a result of this limitation of the field, many quite important matters not ordinarily dealt with in elementary text-books have found a place. For example, the star-delta transformation is treated in the chapter on the electric circuit, and the superposition principle is illustrated, although, oddly enough, it is not utilized in the demonstration of Thévenin's theorem. Chapter 3, on conductors and insulators, includes a paragraph on non-linear circuit elements. The measurement of ground resistance receives attention in the chapter on measuring networks, and electrolytic corrosion under electro-chemical principles. In the treatment of the magnetic circuit, trial and error methods are applied to the calculation of branched magnetic circuits.

Generally speaking, the material used to illustrate the engineering approach is judiciously chosen and well presented, and a satisfactory link is made with the underlying physical concepts. There are, however, examples of statements which might confuse rather than clarify the thoughts of the beginner. On page 9, for example, in relation to current density it is stated that "the distribution of current over the cross-section of a homogeneous conductor will not be uniform if the conductor lies close to another conductor carrying a large current", as though this were a phenomenon of significant magnitude on D.C.; then on page 187, in connexion with the calculation of the flux linkage of a coaxial cable, is the statement: "The component contributed by the current flowing in the outer conductor is difficult to derive, but it is usually so small that we may neglect it without serious error".

Although simple transient conditions in resistance-capacity circuits are treated in the chapter on the electric field, no reference is made to the effects of finite condenser leakage with series-connected condensers on D.C., and, in the reviewer's opinion, some qualitative consideration should have been given to changing electric displacement and the concept of displacement current. The chapter on electro-dynamic principles deliberately avoids all technological detail; but it might have been profitable to demonstrate qualitatively the effect of teeth and slots on flux configuration.

The final chapter gives a useful introduction to the elements of electron ballistics.

It is interesting to note that M.K.S. units are introduced in parallel with C.G.S. electromagnetic units.

The book contains an excellent set of problems to be worked by the student and is altogether a useful introductory text-book with many unusual features.

J. GREIG

HIGH-POWER PULSE GENERATORS

Pulse Generators

Edited by Prof. G. N. Glasoe and Asst. Prof. J. V. Lebacqz. (Massachusetts Institute of Technology: Radiation Laboratory Series, Vol. 5.) Pp. xiv+741. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 54*s*.

THIS volume of the well-known Radiation Laboratory Series is primarily concerned with *high-power* pulse generators, or modulators as they are generally termed in Britain. The general policy with regard to this series has led inevitably to a concentration on American practice. This is not a defect, so long as the book is not taken to be a balanced, representative and historical account of the work of the Allies in the modulator field. Typical instances are: (*a*) A dismissal of mercury thyratrons in a few lines. No hint is given that the British were more successful in developing a 1·5-megawatt valve (C.V.12), and others which were standard in naval and other sets throughout the War. These valves will doubtless be replaced by hydrogen tubes—but they worked at the time. (*b*) The Americans during the War carried out a great deal of work on rotary spark-gaps, and the space devoted to these and to two-electrode enclosed gaps is again characteristic of their design practice rather than that in Britain. Air-blown three-electrode gaps, for example, are not mentioned, though the British naval 274/5 (1·5 MW.) main gunnery sets used a three-electrode air-blown gap.

Certain expressions used in the volume may be obscure to British readers; while 'bootstrap circuit' is now familiar, it is doubtful whether 'tailbiting circuit' is also clear, though it is certainly picturesque. There is also in this volume a certain amount of duplication and of omission which is perhaps a characteristic disadvantage of the symposium type of format. For example, one is surprised to fin in the section on measuring techniques no referenc to current-viewing transformers. For a brief trea ment of them one has to consult the section o pulse-transformers, where no assessment is made their merits compared with those of viewin resistances.

On the credit side of the book is a comprehensiv collation of those reports which showered on during the War from the United States, and th information in it will be indispensable, or a least invaluable, to anyone interested in generatin or transmitting discontinuities in voltage. F example, lengthy sections on the design procedu for pulse transformers, and the effect of puls transformer parameters on all kinds of circuits which they are employed, are the fruits of war-ti research and will now be useful in many differe fields. The inclusion of worked examples once aga makes one grateful for one feature of the editori policy in this series, which recognizes the importan of orders of magnitude to a correct understanding the subject. The name of Guillemin will always associated with the theory of line-type pulsers, and is satisfactory to find here a full account of h systematic treatment and classification of puls forming networks, which is now the basis of standard nomenclature in the United States.

The photographs reproduced in this volume a perhaps less good than in certain others of t series, but numerous oscillograms are reproduc and are very helpful. The general impression creat is one of comprehensiveness and competence, an the book is likely to be of a usefulness long o lasting its topical interest.

J. T. RANDALL

MECHANICS MINUS MATHEMATICS

Applied Engineering Mechanics

By Asst. Prof. Alfred Jensen. Pp. xi+316. (Ne York and London: McGraw-Hill Book Co., In 1947.) 3 dollars.

THIS book is intended for senior school studen and Dr. A. Jensen's aim has been to make it su able for those with little knowledge of mathemati The few integrals and differentials that appear a relegated to appendixes, where they reinforce t arguments in the text. The book teaches largely examples, of which there are a great many, so solved in ample detail and most having answe given. In addition, there are review questions a problems at intervals. The illustrations are pa ticularly clear, and there is good insistence througho on the use of sketches and diagrams. The stude too, is advised to check his work, and alternati methods of doing so are given. The examples a quite practical, so that the student can relate the to problems within his own experience.

The first part of the book is devoted to statics, a the thoughtful student may not entirely be convinc of the truth of the triangle of forces theorem the statement that forces, like velocities, are vecto and so can be added vectorially. The terms 'for and 'stress' are used for the same thing, thou 'stresses' are usually inferred to be the inter forces in a framework. Forces are classified in ystems depending on whether or not they are oplanar, concurrent or parallel; some emphasis on the unifying principles for dealing with any of these ystems would be advantageous. Three-dimensional orce systems are well treated and there is a good hapter on friction.

The second half of the book deals with dynamics, nd here the omission of elementary calculus results n some awkward circumlocutions. For example, on age 167 two "laws of motion diagrams" are formulated which are nothing more than the fundamental ifferential equations of linear motion shown more xplicitly in the appendixes. A slight knowledge of athematics would enable the student to grasp the ruth of these 'laws' without having to memorize hem parrot-wise. The distinction between mass and orce is made quite clear, mass being treated as a uantity derived from the more fundamental concept f force. Problems in dynamics are so far as possible educed to statics by the introduction of inertia orces and inertia couples. Here again the use of ree-body diagrams showing all the forces is urged on he student. In dealing with impulse and momentum would be as well to ensure that both these quantities re treated as vectors. The conservation of momentum equation given on page 292 is only true under ertain conditions; and a few examples showing solutions of momentum would be useful.

R. A. FOULKES

HUMAN ECOLOGY

uman Ecology

he Science of Social Adjustment. By Thomas obertson. Pp. xx + 534. (Glasgow: William aclellan (Publishers), Ltd., 1948.) 21s.

THE interest of men of science in the study of human relationships is growing apace, much to he benefit of sociology. Sociologists have in the ast been far too prone to assume that their subject an be developed in the library; social philosophy as steadily progressed as a result, while social ience, properly so called, has lagged behind.

Anyone interested in contemporary developments ill therefore welcome a book on "Human Ecology" hen he is informed by the dust-jacket that the uthor is "a physician who, after a distinguished niversity career in biological science and medicine, urned to the study of sociological problems". This a hopeful beginning, because it is the medical ofession which has made the most significant ntribution to the study of human relationships in cent years, as is evidenced by the work of psychiatrists in the Armed Forces during the War, and in e Tavistock Institute of Human Relationships and milar bodies more recently. Moreover, the medical ess demonstrates week by week the growing terest and understanding of the practitioner in oblems of social organization. The biologist is rtainly not far behind his colleagues in developing ese new lines of investigation; the work at the ockham Centre has aroused the greatest interest, d research into problems of nutrition, housing, anufacturing processes, and so forth, is beginning achieve most important results.

It is therefore most disappointing to find in the ok under review no realization whatever of the ealth of new knowledge that is now being made ailable in this way. No attempt is made to develop the notion of 'human ecology' in its true sense which was first established on a biological foundation in the popular works of H. G. Wells. Instead, we find served up once again the outworn ideas which were fashionable among discontented young men with a political bent ten or twenty years ago. Much is said on the esoteric subject of 'social credit': many regrets are expressed concerning the unfortunate effects of the growth of the sovereign State; and the "true and secret source" of the "secret power which now dominates society" is found to lie "firstly and for all time in 'avidya', or unreality". The book ends in the lofty strata of the Hindu religion.

The present book is evidence of the fact that only a beginning has been made with the laying of the foundations of the science of man. It is nevertheless to be hoped that those trained in the biological sciences will be able to demonstrate that a more objective approach to the problems of social organisation is possible.

T. S. SIMEY

DEVELOPMENT OF ROMAN CONSTRUCTION

Ancient Roman Construction in Italy from the Prehistoric Period to Augustus

By Marion Elizabeth Blake. (Publication 570.) Pp. xxii+421+57 plates. (Washington, D.C.: Carnegie Institution, 1947.) 9 dollars.

THIS chronological study of the methods and materials used in Roman building is based on notes and photographs left by the late Dr. Esther Van Deman, who had been collecting evidence for many years for a work of this character. Originally it was intended to include all masonry in Rome and the vicinity from the earliest times to the fourth century A.D. or later; but as it was impossible, owing to the War, to complete the necessary field work in Italy, the author decided to terminate her work with the reign of Augustus, while broadening her field to include sites from all over Italy, as a background to developments in Rome. After a preliminary introduction defining the scope and character of the monograph, there follows a chapter on the materials available for building and decoration, namely, stone, clay, metals and wood. A brief geological survey precedes the description of the various types of stone, the sources from which they may have been obtained, and the chronological significance of the choice of material. Timber construction was employed for a variety of purposes; but its use was limited by the scarcity of suitable trees near Rome, and private houses especially were largely built of sun-dried brick.

The next four chapters are concerned with the various ways of building in stone, and they include accounts of the construction of roads, tombs, villas, theatres and temples in Italy during the whole of the period under review, as well as a discussion of the development of city walls from the cyclopean and other early forms. One chapter is devoted to squared-stone construction in Rome and its neighbourhood, and another to the building of arches and vaults in cut-stone work, and their use in such structures as city gates, commemorative arches, bridges, aqueducts and arcades. The fourth of these chapters deals with those methods of providing the stone facing for walls with a concrete core known as *opus incertum* and *opus reticulatum*, together with the intermediate stage of *opus quasi-reticulatum*. A short chapter on the origin and use of sun-dried and semi-baked bricks then leads to a more detailed description of kiln-baked brick and tile construction, including a useful account of the processes of manufacture and of brick-laying. Finally, we come to the consideration of those features for which the Roman builder is especially famous, mortar and concrete. Such traces of early mortars as survive are very friable, and it was only when the value of the volcanic product called pozzolana was realized that the renowned hydraulic mortars of great strength could be made. The colour and texture of both the non-hydraulic and hydraulic varieties differ with the proportions of the materials used for them, and on this account mortar is now seen to be of great value to chronology. The study of its changing colour and consistency has already helped to establish the dating of several Roman sites in Britain; and in Italy the similarities of such features may show the roughly contemporaneous development of building construction over a wide area. The history of concrete is closely bound up with that of mortar.

Throughout the whole book two features particularly attract the attention: first, the important part played by local resources in the development of building methods, a feature which became one of the characteristic signs of Roman influence throughout the Empire; and secondly, the summaries of the technical considerations involved in building, which are to be found in most of the chapters. These provide information which it is difficult for the student of ancient architecture to obtain without detailed study, and so are especially valuable. In her preface the author states that many things have been included in an attempt to ease the burden of future scholars, and in this connexion mention should be made of the very comprehensive indexes provided. Perhaps when her work on ancient mosaics is completed, she will give us a further study of Roman construction, continuing its history to the date originally designed by Dr. Van Deman.

JOAN LIVERSIDGE

VETERINARY PROTOZOOLOGY

Veterinary Protozoology

By U. F. Richardson. Pp. viii+240. (Edinburgh and London: Oliver and Boyd, 1948.) 10*s*. net.

THE number of books devoted entirely to the Protozoa is, in comparison with the number of books about other kinds of animals, unfortunately small. A new book about these beautiful, fascinating and biologically important organisms is therefore an interesting—and to some biologists an exciting—event. If the new book is, like the one which Mr. Richardson has written, restricted to the relatively few species of Protozoa which cause diseases of domesticated animals, this fact does not lessen the importance of its contents. For these species can kill many farm animals or can profoundly affect their health, and thus can effectively menace the food supplies of the world. Some of them can, moreover, cause serious diseases of man, while others are closely related to species which are among man's most powerful protozoal enemies. There are, therefore, plenty of economic reasons why the Protozoa parasitic in domesticated animals should be studied, and, for the same reasons, any book which helps us to contr them is an important one. Mr. Richardson's boo has, also, another claim to importance. Until h wrote it, there was no English book entirely devote to this subject, so that he has filled an importan gap in English biological literature.

The book under notice is not a large one, and it not, perhaps, as ambitious as it might have been yet it gives, in a small space, a surprising amount selected information. One of its most attracti characteristics is its author's simple and conci style, which enables him to convey to the read clearly and briefly an epitome of existing knowledg No doubt Mr. Richardson's experience of research c some of the species discussed and of the teaching veterinary protozoology have helped him to do thi His style is matched by the line drawings which h has wisely chosen to illustrate the book. These a well done; all the illustrations take this form, excep the coloured frontispiece, which is no doubt intende to show what various Protozoa look like in staine preparations, and the two photographs, one of th cæca of a chicken infected with *Eimeria tenella* an the other of the liver of a turkey afflicted wit 'blackhead' disease.

Addressed primarily to veterinary students and t workers in the tropics, where the diseases caused b Protozoa present some of the most serious problen encountered by the veterinarian, the book begi with a brief general account of the Protozoa, an then deals with the Sporozoa, Mastigophora, Amœb and Ciliates which cause the diseases discussed; an also with such organisms as *Globidium*, *Encephalit zoon*, *Rickettsia* and others, the classification of whic is doubtful. The characteristics and biology of eac species, or group of species, are dealt with, and th description of each species is immediately followe by a discussion of the methods of examining th tissues attacked, the lesions caused, the diagnosis the disease, the drugs used against each species an any immunity that the host may develop. The read thus gets a concise outline of each disease and i control in relation to the biology of the species whic causes it. The information given about the dru used for treatment of each disease will be especiall welcomed by some readers who are unable to re the journals in which this kind of information published, and they will also be interested in th chapter on chemotherapy at the end of the boo Another chapter discusses the techniques used f laboratory studies of these particular Protozo Valuable also are the short lists of references important literature given at the end of each chapte

The difficulties confronting anyone who attemp to write a book of this kind are considerable. Shorta of paper and production costs no doubt preclude, these times, the publication of a larger work, a certainly they limit the number and kind illustrations used. It has long been difficult, if n impossible, for any one man to keep himself ful informed about all the work that is being done the whole range of the parasitic Protozoa. Much the literature is scattered in journals in vario languages, many of which are not readily accessib and work on the treatment and control of protozo diseases is frequently inconclusive, so that opini about its value may be conflicting. Advances a moreover, being made continually, so that a man script may, through no fault of its author, be out date in places by the time it is printed. No read therefore, can expect, in a book on this subject, fin dgments on many of the problems discussed. He ill find in the present book, however, a great deal at will interest and inform him, and a great deal lso that will suggest to him lines of fruitful research. eachers will find in it the essentials of a subject the nportance and fascination of which are not often alized outside the veterinary schools.

Mr. Richardson is to be congratulated; and his ublishers have earned our gratitude for producing, t a moderate price, this attractive, easily handled nd well-printed book. G. LAPAGE

GARDEN, SMALLHOLDING AND FARM

mallholdings for Pleasure and Profit

uarter-acre Part-time Holding to Smallholding and arm. By W. V. Ball. Pp. 124. (Worcester: Little- ury and Co., Ltd., n.d.) 10*s.* 6*d.* net.

our Smallholding

dited by Alan Thompson. (Penguin Handbook H.13.) Pp. 192+8 plates. (Harmondsworth: enguin Books, Ltd., 1947.) 1*s.*

nallholder Broadcasts

ol. 3. From the Series of Broadcast Talks "Backs the Land". Pp. 95+8 plates. (Worcester: Little- ury and Co., Ltd., n.d.) 10*s.* 6*d.* net.

lowers, Shrubs and Fruit for the Small Garden

y G. A. Carter. Pp. 86+12 plates. (Worcester: ittlebury and Co., Ltd., n.d.) 9*s.* 6*d.* net.

'T may be claimed for the present post-war period that it has a substantial fund of good counsel vailable for newcomers to the land. Three of the oks under review aim at providing trustworthy lvice to smallholders, actual and potential, and in is they succeed.

The author of "Smallholdings for Pleasure and ofit" was an ex-Serviceman in 1921 who decided obtain a living from the land. His experiences of nall-scale farming, following a course of instruction the Hertfordshire Institute of Agriculture, are set it clearly in his book, and he presents the reader ith facts and figures of a highly enlightening aracter. Holdings ranging from a quarter of an re to those of 50-acre size are discussed, and oservations made on the capital required to run em. Advice is tendered on how to obtain a small- lding and on whether to purchase or to lease. The and Settlement Association Schemes are described, are land settlement schemes in several countries her than England. Illustrations, mostly of mech- ical aids for the small farmer, add to the value of publication certainly well worth perusal by the ospective smallholder.

"Your Smallholding" ably maintains the high andard established by Penguin Handbooks. In is volume emphasis is placed upon the part-time lding, the demand for which is likely to increase w that working hours are being shortened. Chapters aling with the keeping of cows, pigs, goats and bees e included, and rabbit-keeping is not forgotten. ace allotted to food crops is very limited and is voted mainly to fruit-growing. The unwarranted as against the use of mineral fertilizers, encountered the final chapter, is perhaps forgivable in view of e many words of wisdom to be found elsewhere. is handbook, enhanced as it is by several clear photographs, is wonderful value for the small sum which it costs.

In Smallholder Broadcasts, Vol. 3, much material of enduring interest has been put on permanent record and in handy form. Eight chapters are given to various aspects of poultry-keeping; six to bee-keeping; three to glasshouse crops; and pigs and waterfowl have a chapter apiece. The contributions, by thoroughly competent men, together make a particularly useful book which should be in the possession of every smallholder interested chiefly in livestock management.

"Flowers, Shrubs and Fruit for the Small Garden" is concerned with the garden having an area of between 500 and 800 square yards, that is, one which can be looked after by its owner without outside assistance. The author has made and owned several such gardens and now offers plenty of excellent advice to others. A few of his statements, however, ought not to pass unchallenged. The cultural directions are somewhat sketchy, the pruning of gooseberries, for example, being dismissed in one sentence. It were well to attend to leaky washers before rather than after spraying as advised. The illustrations are not as clear as they might be.

None of these books is provided with an index.

EPICURUS UP TO DATE

Matérialisme progressiste

Par Dr. Charles Mayer. Pp. 177. (Paris: Société française de Presse, 1948.) 150 francs

THIS is a clear and straightforward exposition of a type of philosophy more usually called positivism; for matter is taken to be that which the physical sciences study. It is a relief to find that 'progress' in the title means more knowledge, not bigger and better gadgets, and that the author acknowledges his kinship with the ancient Epicureans. There are differences, however. Epicurus, as expounded by Lucretius, was not interested in science except as a dogmatic stick to beat traditional religion with, whereas Dr. Mayer is interested, and on the purely scientific side writes very well. On the other hand, Epicurus' ethical doctrine was well thought out and based on a real understanding of human nature and the human situation of his day.

Dr. Mayer is content to reproduce the teaching of nineteenth-century utilitarianism and liberalism, modifying its individualism by insisting that welfare is social welfare; but does not examine its foundations or its applicability to the present world situation. In general, he is singularly unaware of philosophical problems. In the preface he sets out his fundamental assumptions: (1) there is nothing supernatural; (2) there are no transcendental truths; (3) the universe is not the product of thought, and its evolution is not predestined; (4) there are no final causes; (5) no facts but material ones; (6) thought itself is a spark (*étincelle*) derived from matter; (7) the mind cannot conceive of itself without matter. Of these, (7) might pass as empirical or 'scientific'; all the rest are transcendental truths (or falsehoods). Thus (2), unless carefully hedged about, is self-contradictory, and even so, unplausible in face of the others. The philosophy of Santayana could have shown Dr. Mayer where his assumptions lead if systematically worked out and how much room is then left for progress of any sort. A. D. RITCHIE

Active Psychology and the Welfare and Progress of Man

Notes on the Establishment of a Non-Medical Practical Psychology. By G. E. Witt. Pp. iii+88. (London: H. K. Lewis and Co., Ltd., 1947.) 7*s.* 6*d.*

THE late Dr. G. E. Witt was a pupil of Kraepelin and Bonhoeffer, and it might have been expected that he would produce an authoritative book. Unfortunately, this present one does not fulfil its grandiose title, and is disappointing. A foreword states that it is "A collection of thoroughly worked through and paragraphised notes. These notes or paragraphs have kept their independency. The sequence is fortuitous." This places a strain on the reader. The foreword admits "This mode of presentation has its advantages and its disadvantages. The disadvantages can be reduced by an index." Perhaps an index will be a part of the second volume; none is provided in the present one.

Dr. Witt's views show that he felt that psychiatry should be expanded into 'active psychology', which is defined in paragraph 2 as "An applied psychology. Resulting from certain perceptions it is a practical method of working psychologically upon the human mind." But unfortunately it continues by stating: "The method, and its foundation, will be explicitly dealt with in another volume". It seems that Dr. Witt believed that by emancipating psychiatry from general medicine and by widespread training in 'active psychology' a revolution would occur in social life as well as treatment.

The style of this book is repetitive, the exposition disjointed and difficult to follow, and much of the matter is dependent on a further volume. The printing and paper are good, and the book is paper bound.

Using and Managing Soils

By Prof. A. F. Gustafson. (McGraw-Hill Rural Activities Series.) Pp. xii+420. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 17*s.*

THE object of this book is to provide the intelligent American farmer, smallholder or gardener with a short account of the scientific principles of soil management. The author, who has written several well-known books, is professor of soil technology at Cornell University, and among the topics he discusses the following are most relevant to British conditions: cultivation, drainage, maintenance of fertility, the best ways of using farmyard manure and green manures, and the proper use of fertilizers and crop rotations. He gives many examples of management; but, for obvious reasons, these mainly refer to the agriculture of the north-eastern and middle-western United States. Thus the book is unsuitable for the corresponding practical man or student in Britain. On the other hand, lecturers in crop husbandry at farm institutes and agricultural colleges in Britain will easily be able to pick out from the discussion the principles applicable to British agriculture.

The great difficulty in writing any book such as this is to combine simplicity with accuracy and conciseness with adequacy of presentation. There are a number of places where the reviewer is not in full agreement either with the adequacy or accuracy of the science, or with what has been omitted or included. But his main criticism is that at several places the general principles are not brought out as clearly as they should be, so that no indication is there given of the generality of the results stated, the reasons for them.

The book is very well produced, is copious illustrated and contains many tables of experiment results.

E. W. RUSSELL

Discharge Lamps for Photography and Projectio

By H. K. Bourne. Pp. xv+424. (London: Chapma and Hall, Ltd., 1948.) 36*s.* net.

A BOOK written by a research worker, whic deals with the subject in which he has specializ for a number of years, is always worthy of attentio and Mr. H. K. Bourne's "Discharge Lamps" is exception to this general rule. The title is perha somewhat misleading, as there is a not inconsiderab section dealing with incandescent filament lamps an carbon arcs, as well as a section later in the boo dealing with photographic flash lamps of the aluminium foil or wire type.

There are many people, whether belonging to th class of student or lecturer or potential user, wh have not been in a position to follow the rap developments of the last two decades in the fie of light sources, to whom this book will prov valuable for reference purposes. Account h obviously been taken of most of the important pape which have been published on this subject as well of the patent literature.

Mr. Bourne's book contains much data an information published for the first time, and it ca be strongly recommended as an authoritative wo covering a large section of the field of special-purpo illuminants. It gives in conveniently summariz form data on the electrical and luminous properti of most types of electric discharge lamp at prese available. The sections dealing with applications w no doubt stimulate further interest in these relative new light sources.

J. N. ALDINGTON

The Hunting Wasp

By John Crompton. Pp. 255. (London and Glasgow Wm. Collins, Sons and Co., Ltd., 1948.) 10*s.* 6*d.* ne

THIS book may be described as a popularizati anew of the writings of Fabre and the Peckha on the habits of the solitary wasps, enlivened by number of personal anecdotes not always abo insects, the whole written in a vivid and racy sty which makes for easy reading. The author's mann may be sufficiently illustrated by his description the wasps' nest in winter. "The long low-ceiling halls echo vacantly. The cradles in their thousan lie empty. Vermin creep in: the mouse, the earwi and the beetle keep the courts where Vespa glori and drank deep".

The subject is presented in terms of an unblushi anthropomorphism; the intelligence of insects taken for granted, but there is criticism and a se reliant philosophy of the robust common-sen variety to be expected from a man who has knock about the world.

A number of mis-spellings and small errors of fa do not detract seriously from a very readable boo But in justice to the entomologists of the Ministry Agriculture, who have been conducting a well-plann and highly successful campaign against the Colora potato beetle, it may be pointed out that it was n the British Government "frightened by the threaten invasion" which offered a reward of £10 for eve Colorado beetle; that ill-conceived measure can from a newspaper office.

V. B. WIGGLESWORTH

COLOURING MATTERS OF THE APHIDIDÆ

By H. DUEWELL, J. P. E. HUMAN,
R. A. W. JOHNSON, DR. S. F. MACDONALD
AND
PROF. A. R. TODD, F.R.S.
University Chemical Laboratory, Cambridge

THREE colouring matters (cochineal, kermes, lac-dye) derived from insects belonging to the occidæ have long been of commercial importance nd have been the subject of extensive chemical vestigation. Although many of the related Aphididæ re highly pigmented and are of very common ccurrence, chemical investigation of their pigments as been very scanty. No doubt one reason for this ate of affairs has been the comparative difficulty f collecting adequate supplies of insect material; ut the small amount of information available sugsts that some aphids at least contain colouring atters possessing unusual properties.

An early paper by Sorby[1,2] described an examinaon of the colouring matters of the "red Aphides" und "in downy patches on the bark of the apple ee". Although not expressly stated by Sorby, this sect was presumably the common woolly aphis *Eriosoma lanigerum*, Hausmann). From these and ther aphids he obtained in solution a remarkable ries of inter-related pigments, and although these ere not isolated they were identified by their chareteristic absorption spectra, details of which were corded. Extraction of freshly killed insects with ater gave a solution of the red "aphideine", which as not isolated; but on standing in air it rapidly ssed into the yellow water-insoluble "aphidilutne", which in turn was transformed into an orange gment, "aphidiluteoleine", on standing for longer riods. On still further exposure to the air, a red louring matter was formed which was named aphidirhodeine" and which appeared to form relavely stable solutions. If the crushed insects were t extracted immediately, no aphideine was obtained it only mixtures of the other derived pigments, the lative proportion of which varied according to the me of standing. Details were given of the colour anges of the various colouring matters in acid and kaline media, and it was concluded that, although e pigments were in some respects analogous to emoglobin, the "physical and optical properties ffered completely from those of the colouring atters of the cochineal insects of commerce". Many ars later, Blount[3], unaware of the work of Sorby, lated from the woolly aphis the crystalline orange-d lanigerin, $C_{17}H_{14}O_5$; but the constitution of the gment was not closely studied. It was recorded, wever, that lanigerin formed a deep red solution concentrated sulphuric acid and a crimson solution sodium hydroxide.

Blount[3] also reported the isolation of a red pigment, robinin, from white pine chermes, *Adelges* (*Pineus*) *obi* (Börner). Strobinin gave analytical values rresponding to a formula, $C_{30}H_{24}O_8$, but was not rther examined because of shortage of material, . *strobi* being of only limited occurrence in England. robinin formed a green, sparingly soluble, sodium lt and showed a remarkable colour reaction with acetic anhydride containing a drop of sulphuric acid, the initially reddish solution changing rapidly through green to a pure blue, with simultaneous appearance of an intense red fluorescence. Our interest in this subject was intensified when, a few years ago, one of us examined in a preliminary fashion a small number of black aphids (*Aphis fabœ*), and found that crude extracts of the dried insects showed certain colour reactions similar to those described for strobinin by Blount[3].

During the summer of 1947, *A. fabœ* was prevalent in the Cambridge area on its usual host, the broad bean (*Vicia faba*), and when it was confirmed that it yielded a red pigment giving the characteristic acetic anhydride – sulphuric acid reaction of strobinin, a systematic investigation of the colouring matters of the insect was undertaken. At that time we, too, were unaware of Sorby's paper. The results so far obtained in our investigations on this and other aphids appear to be of sufficient interest to warrant their publication at this stage.

In the course of preliminary studies on the extraction of fat-soluble pigments from *A. fabœ*, it quickly became apparent that the red colouring matter with reactions similar to strobinin is not actually present in the living insect but arises from a yellow precursor, after death of the insect, the change being greatly accelerated by heat or by traces of acid or alkali. When this change was followed spectroscopically by extracting the insects with 80 per cent aqueous acetone and then partitioning the pigments into light petroleum, the yellow precursor proved to be a mixture of a yellow and an orange colouring matter, both of which underwent conversion to the red pigment either spontaneously or, more rapidly, under the conditions indicated above. Under mild conditions the 'primary' yellow pigment could be converted into the 'secondary' orange pigment, and all observations indicated that the primary yellow could only be converted to the red with the intermediate formation of the secondary orange pigment.

In order to obtain these pigments, the fresh insects were extracted with 80 per cent acetone and the pigments taken into light petroleum from the acetone. The petroleum extract was then rapidly concentrated at room temperature until a granular product separated which gave the primary yellow and the secondary orange pigments on fractional crystallization from carbon tetrachloride. These substances, when dissolved in ethyl acetate and a little formic acid added, gave the crystalline red pigment.

Although, as ordinarily obtained from fresh insects, the crude fat-soluble pigment was a mixture of all three colouring matters in varying proportions, it seemed probable that all were artefacts, for the extraction with 80 per cent acetone was considerably facilitated when the crushed insects were first allowed to stand in contact with air for periods of up to one hour. Further investigation showed that if living insects were treated with water at 70°, no pigments could then be extracted with organic solvents; but a crystalline yellow water-soluble precursor of the above pigments could be isolated. Thus, after the preliminary treatment with hot water the insects were extracted with 60 per cent methanol. Fat was removed by extraction with light petroleum and the methanol removed *in vacuo* from the aqueous layer. Adsorption on active charcoal followed by elution with 75 per cent acetone and evaporation of the eluate gave the pale yellow water-soluble colouring matter crystallizing in flat needles. It formed a port-wine coloured solution in alkali, and addition of crushed aphids to its aqueous solutions caused rapid conversion to the 'primary' yellow fat-soluble pigment, presumably as the result of enzymic action. Other water-soluble pigments, green and brown respectively, apparently unrelated to this series, have also been found in extracts of *A. fabæ*.

Our investigations have been further extended to include the following species of coloured Aphididæ: *Tuberolachmus salignus* (Gmelin) from willow trees (*Salix alba*), *Aphis sambuci* L. from elders (*Sambucus nigra*, L.), *A. rumicis* L. from docks (*Rumex obtusifolius*, L.), *A. viburni* Scop. from *Viburnum* spp., *A. ilicis* Kalt. from *Ilex aquifolium* var. *crispifolium-variegatum*, *Sappaphis pyri* (Fonsc.) from cultivated pear trees (*Pyrus communis*), *S. plantaginea* (Pass.) from cultivated apple trees (*Malus pumila*), *S. cratægi* (Kalt.) from garden parsley, *Myzus cerasi* (F.) from wild cherry trees (*Prunus cerasus*, L.), *Dactynotus jaceæ* (L.) from the greater knapweed (*Centaurea scabiosa*, L.), *D. cirsii* (L.) from thistles (*Cirsium lanceolatum*, L.) and *Eriosoma lanigerum* (Hausmann) from cultivated apple trees. Fat-soluble colouring matters analogous to those isolated from *A. fabæ* have been obtained from *T. salignus*, *A. sambuci*, *A. rumicis*, *S. pyri*, *S. plantaginea*, *M. cerasi* and *E. lanigerum*, and their presence in *S. crataegi*, *A. viburni* and *A. ilicis*, of which only small amounts have as yet been available, has been demonstrated by spectroscopic examination of extracts. The pigments isolated from *D. jaceæ* and *D. cirsii* differed from the others in that the 'secondary orange' pigments were much redder in colour and that neither of the 'primary yellow' pigments were isolated. Further work on these species is in progress.

The nomenclature of these pigments presents a number of problems, partly because of the desirability of some generally applicable scheme, and partly because of the possibility that some of the substances isolated from different species may prove to be identical. For these reasons it is felt that such names as 'strobinin' and 'lanigerin' are not wholly satisfactory. It is proposed that the water-soluble pigment in the insect should be called a 'protoaphin', and that the primary yellow pigment derived from it by enzymic action, a 'xanthoaphin'. The secondary and tertiary pigments derived from the latter would be 'chrysoaphin' and 'erythroaphin'. It is further proposed that, for the present at least, the pigments from each species should be distinguished by adding to each of these stem names a two-letter suffix based on th name of the insect species. Thus the pigments fro *A. fabæ* are described as protoaphin-*fb*, xanthoaphi *fb*, chrysoaphin-*fb*, and erythroaphin-*fb*; those fro *T. salignus* take the suffix -*sl*, from *A. strobi* -*st*, *lanigerum* -*ln*, *A. sambuci* -*sm*, *A. rumicis* -*rm*, *plantaginea* -*pl*, *S. pyri* -*py*, *S. cratægi* -*cr*, *M. cera* -*ce*, *D. jaceæ* -*jc*, *D. cirsii* -*ci*, *A. viburni* -*vi* an *A. ilicis* -*il*.

Details of the pigments obtained from *A. fabæ* a given in the accompanying table.

The xanthoaphins, chrysoaphins and erythroaphi from all the species listed above have very simil and characteristic absorption spectra in the visib region, and examination with a hand spectrosco is a convenient method of identification. Melti points can seldom be used as criteria of purity in th series, and the similarity in absorption spectra leav open the possibility that some, although not all, the corresponding pigments isolated from sever species may be identical. Of the species mention above, *T. salignus* and *A. fabæ* have been the mo exhaustively studied. The former, which at tim causes heavy infestation on willow trees, is mc readily collected alive and undamaged than *A. fab* is usually less contaminated with parasites a foreign insects and has a relatively high content colouring matter (1·3 per cent). As in *A. fabæ*, t living insects contain a protoaphin occurring in t hæmolymph, and this pigment rapidly chang after the death of the insect to fat-soluble xanth aphin-*sl*, readily converted in turn to chrysoaphin and erythroaphin-*sl*. Although closely similar to t corresponding substance from *A. fabæ* in its cor position and its properties, erythroaphin-*sl* gives different X-ray powder photograph.

Our results confirm in every respect the findin of Sorby in showing that representatives of t remarkable class of pigments are found widely amo the Aphididæ. It is evident, too, that strobinin c responds to our erythroaphins, and indeed an X-r powder photograph of a specimen kindly suppli by Dr. Blount indicated that it is probably identi with the *T. salignus* pigment. From the record its colour reactions, Blount's lanigerin is alm certainly one of our chrysoaphins (chrysoaphin-*l* Chemical investigation of the structure and int relationships of all the colouring matters is bei undertaken in this Laboratory and the work is bei extended to include other insect species as th become available.

Pigments from *A. fabæ*

Pigment	Crystal form and solvent for crystallization	Effect of *p*H on colour and fluorescence of aqueous-dioxan solutions						† Position c visible absorption bands (mμ) (neutral chlo form solutio
		Neutral		Alkaline*		Acid*		
		Daylight	Ultra-violet fluorescence	Daylight	Ultra-violet fluorescence	Daylight	Ultra-violet fluorescence	
Protoaphin	pale yellow needles (water)	pale yellow; no fluorescence	dull grey-green	red-violet; no fluorescence	dull violet	pale yellow; no fluorescence	dull grey-green	—
Xanthoaphin	small bright yellow needles (carbon tetrachloride)	yellow; blue-green fluorescence	brilliant blue-green	pale pink	brilliant yellow-green	yellow; blue-green fluorescence	brilliant blue-green	433, 462
Chrysoaphin	orange yellow micro-crystals (carbon tetrachloride)	yellow; green fluorescence	intense yellow-green	crimson	brilliant orange	yellow; green fluorescence	intense yellow-green	457, 488
Erythroaphin	deep carmine-red needles (chloroform/ethanol)	red	orange-red	dark green. Ppt. on standing	dark ruby-red	red	orange-red	589, 564, 5 (faint) 452 (very fain

* 3*N* HCl (1 drop) or 3*N* NaOH (1 drop) respectively added to pigment (0·5 mgm.) in dioxan (2 c.c.).

† Determined visually on a microspectroscope.

Most of the chemical work so far carried out has been done on the erythroaphins-*fb* and -*sl*, as these have been available in the largest quantity and hey are the most stable members of their respective series. They are tenaciously held on alumina or alcium hydroxide chromatograms, and although some purification can be effected on talc columns, hromatography has not been generally employed. Solutions of these pigments show an intense fluorscence which is red in daylight and orange in ultraviolet light. They have no definite melting point but decompose with considerable charring above 00°, and they cannot be sublimed even in a high vacuum. They are readily soluble in pyridine, much ess so in acetone, chloroform and carbon tetrachloride and very sparingly so in ethanol, ether and the other common organic solvents. Solutions in aqueous pyridine, sodium hydroxide and sodium carbonate are bright green and deposit green amorphous precipitates on standing. They contain neither nitrogen, halogens, sulphur nor methoxyl (Zeisel). Erythroaphin-*fb* contains acidic hydroxyls (0·84 per cent active hydrogen; Zerewitinoff) and several C—CH_3 groupings (12·4 per cent; Kuhn – Roth). Considerable difficulty has been encountered in obtaining consistent analytical values both for these substances and for the xantho- and chrysoaphins owing mainly to their tenacious retention of small amounts of solvent, but the results of a series of analyses suggest that the erythroaphins have an empirical formula $C_{15}H_{12}O_4$.

Low solubility in suitable solvents and tendency to decompose at higher temperatures have prevented accurate molecular weight determinations; the acyl derivatives, although more suitable for this purpose, still give variable results. In the case of erythroaphin-*fb*, X-ray analysis of the crystalline material indicates a molecular weight of either 260 or 519 ± 3 per cent according to whether the unit cell contains eight or our molecules. The higher value is in better accord with the results of cryoscopic determinations on the benzoyl derivative and would also be more in keeping with the intense fluorescence and extremely sharp absorption bands shown by the pigment, so that we have adopted provisionally a molecular formula $C_{30}H_{24}O_8$ for erythroaphin-*fb*.

Hydrogenation of the erythroaphins in presence of a platinum oxide catalyst or reduction with sodium hyposulphite yields orange fluorescent leuco-compounds which are rapidly re-oxidized in air, suggesting the presence of a quinonoid structure in these pigments. The exact nature of the nucleus as well as the nature of the changes involved in the series of conversions protoaphin → xanthoaphin → chrysoaphin → erythroaphin are still obscure.

It is of considerable interest that there is a very trong general resemblance between the properties of the erythroaphins (even to the difficulty of analysis and molecular weight determination) and those of hypericin, the photodynamic colouring matter of St. John's wort[4,5], which has been provisionally formulated as a polyhydroxy-*meso*naphthodianthrone deivative, and it seems not unlikely that they are related in structure. Using *Paramecium* as test organism, Prof. D. Keilin has shown that erythroaphin-*sl* is strongly photodynamic. It is noteworthy that Dhéré[6] has already remarked on the similarity between the ultra-violet and fluorescence spectra of hypericin, lanigerin (chrysoaphin-*ln*), strobinin (eryhroaphin-*st*) and the mould pigment oxypenicilliopsin[7].

Full details of the investigation here outlined will be published elsewhere. We record with pleasure our gratitude to Mr. H. L. G. Stroyan for his invaluable assistance in locating and identifying the various Aphididæ which we have examined, and to Dr. W. Cochran for the X-ray crystallographic examinations.

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INSTRUMENTATION AND CONTROL IN INDUSTRY

SECTION A (Physics) of the British Association held a symposium on September 14 on "Instrumentation and Control, including Electronic Devices". The discussion was opened by Sir Ewart Smith, who spoke on "The Contribution of Instruments to Industrial Progress".

"The instrument field is already a vast one and it is extending rapidly as the result of advances in physical science on the one side, and the ever-growing demands of industry on the other. Industrial processes are becoming more complex in detail and the size of the unit is continually tending to increase; in addition, there is the demand for higher efficiency, for continuity in operation and for better control of finish and consistency, all of which call for a higher degree of instrumentation. Better instrumentation in turn leads to still wider possibilities of technical progress."

Sir Ewart summarized the main stages in the historical development of instrumentation, to indicate the lines future progress might be expected to follow, and stressed both the dependence of modern industry on instrumentation and the need for a new outlook with regard to it. When a large and complex industrial plant may depend entirely on instruments for its automatic control, it is clearly time to regard these instruments not as accessories but as an integral part of the plant. They are, in fact, the heart and brains around which the process should be designed. Industry is now recognizing this important fact, and is attempting to secure the full potential benefits of automatic control in this way.

Relation between Research and Industrial Application

Sir Ewart directed attention to the way in which an industrial instrument is frequently developed from a laboratory instrument which has been designed to meet a need in research, and stressed the important part played in the development of the instrument from one stage to another by the 'development' or 'design' engineer. He emphasized the vital need which had been pointed out at several previous meetings of other sections, and by Sir Henry Tizard in his presidential address to the Association, for ensuring that Great Britain possesses a sufficient number of properly trained applied scientists to take the knowledge made available by the research worker and to put it to effective use in industry.

The applied scientist has a very large part to play in revitalizing the national economy of Britain, for upon his ability must depend progress in applying the large amount of knowledge which has been discovered by the research worker. The applied scientist's function is to be the essential link combining together the potentialities of research, the requirements of the user and the possibilities of fabrication and construction in the industrial field. Sir Ewart defined 'development' as "the process of bringing knowledge derived from research to the state in which it can be applied directly to useful ends". The development engineer must therefore be an applied scientist in the true sense of the term, and it has been in the training of such men that Britain has not made the best use of its potentialities.

Sir Ewart recalled that at a previous meeting of the Association he had defined research as "the process of gaining knowledge in a systematic manner by the study of phenomena, or by the examination and correlation of existing data". Much attention has recently been directed to the importance of research work as defined by the first half of this definition; but Sir Ewart stressed very strongly that the time has now arrived when it is proper to emphasize the importance of work defined by the second half. As knowledge becomes more and more specialized, the need for co-ordination of the various specialized fields increases—for without it existing knowledge cannot be applied promptly to industrial problems. It is, therefore, necessary to give very serious thought to methods of correlation, indexing and dissemination of detailed knowledge in a form suitable for the applied scientist to use. At the same time, the student must be taught how to find such knowledge when it is required.

Sir Ewart said that in order to make effective progress, it is far more important that the applied scientist should have the right approach than that he should possess a vast fund of detailed knowledge. The universities and technical colleges should aim primarily at training men to understand basic principles, to be critical and to think for themselves. Educationists and industrialists alike should make it their duty to see that a proper proportion of the best brains coming forward should be trained in this manner to undertake the vitally important and supremely interesting work of development and design over the whole industrial field. If a sufficient number of applied scientists is assured, industrial progress will be accelerated and the fruits of research will be used to benefit the community much more promptly than is normally the case now.

Standardization of Technical Terms and Equipment

As a corollary to the need for correlation of information, so that it is easily accessible to the applied scientist, attention was directed to the equal need for standardization of units, definitions and general methods of presentation. It is in general agreed that such standardization would be extremely beneficial; but when attempts are made to obtain it, difficulties arise immediately. These difficulties are undoubtedly very real; but it is certainly worth while making individual sacrifices in order to overcome them.

Sir Ewart suggested that the whole subject of education of the applied scientist, and the correlation and indexing of information to make his work more efficient, is one worthy of discussion by the British Association, which provides a natural forum for the general consideration of such matters. This suggestion was warmly welcomed by the president o Section A, Sir Lawrence Bragg, who suggested tha a special session should be devoted to these matters at a future meeting of the Association.

From the standardization of units and nomenclature, it is a natural step to the standardization o material things. Sir Ewart advocated a very much greater degree of standardization of equipment and components in order to reduce production costs, and to assist interchangeability. It was made quite clea that it was not intended that this standardization should apply, for example, to complete instruments but only to those dimensions or components o instruments which are commonly used. Far from hampering progress in design, such a measure o standardization would accelerate progress—as ha been clearly demonstrated in other fields where standardization had been applied. Sir Ewart quoted the instance of the recent discussions between the United States, Canada and Great Britain on the standardization of screw threads. Here a major degree of tentative agreement has been reached, and it is hoped that all concerned will do whatever is possible to bring the discussions to a fruitful end. By putting off the problem to a future date the difficulties are only increased. They should be tackled now in a realistic and effective manner, instead of leaving them to increase in difficulty year by year.

In conclusion, Sir Ewart said that to obtain the most rapid progress in instrumentation, it is essentia to adopt a progressive and critical outlook; to ensure that a large number of properly trained applied scientists are available to industry; to obtain acceptance of common standards of measurement and nomenclature; to index available knowledge to make it easily accessible; to increase the measure o standardization of some types of equipment, and to make sure that industrial processes are designed to give full scope to the potentialities of automatic control.

Use of Electronic Instruments in Iron and Steel Making

The need for good presentation of basic principle and good design was again stressed by Mr. S. S. Carlisle in his paper on "The Use of Electroni Instruments in Iron and Steel Making". The iro and steel-making industry is at present carrying through an extensive programme of modernization and development, and is thus finding wide use fo the latest techniques of industrial measurement an control. There is, however, an understandable tendency to adopt techniques which are firml established as reliable and suitable for continuous operation in the particularly rigorous conditions encountered. Those responsible for operating stee plant are keenly interested in electronic instruments but sufficient confidence has not yet been inspired i electronics to create a great demand for them.

Mr. Carlisle believes there are three main reasons for this. In the first place, very exaggerated claim have been made for electronics as a solution to ever problem. Secondly, the impression has not bee dispelled that electronic equipment is fragile an inevitably extremely complicated. Thirdly, insuffcient attention has been given, in general, to the design of electronic equipment to meet the requirements of the heavy engineering industry—which a robustness, continuous operation and immunity t large temperature variations, to dust, to fumes and to vibration.

A great wealth of information has been made available by research work; but design technique, it was suggested, has not progressed sufficiently rapidly to use this information to the best advantage for industry. The development of the operating principles and of the techniques of using the thermionic valve has progressed at such a pace during the war years that the establishment of sound design technique applicable to industrial use has been rather left behind. This may result from the ease with which thermionic valves can be used to construct measuring devices without the necessity of giving a great deal of attention to good engineering design. There has also been a tendency to instal such instruments on the plant before they have been sufficiently tested and developed.

Mr. Carlisle said that the greatest help to a proper application and use of electronics in industry would be rendered by the clear presentation of the basic principles used. The number of actual electronic components necessary to build up equipment for instrument needs is small, and a thorough understanding of the characteristics and limitations of these components and the circuits into which they are built would immediately remove much of the suspicion with which electronic equipment is regarded by those who run industrial plants. Mr. Carlisle proceeded to illustrate his general points by reference to particular types of installations, and then described in some detail the problems of temperature measurement in the steel industry and the methods used to overcome them. Unfortunately, there was insufficient time for Mr. Carlisle to give descriptions of several instruments which had been developed specially for the steel industry; but these, no doubt, will be published in the literature in due course.

In summing up his remarks, Mr. Carlisle suggested that electronic instruments will ultimately find preference over the established systems because of their greater flexibility, in design and application, their simplicity and their suitability for production in large numbers at low cost. There is clearly a strong argument for their use when so large a proportion of the measurements required are, or can be, made by primary measuring elements giving an electrical output. It was emphasized once again that the information and the components are available; it only remains to provide good application technique and sound design for the arduous operating conditions experienced in the heavy engineering industries.

Servo Mechanisms

No better example of what can be done in a specialized field to implement Sir Ewart Smith's plea for better training, more correlation of specialized knowledge and more standardization of terminology, etc., could be found than in the work described by Prof. K. A. Hayes in his paper on servo mechanisms.

The rapid development required for Service needs during the War led to production of a new fundamental theory and a new approach to design. It also led to a new technique for testing—which in itself is of very considerable scientific interest. The complexity of the equipment called for a new type of technician capable of dealing with the intricate circuits and mechanisms evolved; for example, in the No. 10 Predictor there are several servo mechanisms and numerous three-stage amplifiers connected in a very complicated manner. To maintain such equipment in the field, it was necessary to train a large number of men who could think for themselves and use their initiative in carrying out repairs in the field. The ability to reason was called for in a high degree.

It fell to the lot of the Military College of Science to take a large part in working out a suitable training scheme and putting it into operation. The methods of teaching adopted should be of great interest to those in industry who have similar—although perhaps less complicated—problems to deal with. Although this training scheme was worked out for the maintenance man as opposed to the design engineer, it was initiated with the same intention as lies behind Sir Ewart Smith's suggestions. It was designed to inculcate ability to think rather than to amass a large amount of detailed knowledge—which in this instance would have proved useless in the field.

Prof. Hayes outlined the growth of servo mechanism technique, which had achieved rapid advances in the period 1925–38, and even more rapid advances since, during the Second World War. It was recognized by the Services at an early stage that the degree of accuracy required for gunnery, navigation, etc., could only be achieved by the use of automatic computing and controlling devices. Establishment of the underlying fundamental principles of the theory of position control followed quickly, and upon these principles the war-time success in the application of servo mechanisms was built up.

It is interesting to note the high order of performance demanded of the equipment required. For example, even a comparatively light gun weighs a matter of several tons, has a moment of inertia of order 10^6 lb./ft.^{2} units, and yet may be required to move at rates up to 30°/sec. with an acceleration of as much as 10°/sec./sec. It must be trained to coincide continuously with the directing device with an accuracy of a few minutes of arc. The precision of the servo mechanisms was such that the limit to the accuracy of the whole system in this kind of application was normally set by that of the gears and bearings, and the rigidity of the frame and mounting, etc., of the heavy equipment to be moved.

A simplified example of position control was shown to illustrate the fundamental techniques employed. The importance of 'monitoring feed back' was stressed, and the difficulties introduced by the 'stiffness', natural period of oscillation, and lags in the system, were indicated. Time did not permit any detailed discussion of the correcting controls necessary to overcome them.

The amount of work proceeding in various Service establishments during the War on servo mechanisms was such that in order to spread the available information among all concerned and to stimulate discussion among them, the Ministry of Supply Servo Panel was suggested by Dr. A. K. Soloman and was formed under the chairmanship of Sir John Cockcroft, who was later succeeded by Prof. D. R. Hartree. The Servo Panel held regular meetings at which papers were read and discussed in the manner of a learned society, and special panels were set up to deal with particular aspects of the problem.

It is interesting to note how the Servo Panel performed many of the functions of correlation and codification of information, standardization of nomenclature and terminology, which Sir Ewart Smith had already stressed as being so vital to the applied scientist in the whole industrial field. Prof. Hayes reminded the meeting that the library of the Servo Panel, which contains one of the most comprehensive ranges of books in existence on servo technique, is still available in the Ministry of Supply.

In conclusion, Prof. Hayes, commenting on the general nature of servo mechanism theory, said that the testing techniques evolved are being used to examine the nervous and muscular response of human beings, and that Prof. Tustin has suggested that the theory will predict the oscillations of an economic system.

The two papers which followed were more specialized. Dr. Uttley's paper directed attention to the great utility of servo mechanisms in the field of automatic spectrophotometry and, therefore, followed on very fittingly from the general discourse given by Prof. Hayes.

Dr. D. Gabor's paper, "Microscopy by Wave-Front Reconstruction" (see also *Nature*, **161**, May 15, 1948), was not related directly with those which had preceded it. The new method of obtaining increased resolving power is expected to be of great importance in electron microscopy; and calculations show that it should be possible to obtain a resolving power of one Angstrom unit—which would make it possible to resolve the atomic structure of molecules which are not suitable for the usual methods of structure analysis. An interesting demonstration of the method, using an optical model, was given later in the day.

A. J. YOUNG

OBITUARIES

Prof. Johan Hjort, For.Mem.R.S.

THE scientific work of Prof. Johan Hjort, who died on October 7, shows three overlapping phases. As a young man, after his university training at Oslo and Munich, he spent some time at the Zoological Station in Naples (where he met MacBride and Boveri) investigating a problem of pure zoology, the development of the bud in the ascidian *Botryllus*, with special reference to the germ-layer theory, then in full vogue. His paper, published in 1896 (*Zool. Res. Norwegian North Atlantic Expedition*), is still regarded as outstanding by modern experts on the group. Until 1900 he was lecturer in zoology at the University of Oslo and seemed headed for an academic career. But even in this first phase his interests turned to the sea and its practical problems, for it was in 1897 that he made his first discoveries about the Norwegian prawn and its commercial possibilities.

His great period as a marine biologist and fishery expert began in 1900, when he was appointed director of fisheries in Norway, a post he held until 1916. He had at his disposal an excellent research vessel, the *Michael Sars*, and made extensive cruises in her, not only in Norwegian waters but also so far afield as Spitsbergen and Jan Mayen. Hjort was always happy in a ship. His investigations were not only scientific but also practical, for he had always the welfare of the fishermen at heart. By charting the distribution of the pelagic eggs of the cod, he was able to discover lucrative banks that had never been fished before, the high concentration of eggs indicating the presence of great spawning shoals; the results of this early work were published in "Fiskeri og Hvalfangst i det nordlige Norge" (Bergen, 1902). He advised the International Council to undertake a co-operative study of the spawning areas of the Gadoid fishes, and was largely responsible for organising the research, which resulted in the publication in 1909 of the classical report of "Committee A" (*Rapp. Proc. Verb. Inter. Council*, **10**).

Hjort's greatest achievement in this brilliant period was his elucidation of the problem of good and bad years in the herring and cod fisheries of Norway. With the help of able assistants—Dahl, Damas, Lea and Sund—Hjort made a vigorous attack upon the practical problem of why these fisheries showed such big variations from year to year. It happened, fortunately, that at the time when Hjort's work started, the technique of age-determination in fish by means of scales and otoliths was just being worked out. Under Hjort's direction this method was applied with great success to the study of the herring, particularly by Einar Lea, and it soon became established that the main cause of the fluctuations in the great spring herring fishery was the success or failure of the individual broods or year-classes composing the stock. Thus it was found that the 1904 year-class was remarkably abundant, and predominated in the catches for many years, while succeeding year-classes were very poor. Similar methods applied to the Norwegian cod, supplemented by extensive measurements, demonstrated the existence of specially prolific brood-years, as, for example, those of 1904 and 1912, while other years contributed little to the stock. Preliminary results for the herring were published by Hjort and Lea in 1911 (*Pub. de Circ.*, No. 61) and a full study of the question by Hjort in 1914, in an extensive paper on "Fluctuations in the Great Fisheries of Northern Europe" (*Rapp. Proc. Verb.*, **20**). In 1914, at the request of the Canadian Government, he investigated on the spot the herring of the Gulf of St. Lawrence and adjacent waters, and found that their age-composition was similar to that of the Norwegian herring.

The study of fluctuations and their possible causes, initiated by Hjort, became a principal theme in all fishery and marine biological research for many years, and at Hjort's instigation it was frequently discussed at the International Council, particularly in the special scientific meetings which he introduced in 1926 (see, for example, *Rapp. Proc. Verb.*, **65** and **68**; 1930). Hjort returned again and again to this problem, right up to the last.

Hjort was above all a great biologist, with a profound interest in, and understanding of, the relations between the organism and its environment. This is made particularly clear in the chapter on general biology which he contributed to that admirable book "The Depths of the Ocean" (1912), familiarly known as "Murray and Hjort". This book was the outcome of a four and a half months scientific expedition in the North Atlantic in 1910 in the *Michael Sars*, chartered for the purpose by the famous oceanographer Sir John Murray. The cruise gave Hjort a renewed interest in the general problems of marine ecology.

After his retirement from the post of director of fisheries in Norway, Hjort became a professor at the University of Oslo, and the third phase of his scientific odyssey began. Though he still retained his keen interest in fishery problems and continued to be a dominant figure in the International Council his mind turned more towards general scientific and social questions. He gave much time to private study, including a period spent at Cambridge.

In 1921 he published a small book on general scientific method, "The Unity of Science", and in 1931 a larger volume called "The Emperor's New

Clothes", in which he attempted to show that modern physical theories were nothing but fairy tales, inconsistent with experience and reason. Hjort was not at his best in abstract thinking, and his incursions into philosophy and scientific method were not, to my mind, altogether happy. In both books, however, as also in his later publication, "The Human Value of Biology" (Cambridge, Mass., 1938), the sections in which he expresses his ecological attitude to the problems of life are excellent.

But Hjort was much too practical a man to devote himself to purely philosophical studies, and as professor at Oslo he did not neglect research, much of it concerned with practical issues. He took up with vigour population studies in organisms so diverse as yeasts and whales, and with his fellow-workers published many important papers in the series of *Hvalrådets Skrifter* (see particularly No. 7; Oslo, 1933). The sigmoid curve fascinated him. His views on population growth and the social problems involved are set out in his Huxley Lecture of 1934 entitled "The Restrictive Law of Population". Arising out of his population studies he worked out, with G. Jahn and P. Ottestad, the theory of the 'optimum catch', of great importance in connexion with the signs of over-fishing which were becoming apparent in the intensive whale fishery (largely Norwegian) in the Antarctic. The study of the whale population in these waters engrossed him in later years, and his studies were not limited to statistics and reports; he went out to the Antarctic to see for himself what the conditions of the fishery really were —an action typical of the man. He played a considerable part in the international negotiations which led to some measure of control being imposed on the fishery, and kept the International Council in touch with whaling problems.

In 1936 Hjort was invited to attend the celebration of the three hundredth anniversary of Harvard University. He used this opportunity to demonstrate the accuracy of his prophecy that *Pandalus borealis* would be found on the western side of the Atlantic in exactly the same ecological conditions in which it occurred in Norwegian waters. Through the good offices of his friend, Henry B. Bigelow, he made a cruise in the *Atlantis* off the coast of New England and found quantities of this prawn just where he expected to find it. The story is told in his paper (jointly with J. T. Ruud) in *Hvalrådets Skrifter*, No. 17 (1938). This paper contains also a study of the over-fishing problem in relation to the prawn fishery.

About Hjort's social and political views, which he held strongly, it is unnecessary to say much here; they will be found set out particularly in his Huxley Lecture and in his later books and lectures. Suffice it to say that he looked at the problems of human societies with the eye of a biologist, and that he was a strong individualist, temperamentally averse from any form of restrictive control. The old Viking spirit still lived in him. His outlook on life in his later years is well summarized in his last published lecture (*J. Conseil*, 15; April 1948), significantly entitled "The Renaissance of the Individual". Like us all, Hjort had his failings; his personality was so powerful and his views so decided that he was apt to impose them on others, and he was not very receptive of views that differed from his own. But he was a great figure whom his colleagues and friends regarded with respect, admiration and affection, even when they differed from him. E. S. RUSSELL

JOHAN HJORT was a personality in the sense that he could not be overlooked in any assembly of men; and he was a many-sided personality, man of science, philosopher, politician, diplomatist, administrator and, withal, a man of warm friendships. He had a great admiration and affection for the British race and actively sought to promote the best and closest relations between his country and ours. Of all the honours bestowed upon him, he treasured most his membership of the Royal Society.

Early in life he turned his attention to marine biology, and studied at Naples. This choice of a scientific career was almost inevitable. Norway, with its great length of coast-line and its famous seasonal fisheries for cod and herring, breeds especially seamen and fishermen. Fishing is the chief native industry of the country, and Norwegian biologists direct their attention, as one might say, automatically to the sea and all that therein is. Hjort, in particular, recognized the danger to which the fisheries were exposed by the mechanization of fishing, the ever-increasing power of mechanized fishing vessels and the rapid development of the efficiency of fishing instruments. He recognized, further, that the rational exploitation of fish stocks could be realized only in the light of wide knowledge of the complex ecology of marine life, including, of course, its physical environment. His voyage with Sir John Murray on the *Michael Sars* was one of his many excursions into this field of study.

In 1900 Hjort became director of fisheries in Norway, and in the same year began the movement, originating in Sweden, for the establishment of an international organisation for marine studies. When, in 1902, the International Council for the Exploration of the Sea was established, with its seat in Copenhagen, he was appointed Norwegian delegate, a position he occupied, in spite of his resignation of the post of director of fisheries some time after the First World War, until his death. From 1920 onwards he was one of the vice-presidents, who, with the president, constitute the Executive Committee of the Council, known as the Bureau, and, in 1938, he was elected president of the Council, a post he was about to surrender when death overtook him. Soon after the First World War he turned his attention to the machinery of the Council and, in close collaboration with the British president, devised a practical lay-out of regional and specific committees, the chairmen of which constituted a co-ordinating committee named the Consultative Committee, of which he became and, until he succeeded to the presidency, remained chairman. There is no possibility of doubt that this reorganisation of the machinery of the Council was mainly responsible for the great practical results achieved by co-operation between the member countries.

As director of the Norwegian fisheries, Hjort proved himself a competent and original administrator. He had also a wise belief in practical demonstration. When the naturalists of his department had discovered the existence in vast numbers in the deeper waters of many of the fjords of *Pandalus borealis*, now commonly referred to as the Norway prawn, the fishermen were disinclined to be interested. Hjort wasted no time in argument. He went prawn fishing, returned to harbour with a spectacular catch and dumped it on the quay. That was enough. With that practical demonstration he laid the foundation of an exceedingly profitable fishery and a flourishing export trade.

Cautious and precise as a man of science, Hjort was always apt to be impetuous in his relations with others. He had, in fact, a somewhat volcanic temperament which did not easily brook opposition. He was as apt to walk off stage as a film star, and it came about that he handed in his resignation of the post of director of fisheries in Norway once too often. The time came when the authorities did not ask him to reconsider, and accepted his resignation. But he became professor of zoology in the University of Oslo and remained a Norwegian delegate to the International Council. There, too, his volcanic temperament was sometimes active; but his fundamental friendliness always triumphed in the long run, and there is not one of his colleagues, national and international, who does not deplore the loss of a friend and a great man.

His diplomatic gifts were revealed in long and earnest endeavours to settle the vexed question, as between Norway and Great Britain, of the limits of territorial waters off the coasts of Norway. Indeed, if the last word had been with him the long negotiations would, almost certainly, have resulted in agreement; but his views were unacceptable in Norway and agreement seems to be as remote as ever. He attributed the failure to "the politicians". The trend of his political views is revealed in a remark he made to me. "No one," he said, "should be allowed to exercise the Parliamentary vote who has not passed an examination in biology, and members of Parliament, especially Ministers, should be required to have, if not a degree, at least a diploma in natural science. Then there would be no -isms, for none of the -isms will bear examination in the light of biological truth." Thus, picturesquely, he expressed the view that, inasmuch as the well-being of mankind is intimately bound up with the complex biology of all living things, political systems divorced from Nature are built on rotten foundations. But he did not believe that all wisdom was the exclusive possession of the scientific worker, as readers of "The Emperor's New Clothes" and of his Huxley Memorial Lecture, delivered in 1934, will be aware.

In recent years some of his friends have felt that his powers and, with them, his clarity of thought, were failing. But he had a long and useful life behind him, and the influence of the dynamic force he exercised in the field of science and the practical application of scientific findings will endure for generations to come. H. G. MAURICE

Mrs. Savage

MRS. E. J. SAVAGE (née Fry), whose death occurred recently, was an old student of the University College of Wales, Aberystwyth, graduating with first-class honours in botany in 1916.

Her early work concerned the "Cryptogamic Pioneer Vegetation of the Aberystwyth Shales", and later she carried out an investigation of rock floras in Caernarvon and Anglesey. She was able to add to our knowledge of the action of lichens in bringing about rock disintegration and soil formation. Several of her papers on this subject appeared in the *Annals of Botany*. During the First World War she carried out researches in anæsthetics and afterwards became a fellow of the University. In 1919, having obtained her M.Sc., she was appointed assistant lecturer in the Department of Botany at Aberystwyth. In 1925 she was appointed lecturer in botany at Westfield College, University of London, a post she held until her marriage to Mr. S. Savage, librarian and assistant secretary of the Linnean Society, in 1932. Afterwards she lived at Welwyn Garden City, where she soon became well known as an artist and miniature painter, some of her work hanging at the local art club's annual exhibition and also at the shows of the London Water Colour Society.

Mrs. Savage has left botanical records of value carefully labelled and annotated with the meticulous care she bestowed on all her work, together with the memory of a charming personality which continued to survive the heavy trials of a long illness. Her husband has the sympathy of her many friends.

LILY NEWTON

NEWS and VIEWS

Nobel Prize for Chemistry:

Prof. Arne Tiselius

THE recipient of the Nobel Prize for Chemistry this year is Prof. Arne Tiselius, who is well known to protein chemists in Great Britain. For many years he worked in the Physical Chemistry Institute of Prof. Svedberg at Uppsala, and became one of its most outstanding members. Recently a chair in biochemistry was created for him and a new Institute is in the course of construction. His greatest work, and that for which he is most widely known, was in the development of an apparatus for the electrophoretic analysis of biological substances. The apparatus, which now bears his name, has made possible accurate measurements of the electrical properties of proteins and has been most extensively applied both as a test of protein purity and to characterize the components of more complex systems. In this connexion, the application to normal and pathological sera is of great clinical importance. The apparatus is undoubtedly one of the most powerful tools ever developed in the field of protein chemistry. More recently, Prof. Tiselius has returned to the study of adsorption analysis, a subject which interested him in his earlier research years. Since the introduction of chromatography by Tswett, the method has been employed and developed on somewhat empirical lines. Prof. Tiselius and his school have studied the underlying principles involved in this type of separation and have developed elegant apparatus for the adsorption analysis of colourless substances. Many scientific men who have worked in his laboratory have benefited greatly by his patient application to their problems and by his wide knowledge. All who know him well will agree that this latest honour is indeed well deserved

Biological Service in Great Britain:

Capt. Cyril Dive

IN continuation of the announcement made in the House of Commons on April 27 that the Government accepted in principle the establishment of a Nature Conservation Board and a Biological Service under the auspices of the Agricultural Research Council, Mr Herbert Morrison on November 1 stated in the House that the preparations for the service were approaching completion, and that Capt. Cyril Diver had been appointed to take charge of it and had taken up his duties that day. The London office of the service is at Thorney House, Smith Square, S.W.1. Capt. Diver brings to his new post extensive administrative experience as clerk of the Financial Committee of the House of Commons, and in addition has long been keenly interested in natural history, and in particular the study of ecology. While on active service in the First World War he made a study of snails in the trenches. He has been an active member of the British Ecological Society, of which he has been president. He served on the Nature Reserves Investigation Committee and assisted in drafting its report, and also on the Wild Life Conservation Special Committee, which in its report recommended the formation of a Biological Service in Great Britain.

Social Studies at Sheffield: Miss Ellinor I. Black

THE University of Sheffield has recently decided to create a new School of Social Studies, which will provide a postgraduate course leading to a diploma in social studies, and other courses leading to lower qualifications. The School will be governed by a board, on which the Science as well as the Arts Faculty will be represented. As a first step to establishing the school, the University has appointed Miss Ellinor I. Black as its director. Miss Black has been associated with the Social Science Department of the University of Liverpool, which she joined in 1924 at the most critical period of its development. Since 1941 she has been a senior lecturer, and for five years during the period of the War she acted as head of the Department. In addition to the reputation she has established in Great Britain, she has also created for herself a somewhat unique position in the international field; she has since 1936 been closely connected with the Social Welfare Committee of the League of Nations, and the International Committee of Schools of Social Work. In recent months she has renewed her personal contacts with schools of social work in the United States and in Germany. Miss Black is particularly interested in the welfare of the aged. She was a member of the Old Age Survey Committee of the Nuffield Foundation, and she has carried out detailed investigations of the problem in the Merseyside area. Miss Black has made a very deep impression on the education of the professional social worker in Great Britain; as a teacher she has been able to win both the intellectual and the more personal loyalties of her students, as so many that have passed through the Liverpool School can testify. Sheffield will gain in her one who will devote herself wholeheartedly to the creation of the new institution, which will thus possess a very special human quality.

Cooled-Anode Radio Valves

THE new chairman of the Radio Section of the Institution of Electrical Engineers, Mr. F. Smith, delivered his inaugural address on October 13, under the title of "The Development and Design of Cooled-Anode Valves". The term 'cooled-anode valve' is applied to all valves having anodes which form part of the envelope, without discrimination between the different methods of cooling. Probably the earliest valve using air-cooling was the Catkin receiving valve produced in 1933, as a miniature of the then existing large water-cooled transmitting valve. When similar methods of construction were used for valves of about 60-watts dissipation, it was necessary to add a radiator with fins to the anode. The approach of the Second World War, with its demands for special short-wave transmitting valves for pulse operation, led to the development of several series of valves with external anodes cooled by a forced air draught.

Mr. Smith's address was a survey of the development during the past ten years of the various types of cooled-anode transmitting valves. The special problems associated with the use of thoriated-tungsten filaments and oxide-coated cathodes, with the glass-to-metal joints, and the construction and cooling of the electrode seals were described. As the operating-frequency was increased, special design problems were encountered in dealing with the reduced dimensions and electrode spacings. At the highest frequencies, the valve has necessarily to be regarded as an integral part of the oscillatory circuit, and this may take the form of a coaxial transmission line or resonant-cavity in some cases. Recent developments, over the whole range of valves, have continued to be chiefly in the direction of obtaining more power at higher frequencies, and of maintaining this output over a greater band of operating frequencies. The successful development of such valves with water-cooling has been a major factor in many modern radio applications.

Radio Components Exhibition in Stockholm

A PRIVATE exhibition of radio and electronic components held in Stockholm during October 18–22 was arranged by the Radio Component Manufacturers' Federation, which is a constituent association of the Radio Industry Council in Great Britain. Some thirty-seven British firms participated and showed a wide range of products, including transformers, resistors, condensers, plugs and sockets of the many different types now in use, together with chassis, cables and terminals which contribute to the assembly of modern electronic equipment. Certain classes of measuring apparatus for the testing of such equipment were also displayed.

The exhibition was opened by Mr. J. Thyne Henderson, chargé d'affaires at the British Embassy in Stockholm, and a large number of people took advantage of the invitations to attend. It was stated that many of the components and instruments had not previously been demonstrated outside Great Britain, and that it would assist British exports to Sweden to arrange this display. In conjunction with the Federation's exhibition, and at the invitation of the British Council, Dr. R. L. Smith-Rose, director of radio research in the Department of Scientific and Industrial Research, gave two lectures at the Royal Institute of Technology, Stockholm. In the first of these lectures, he described the principles of radar and the various types of radio navigational aids, while in the second he surveyed the progress made in the development of some radio and electronic techniques during the past few years.

Science Teaching at the City of London School

IN 1839 the Rev. W. Cook was appointed to the City of London School to deliver ten to twelve lectures a year on chemistry and natural philosophy, and this was considered sufficient until 1845, when the programme was increased to four lectures per week. In 1847 Thomas Hall, who was already on the staff, was appointed as lecturer, and the teaching of science in the School may be reckoned to commence from this date. On Hall's retirement in 1869, he was succeeded by Henry Durham, who had joined the staff with Isaac Scarf in the previous year. These two gave yeoman service to the School and did not retire until 1910 and 1919 respectively. They taught throughout a period when science underwent revolutionary changes, and the development of science teaching in the School kept pace accordingly. In 1869 Dr. Abbott, the headmaster, introduced science throughout the curriculum, and his successor, Mr. Pollard, founded the science side in 1892; the jubilee of the teaching of science was marked in 1897 with the Hall Memorial Scholarship. Durham was succeeded by G. C. Donington as senior science master, but the latter died soon afterwards and was replaced by G. H. J. Adlam, who died recently. In 1927 the new science laboratories were opened by the Lord Mayor of London, and they consisted of advanced and elementary laboratories, a chemistry lecture room, a balance room and a room for the science staff; soon afterwards, in 1929, a biological laboratory was completed. A further biological laboratory and a museum were added in 1937, and in 1946 the balance room was converted to an advanced physics lecture room.

The centenary of the teaching of science fell in 1947 and was celebrated at the Great Hall of the School on the afternoon of November 6 this year. There was a large gathering of officials of the Corporation, the Schools Committee, the School staff, parents, and past and present pupils, and the chief guest was the Lord Mayor and Lady Mayoress of London. The headmaster, Mr. F. R. Dale, reminded his audience that, on inspecting some laboratories, a predecessor of his, Dr. Abbott, had once said, "You and I know that this is not education". The Lord Mayor made a short address, and was followed by Sir Harold Scott, lately director of the Bureau of Hygiene and Tropical Diseases, who was himself an old pupil of the School. Various demonstrations and exhibits had been arranged in the School laboratories.

Chemistry and Chemical Technology at University College, Dublin

Mr. Michael Tierney, president of University College, Dublin, recently opened in the College a new laboratory for the teaching of chemical technology. Prof. T. S. Wheeler explained that this new laboratory would be known as the Nolan Laboratory in remembrance of the late Prof. T. J. Nolan, whose untimely death had prevented him putting into operation plans he had formulated for the teaching of chemical technology in the College. Mr. Tierney also opened a laboratory for final years honours chemistry, which will be known as the Ryan Laboratory, in remembrance of the late Prof. Hugh Ryan, the first professor of chemistry in University College, Dublin.

Bioluminescence

In connexion with Dr. V. B. Wigglesworth's article on bioluminescence in *Nature* of September 11, p. 423, Mr. K. B. Williamson, c/o Manson House, 26 Portland Place, London, W.1, has recalled observations made by him while he was malaria research officer in Malaya some years ago. A dytiscid beetle which fell about three feet off the laboratory bench on to the floor of the old Malaria Bureau, Kuala Lumpur, displayed a unique type of bioluminescence. The beetle appeared to emit bright flashes of white light, three or four at a time, from its eyes. The fluorescent type of bioluminescence is invisible even in weak light; but these flashes were conspicuous in competition with the light from a fairly bright electric bulb on the laboratory bench. The groups of flashes were repeated several times within half an hour, when the beetle was again dropped from the same height; but never afterwards, when the dropping was repeated during the subsequent months it was kept alive. In sharp contrast to another *Dytiscus*, it failed to capture any mosquito larvæ or pupæ during these months, and it not improbably died of starvation; and may have been blinded by destruction of retinal pigment and damage to the cells producing it. Mr. Williamson tentatively suggests that the flashes from the beetle's eyes were caused by reversal of the normal process of vision, energy in the form of light having been emitted instead of being absorbed by retinal pigment, as the result of intermittent outwardly directed nervous impulses, due to shock.

Earthquakes during July and August

During July, nineteen strong earthquakes occurred in various parts of the world, the strongest being of instrumental scale 7¼ and occurring off the south-west coast of Peru on July 20. It had a depth of focus of 100 km. Two earthquakes on July 16 radiating from a focus having an epicentre near the coast of Guatemala and having strengths 6½ and 6¾ were felt in Guatemala and San Salvador. The only earthquakes to do damage during the month occurred on July 20, damaging buildings on Coiba Island.

During August, twenty-four strong earthquakes occurred in various parts of the world. The strongest occurred on August 25 in the Salta Province of Argentina and attained scale 7½. During the month there was also rather more activity than usual along the south European seismic zone, earthquakes occurring on August 10 in the region of Alasehir in Turkey; on August 12, 13 and 15 near Oporto in Portugal; on August 18 near Sivrice in Turkey, and at Apulia in south Italy; on August 21, destructive at Orda Nova in south Italy; on August 22 in Portugal and Italy; and on August 27 in the region of Skadar, Albania. On August 30 there was also a repetition of an earthquake which occurred on July 8 in a rather unusual area—near Jan Mayen Island.

Group reports have been received from the United States Coast and Geodetic Survey, the central station at Strasbourg, the Jesuit seismological central station at St. Louis, United States, and individual station reports have been received from Beograd, Cleveland (Ohio), De Bilt, Durham, Kew, Stuttgart, Toledo and Uccle.

Polytetrafluoroethylene

The outstanding stability of fluorinated hydrocarbons has been fully exploited in the field of high polymers. The preparation and polymerization of tetrafluoroethylene was described some two years ago (*Ind. Eng. Chem.*, 870; 1946). The polymer (P.T.F.E.) is an excellent dielectric (power factor = 0·0002 over a wide frequency-range) and it is resistant to all common solvents up to 300° C. Molten alkali metals alone have any appreciable attack. In its strength, however, lies its greatest weakness. Form stability is retained up to 250° C., and even at higher temperatures there is no true softening; thus moulding and fabrication present major obstacles. Progress in overcoming this difficulty has, however, been made by Messrs. British Mechanical Productions, Ltd., 21 Bruton Street, London, W.1, who recently exhibited in London examples of moulded valve-holders and other components in polytetrafluoroethylene.

Pure Science and Industrial Development

In an address, "Pure Science, Fertile Source of Industrial Progress", on receiving from the Société pour l'Encouragement de l'Industrie Nationale the medal of the Grand Prix du Marquis d'Argenteuil for 1947, Prof. L. de Broglie gave a brilliant review of the contribution of research in fundamental physics to the progress of industry, in which he referred particularly to the achievements of such French physicists as D. Papin, S. Carnot, Ampère and M. Deprez. He also pleaded for the vigorous prosecution both of the investigation of the laws of Nature without reference to their application, and of industrial and technical research directed towards the utilization of scientific knowledge for the improvement of human welfare. Prof. de Broglie drew his illustrations from the fields of heat, electricity, wave mechanics, relativity and nuclear physics, indicating how discoveries and investigations which have appeared incredibly remote from practical life have yet in due course made most important contributions to industrial progress.

Sugar Research Foundation Prize

Entries are invited for the 1949 fourth intermediate prize award of 5,000 dollars offered by the Sugar Research Foundation. The award will be given for discoveries in the chemistry, physiology or technological application of carbohydrates which contribute to an understanding of the functions of sugar (sucrose) or to its practical utilization. The first of these awards (1946) was made to Drs. W. Z. Hassid, M. Doudoroff and H. A. Barker, of the University of California, Berkeley, for research leading to the enzymatic synthesis of sucrose; the second (1947) went to Dr. Carl F. Cori, professor of biochemistry, Washington University, St. Louis, Missouri, for research on problems of carbohydrate metabolism in the animal body; the third (1948) to Dr. Leslie F. Wiggins, University of Birmingham, for chemical studies of the sucrose molecule and transformations which may make sucrose a valuable raw material n the chemical industries. Winners of these intermediate annual awards are eligible for the Grand Prize of 25,000 dollars to be given in 1950 for the most important work during the five preceding years. Further particulars can be obtained from the Executive Secretary, National Science Fund, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington 25, D.C., to whom entries must be submitted by January 1, 1949.

Beilby Memorial Awards

From the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals o be determined by the administrators representing he Royal Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals, awards are made to British investigators in science o mark appreciation of records of distinguished work. Preference is given to investigations relating to the pecial interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy, and awards are made generally to younger men who have done original independent work of exceptional merit over a period of years. The administrators—the presidents, honorary treasurers and secretaries of the three participating institutions—will be glad to have their attention directed to outstanding work of the nature indicated, not later than December 31, 1948. Communications should be addressed to the Convener, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

"Changing Aspects of Nutrition"

An article under this title in *Nature*, October 2, pp. 543 and 544, dealt with the proceedings of a discussion on September 9 in Section I (Physiology) of the British Association. In the report of Dr. J. W. Howie's contribution, reference is made to a "protein rice concentrate"; this should read "protein-rich concentrate". Ewes fed this concentrate as a supplement to pasture grazing showed, over a period of two years observation, no difference in fæces worm-egg counts from similar ewes grazed on the same pasture but not fed concentrate. Lambs born of the ewes and fed the same diet as their mothers, however, showed a marked difference in worm burden during a year's observation, the lambs given concentrate having significantly fewer worm eggs in the fæces. The account of Dr. Howie's second experiment, in which diet was shown to influence the resistance of mice to experimental tuberculosis, may have suggested that the higher protein in the better diet was established as the cause of the superior resistance. Dr. Howie wishes to make it clear that he has not yet examined this possibility, and that other important differences between the diets must be taken into account.

Announcements

The Meldola Medal is the gift of the Society of Maccabæans and is normally awarded annually. The next award will be made early in 1949 to the chemist who, being a British subject and less than thirty years of age on December 31, 1948, shows the most promise, as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31, 1948. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

A symposium on the "Applications of Electronics to Research and Industry" has been arranged by the Electronics Group of the Scientific Instrument Manufacturers' Association. It will be held at the Caxton Hall, London, during November 18 and 19.

A fund for the encouragement of the gliding and soaring movement is being raised as a tribute to the late Robert Kronfeld, who was killed while testing a tailless glider early this year. A committee has been formed to make the appeal and receive subscriptions, which should be sent to Mr. Lawrence Wingfield, c/o Royal Aeronautical Society, 4 Hamilton Place, W.1, marked Kronfeld Memorial Fund.

A half-yearly list of botanical papers printed in India, Pakistan, Burma, Ceylon, Siam, Malaya and Indonesia will be published by the Botanical Society of Bengal in the Society's *Bulletin* issued in April and October every year. Authors are requested to send their reprints to the Honorary Secretary, Botanical Society of Bengal, 35 Ballygunge Circular Road, Calcutta 13.

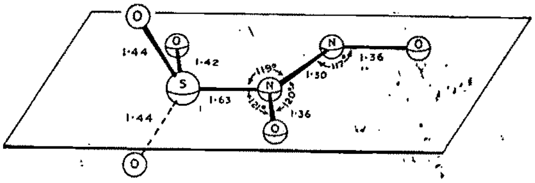
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of the Dinitrososulphite Ion

SINCE the observation by Davy[1] that nitric oxide is absorbed by alkaline potassium sulphite to form a crystalline compound (shown later by Pelouze[2] to have the composition $K_2SO_5N_2$), several conflicting formulæ have been suggested to account for its chemistry[3-6].

We have found that the corresponding thallium and ammonium salts are isomorphous with the potassium salt, and this has enabled us, by direct X-ray crystal analysis, to determine the structure of the dinitrososulphite ion independently of any preconceived formulation. The results of Fourier syntheses show the configuration of the ion to be as in the accompanying figure.



An interesting feature of the structure is that the S atom and the N_2O_2 group lie in one plane and that the bond-angles approximate closely to 120°. This, together with the short N—N distance of 1·30 A., implies, as suggested by Evans and Gergely (see following communication), a double-bond between the nitrogen atoms with trigonal [sp^2] hybridization. It invites comparison with the structure of dimethyl nitramine[7]. Both the N—O distances of 1·36 A. correspond to a bond-order of about 1·2 if compared with the most recently suggested covalent radii[8,9].

As was to be expected (cf. the structure of the sulphamate ion[10]), the SO_3 and the adjoining nitrogen atom form an approximately tetrahedral group, with S—O = 1·44 A. and S—N = 1·63 A.

Although three-dimensional methods were used in the structure analysis, we cannot at this stage exclude the possibility of the bond-lengths being subject to errors up to ± 0·06 A., owing to the large absorption errors unavoidable in intensity measurements with the potassium salt. The isomorphous ammonium salt will be used to obtain more exact values for the atomic parameters.

We wish to thank Mr. F. J. Garrick and Mr. A. White for the preparation and chemical analysis of the thallium salt.

E. G. COX
G. A. JEFFREY
H. P. STADLER

Chemistry Department,
University of Leeds.
July 7.

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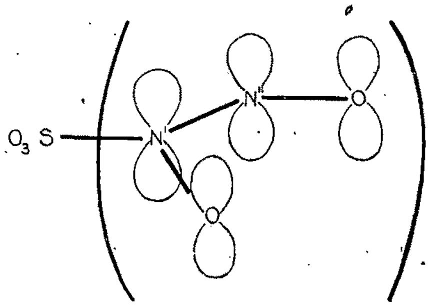
[1] Davy, H., *Bibl. Brit.* (Serie Sci. Arts), **20**, 358 (1802).
[2] Pelouze, J., *Liebigs Ann.*, **15**, 240 (1835).
[3] Hantzsch, A., *Ber.*, **38**, 3079 (1905).
[4] Divers, E., and Haga, T., *J. Chem. Soc.*, **69**, 1610 (1896).
[5] Raschig, F., "Schwefel und Stickstoff Studien", 108–127 (1924).
[6] Weitz, E., and Achterberg, F., *Ber.*, **66**, 1718 (1933).
[7] Costain, W., and Cox, E. G., *Nature*, **160**, 826 (1947).
[8] Schomaker, V., and Stevenson, D. P., *J. Amer. Chem. Soc.*, **63**, 37 (1941).
[9] Gordy, W., *J. Chem. Phys.*, **15**, 81 (1947).
[10] Brown, C. J., and Cox, E. G., *J. Chem. Soc.*, 1 (1940).

THE trigonal planar symmetry of the three bonds formed by the nitrogen atom attached to the sulphu atom in the structure described in the preceding communication, suggests that the orbitals of this nitrogen atom correspond in bond formation to a hybridization of the type $(1s)^2(2p)^2(2s2p^2)^3$ rather than to $(1s)^2(2s)^2 2p_x 2p_y 2p_z$. In the former electronic configuration, the three sp^2 orbitals will possess trigonal symmetry, and there will be one doubly occupied π-orbital orthogonal to the plane of the sp^2-orbitals. This type of hybridization has been postulated by us[1] in a discussion of the properties of the >N—H O=C< structure in proteins.



We have based molecular orbital calculations on the structure shown in the accompanying illustration, in which the π-orbitals are occupied by six electrons, the whole group within the brackets having a full negative charge. Since the SO_3 group has a tetrahedral structure, it appears reasonable to neglect conjugation of this group with the π-electrons of the nitrogen and oxygen atoms; we have therefore dealt with the four atomic centres in the structure within the brackets

The secular equation for this array of centres is

$$\begin{vmatrix} q_O - E & \beta_{ON'} & 0 & 0 \\ \beta_{ON'} & q_{N'} - E & \beta_{N'N''} & 0 \\ 0 & \beta_{N'N''} & q_{N''} - E & \beta_{N''O} \\ 0 & 0 & \beta_{N''O} & q_O - E \end{vmatrix} = 0$$

where the β's stand for exchange integrals and th q's for Coulombic integrals.

The ionization potential[2] and thus the Coulombi integral of the trigonal nitrogen N′ is lower than tha of the pyramidal nitrogen N″. Since all the β's ar very nearly the same, a difference between $q_{N'}$ an $q_{N''}$ of the order of the difference in the ionizatio potentials would lead to a structure with unequa NO bond-distances. The inductive effect of the sulphu atom of the SO_3 group on the N′ to which it i attached, must, however, be taken into account, an because of the symmetry of the structure we hav assumed that this effect offsets the difference in th q's.

We find the following values for the charg densities and the bond-orders:

Atom	O		N′		N″		O
Charge	− 0·724		+ 0·724		− 0·276		− 0·72
Bond-order		1·45		1·72		1·45	

when $q_{N'} = q_{N''} = q_O$

Atom	O		N′		N″		O
Charge	− 0·84		+ 0·84		− 0·16		− 0·84
Bond-order		1·40		1·76		1·40	

when $q_{N'} = q_{N''}$, and $q_O - q_N = 0·5$.

It is interesting to compare these results with th experimental values reported above. For this purpos we have used the covalent radii given by Gordy[3] t construct a bond-order – bond-length curve for NN and NO bonds. On this basis we can make the following comparison:

Bond	Bond-order calculated	Bond-length (A.) calculated	Bond-length (A.) observed
ON	1·45	1·32	1·36
	1·40	1·33	
NN	1·72	1·30	1·30
	1·76	1·29	

The undistorted angle N′N″O should be close to 90°, and we suggest that the observed angle of 117° arises because of the strong repulsion between the negatively charged oxygen atoms.

The same treatment can be applied to the dimethylnitramine structure[4], and, although owing to hyperconjugation with the methyl groups the simplifications are less justified, the results do reveal strong double-bond character in both the NN and the NO bonds.

M. G. Evans
J. Gergely

Chemistry Department,
University of Leeds.
July 7.

[1] Evans, M. G., and Gergely, J. (in the press).

[2] Mulliken, R., *J. Chem. Phys.*, **2**, 782 (1934).

[3] Gordy, W., *J. Chem. Phys.*, **15**, 81 (1947).

[4] Costain, W., and Cox, E. G., *Nature*, **160**, 826 (1947).

Crystal Structure of 'Gammexane'

The crystal structure of γ-benzenehexachloride, the insecticide 'Gammexane', has been determined by X-ray analysis (Weissenberg diagram) in the usual way of trial and error, starting from Patterson data and supported by repeated Fourier syntheses. Cell dimensions: $a = 8{\cdot}5$ A.; $b = 10{\cdot}3$ A.; $c = 13{\cdot}9$ A.; $\beta = 121°$. Space group $P2_{1/c}$; four molecules per cell.

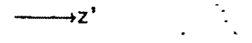


Fig. 1. Projection of the electron density on a plane perpendicular to the a-axis. ($z' = z \sin \beta$)

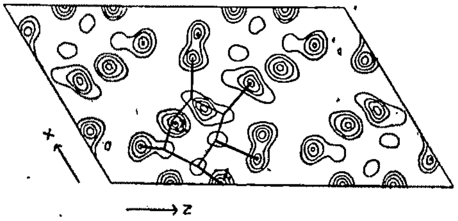


Fig. 2. Projection of the electron density along the b-axis

Figs. 1 and 2 give the Fourier map of the 100 and 010 projections. The carbon ring is of the 'chair'-form and the configuration of the chlorine atoms proves to be of type εεεϰϰϰ (in the nomenclature of Hassel[1]), as is seen in Fig. 3.

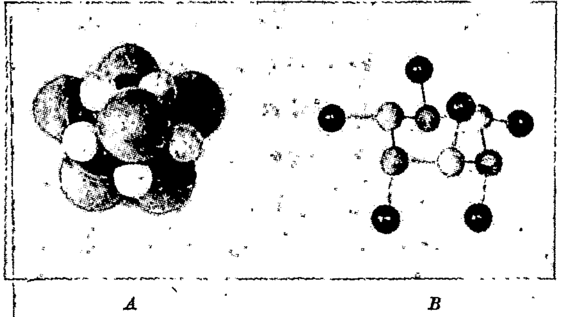


Fig. 3. Atomic models of the 'Gammexane' molecule. *A*, All dimensions to scale (small white balls represent hydrogen atoms). *B*, Schematic (hydrogen atoms omitted)

Thus the molecule of the insecticide is shown to be not isomorphous with the molecule of meso-inosite (type εϰϰϰϰϰ), contrary to a suggestion by Slade[2]. Moreover, it has been generally supposed that steric hindrance should not allow chlorine atoms in 1,3 positions both to have the ε-configuration[2,3].

This, too, is disposed of by our result. The steric hindrance causes only a slight bending apart of the 1,3 C—Cl bonds in question (see Fig. 2, where the projections of these bonds are not of equal length). The number of isomers is now no longer restricted to five; and as a matter of fact, Hassel quite recently announced the preparation of a sixth isomer[4].

G. W. van Vloten
Ch. A. Kruissink
B. Strijk
J. M. Bijvoet

van 't Hoff-Laboratorium,
Utrecht, Holland.

[1] Hassel, O., *Tids. Kjemi, Bergvesen, Met.*, **3**, 32 (1943). Hassel, O., and Viervoll, H., *Acta Chem. Scand.*, **1**, 149 (1947).

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A High-Pressure Hydrogen-filled Ionization Chamber

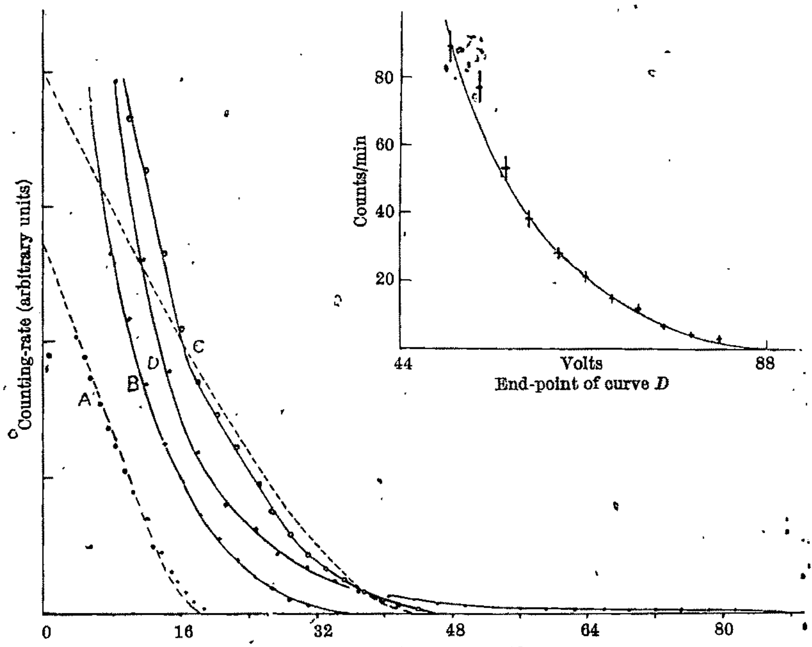
Electron collection has been obtained in hydrogen up to pressures of about 90 atmospheres. To get the very pure hydrogen needed, a cylindrical ionization chamber was made of glass (12 cm. long; 5 cm. diameter), with an axial wire (0·2 mm. diameter), for the collecting electrode; a coating of 'Aquadag' on the outside of the glass formed a convenient high-voltage electrode. The chamber was very carefully evacuated, baked, sealed off, and then placed in a steel container in which the pressure of hydrogen was slowly raised at the rate of one atmosphere per hour. By means of two heated palladium tubes sealed into the glass chamber, the chamber was slowly filled with purified hydrogen.

The size of recoil proton pulses produced by neutron irradiation was found to decrease with increase in pressure. At 60 atmospheres and 4,000 volts, the pulse size was very nearly independent of collecting voltage, but only 0·32 times that expected for complete electron collection. At 88 atmospheres the pulse size had decreased to 0·18 times the expected value.

To check whether, in spite of the electron loss, all pulses were still proportional to the initial ionization, the chamber was irradiated with neutrons produced by the known (*d,n*) reactions in hydrogen-2, beryllium-9, nitrogen-14[1] and lithium-7[2]. The respective neutron energies are 2·2, 4·14, 5·32, 13·05 MeV., that is, in the ratio 1 : 1·88 : 2·42 : 5·94. The maximum pulse sizes were found to be (see graph) in the ratio 1 : 1·9 : 2·4 : 4·7. The low measured value for the 13 MeV. neutron group may be due to the small intensity. The end-point does, in fact, agree well with the more intense 10 MeV. group (the ratio then is 1 : 4·55). Bias curves calculated from the known chamber geometry are shown (broken lines) for the homogeneous neutrons from hydrogen-2, and from nitrogen-14. Agreement is good, and the small deviations may be due to lack of complete voltage saturation, the effect of valve noise, and a known slight inhomogeneity in the neutrons produced by a thick target and by scattering in the target assembly.

With a pulse-size analyser[3], or a pulse spectrograph[4], the present chamber should be useful for measuring neutron spectra up to approximately 13 MeV., the limiting factor being the range of the proton recoils. An important advantage is the high efficiency for neutron detection. For example, at 90 atmospheres the present chamber will detect 17 per cent of incident neutrons of 2·2 MeV.

In view of the freedom from electronegative gas contamination and the lack of electron attachment in hydrogen, it is unlikely that the electron loss can be explained by volume recombination or negative ion formation. Moreover, such electron loss would seriously distort the bias curves. It must therefore be attributed to preferential or initial recombination. The magnitude of the effect is surprisingly large.



Curve *A*: ²H + D neutrons Curve *C*: ¹⁴N + D neutrons
Curve *B*: ⁹Be + D neutrons Curve *D*: ⁷Li + D neutrons

Curve *A* was obtained at 60 atmospheres pressure, the remaining three at 88 atmospheres. The abscissæ in curve *A* have been scaled down by a factor 0·18/0·32 = 0·57, to allow for the difference in pressure. The break in the upper part of curve *C* shows the presence of some ²H + D neutrons

It is hoped to fill a similar chamber with deuterium and use it for studies of the nuclear photo-effect.

G. H. STAFFORD

Cavendish Laboratory,
Cambridge.
Sept. 22.

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Masses of Mesons

IN 1929 I published a number of papers[1] on the problem of the masses of the fundamental particles, in which I proposed a new principle, called the "hypothesis of elementary indeterminacy". According to this hypothesis, a fundamental neutral particle is ascribed a certain fundamental length, q_0, related to a fundamental momentum, p_0, by the relation

$$q_0 p_0 = h, \qquad (1)$$

and a fundamental time, t_0, connected to the energy, E_0, by the conjugate relation

$$t_0 E_0 = h. \qquad (2)$$

q_0 is interpreted as the linear dimension of a cell structure of the configuration space of the particle; this amounts to the assertion that the position of the particle cannot be determined to a greater accuracy than q_0, so that this quantity constitutes the linear extension or 'radius' of the particle. t_0 is interpreted as a natural time unit connected with the particle, which is essentially the same as ascribing to it an oscillation of periodic time t_0.

Applying this hypothesis first to photons, one has to put $t_0 = 1/\nu$, which immediately leads to $E_0 = h\nu$. Further, one has to put $p_0 = h\nu/c$, which leads to $q_0 = \lambda$; thus the 'radius' of the photon is identical with the wave-length of the corresponding wave. Next, applying the hypothesis to a stationary particle of rest mass m_0, one finds with the help of the Einstein relation $E_0 = m_0 c^2$,

$$t_0 = \frac{h}{m_0 c^2}, \qquad (3)$$

which is equivalent to the de Broglie relation $h\nu_0 = m_0 c^2$ for the de Broglie frequency of the particle. One can further show that

$$q_0 = \frac{h}{m_0 c}. \qquad (4)$$

In other words, the linear dimension or radius of the particle turns out to be equal to its Compton wave-length.

In the previously mentioned papers the attempt was made to obtain the mass ratio of proton and electron from this hypothesis on the basis of the derived formulæ by considering the transformation of a neutron into a proton and an electron (β-decay) at a time when the neutron had not actually been discovered[2]. It led to a very satisfactory value for this mass ratio. In the present note, the hypothesis is applied to the problem of the masses of the mesons.

From (4) one obtains for the radius r_n of the neutron

$$r_n = \frac{h}{m_p c}, \tag{5}$$

where the neutron mass is replaced by the almost equal mass m_p of the proton. On the other hand, this radius can also be defined as the range of the nuclear field surrounding the neutron which, according to Yukawa's theory, is roughly given by

$$a = \frac{h}{2\pi m_\pi c}, \tag{6}$$

where m_π is the mass of the meson connected with this field, which is most probably a π-meson. Identifying (5) and (6), one gets at once

$$m_p/m_\pi = 2\pi. \tag{7}$$

This gives for the mass number of the π-meson in electronic units the value 293, which compares well with the experimentally established value[3] 260 ± 40.

It is well known that the π-meson is in many ways analogous to a photon. Thus the production of such a meson by a fast nucleon is the analogue of the *Bremsstrahlung* of an electron, and the nuclear disintegration caused by a π-meson is the analogue of the ionization of an atom by a photon or the photo-electric effect. It is suggested here that the 'decay process' of a π-meson into a μ-meson is, in fact, the analogue of the Compton effect. In other words, it is assumed that the collision of a π-meson with a nucleon (neutron) results in the production of a μ-meson, the remainder of the energy being disposed of by the emission of some neutral particle of small rest mass (neutretto, neutrino or photon).

The maximum change of wave-length for the ordinary Compton effect is given by

$$\lambda' - \lambda = \frac{2h}{m_e c}. \tag{8}$$

In the analogous case of the 'meson Compton effect', we have to replace the 'radii' λ′, λ of the photons by the radii

$$r' = \frac{h}{m_\mu c}, \quad r = \frac{h}{m_\pi c}, \tag{9}$$

of the primary and the secondary mesons, and the electronic mass m_e is to be replaced by m_p. This with the help of (7) leads to

$$m_\pi/m_\mu = 1 + \frac{1}{\pi} = 1 \cdot 32. \tag{10}$$

The results of the experimental determination of the mass ratio m_π/m_μ by the Bristol school is considerably higher, near 1·6; but recent results by American workers, reported at the Bristol Symposium on Cosmic Radiation, indicate a value near 1·35, which is in agreement with formula (10).

This 'scattering' process could, of course, be repeated and would result in the production of smaller and smaller mesons. Indeed, the existence of mesons of small mass (or of some sort of 'heavy electrons') has been claimed recently by a number of workers in the field of cosmic radiation. Furthermore, if the close analogy between mesons and photons is correct, all mesons are, in fact, the same type of fundamental particle, and one should therefore expect to find a continuous spectrum of mesons over a wide range of masses below and above that of the π-meson.

R. FÜRTH

Birkbeck College,
University of London.
Sept. 25.

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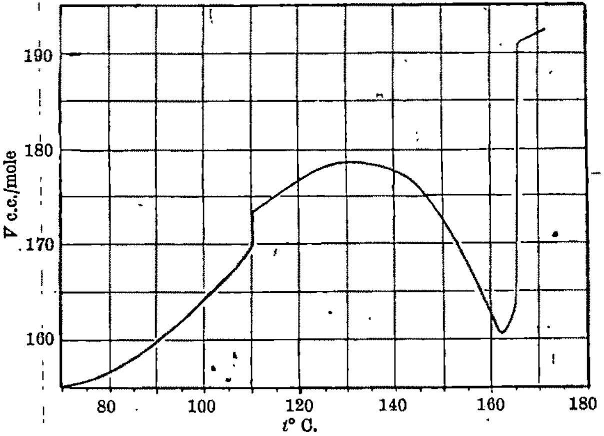
Volume Change of Hexamethyl Benzene

SINCE the crystal structure of hexamethyl benzene at room temperatures has been accurately determined by Robertson and Brockway[1], it seemed of interest to investigate the intra- and inter-molecular interactions of the methyl groups. Pauling[2] has suggested that a lower transition point at − 165° C. marks the beginning of rotation of methyl groups. It is then desirable to elucidate the mechanism of an upper transition found at 110° C. The thermal data of these transitions as well as those of the melting point have been reported by Parks and his co-workers[3]. We have made a preliminary dilatometric investigation of this substance from room temperature to the liquid temperature. The results are shown in the accompanying graph.



Throughout the whole region of temperature, except the transition and melting temperatures, the heating-rate is about 0·2° C. per minute, and at the melting and transition points the temperature was kept constant for about two or three hours in order to reach the equilibrium state. The molecular volumes are calculated by subtracting the expansion of mercury which is used as the dilatometer liquid. The volume expansion from room temperature to just below the transition point is about 10·2 per cent, which is comparable with the density decrease of 9 per cent suggested by Robertson and Brockway as likely to occur if the triclinic crystal had taken a monoclinic structure by a slight rearrangement. The abrupt volume change at the transition point is 3·65 c.c./mole, corresponding to about 2·4 per cent of the volume at room temperatures. After passing through the transition point, the volume still increases to a conspicuous maximum value (178·5 c.c./mole) at about 130° C. and then decreases to a minimum value (160·5 c.c./mole), showing negative thermal expansion, melting finally at 165·5° C. The volume change at the melting point is about 30 c.c./mole, corresponding to 8 per cent of the volume at room temperatures.

The ratio of entropy changes at the transition and melting points measured by Parks and others is nearly equal to the ratio of the corresponding volume changes given above. Examples of similar unusual negative thermal expansion are known in the cases of ammonium iodide[4] (— 60° C. $\sim$ — 40° C.), deutero-ammonium bromide (ND_4Br)[5] (— 70° C. $\sim$ — 58° C.), ice[6] under the pressures of about 1,500 kgm./cm.^{2} (— 10° C. $\sim$ — 2° C.), and a few other substances in the neighbourhood of their transition points. We are now making an X-ray analysis of the structure in the region between the transition and the melting points. The examination of the effect of substitution of the methyl groups by chlorine atoms will also be interesting in connexion with the dielectric study by White and Bishop[7].

H. CHIHARA
S. SEKI

Department of Chemistry,
Osaka University,
Osaka.
July 15.

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Nitrogen Afterglow

IN a recent communication in *Nature*, L. Herman and R. Herman[1] have given an account of their spectroscopic study of the complex afterglow in nitrogen immediately after the discharge is stopped. These short-lived afterglows have also been extensively studied by Kaplan[2]. In this connexion, Herman and Herman remark that it seems difficult to explain the characteristics of the complex afterglow as recorded by them with the help of the theory of active nitrogen proposed by me[3]. It appears, however, that these authors have missed the very important point that my theory was developed for the long-lived Lewis – Rayleigh afterglow, and not for the short-lived Kaplan afterglow, which is quite a distinct phenomenon. According to my hypothesis, the Lewis – Rayleigh afterglow phenomena, for example, the long life, the rate of decay, ionization, the characteristic spectrum (selected bands from the first positive group), etc., can be very satisfactorily explained if it is assumed that the active substance in the glow is $N_2^+(X')$ ions. The Kaplan afterglows, however, contain besides $N_2^+(X')$ ions other particles such as $N_2^+(A')$, N, N′ which are responsible for the complex nature of the short-lived spectrum. It may, however, be mentioned in this connexion that in some of his experiments Kaplan has observed the persistence of the first negative bands for several seconds after the discharge is stopped. This provides a direct proof of the presence of N_2^+ ions, at least in the first stage of the afterglow. According to my hypothesis, the N_2^+ ions continue their existence even after the short-lived afterglows have died out and produce the phenomena associated with the Lewis – Rayleigh afterglow.

For explaining the afterglow characteristics M. and Mme. Herman prefer the Cario – Kaplan mechanism[4]. This necessitates the presence of atomic nitrogen. There is no doubt that nitrogen molecules (N_2) are dissociated in the strong discharge and excited nitrogen atoms are produced. This, indeed, is proved by some of Kaplan's spectrograms[5]. But the presence of such atoms when the discharge is on, or for a very short time thereafter, is a different matter from their persistence for several hours producing the Lewis – Rayleigh afterglow, remembering that atomic nitrogen is known to have very short life.

S. K. MITRA

Wireless Laboratory,
92 Upper Circular Road,
Calcutta.
Aug. 25.

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Evolution of the Universe

IN checking the results presented by Gamow in his recent article on "The Evolution of the Universe" [*Nature* of October 30, p. 680], we found that his expression for matter-density suffers from the following errors: (1) an error of not taking into account the magnetic moments in Eq. (7) for the capture cross-section, (2) an error in estimating the value of α by integrating the equations for deuteron formation (the use of an electronic analogue computer leads to $\alpha = 1$), and (3) an arithmetical error in evaluating ρ_0 from Eq. (9). In addition, the coefficient in Eq. (3) is 1·52 rather than 2·14. Correcting for these errors, we find

$$\rho_{\text{mat.}} = \frac{4 \cdot 83 \times 10^{-4}}{t^{3/2}}.$$

The condensation-mass obtained from this corrected density comes out not much different from Gamow's original estimate. However, the intersection point $\rho_{\text{mat.}} = \rho_{\text{rad.}}$ occurs at $t = 8 \cdot 6 \times 10^{17}$ sec. $\cong 3 \times 10^{10}$ years (that is, about ten times the present age of the universe). This indicates that, in finding the intersection, one should not neglect the curvature term in the general equation of the expanding universe. In other words, the formation of condensations must have taken place when the expansion was becoming linear with time.

Accordingly, we have integrated analytically the exact expression[1]:

$$\frac{dl}{dt} = \left[\frac{8\pi G}{3}\left(\frac{aT^4}{c^2} + \rho_{\text{mat.}}\right)l^2 - \frac{c^2 l_0^{\,2}}{R_0^{\,2}}\right]^{1/2},$$

with $T \propto 1/l$ and $R_0 = 1{\cdot}9 \times 10^8 \sqrt{-1}$, light-years. The integrated values of $\rho_{\text{mat.}}$ and $\rho_{\text{rad.}}$ intersect at a reasonable time, namely, $3{\cdot}5 \times 10^{14}$ sec. $\cong 10^7$ years, and the masses and radii of condensations at this time become, according to the Jeans' criterion, $M_c = 3{\cdot}8 \times 10^7$ sun masses, and $R_c = 1{\cdot}1 \times 10^3$ light-years. The temperature of the gas at the time of condensation was 600° K., and the temperature in the universe at the present time is found to be about 5° K.

We hope to publish the details of these calculations in the near future.

Our thanks are due to Dr. G. Gamow for the proposal of the topic and his constant encouragement during the process of error-hunting. We wish also to thank Dr. J. W. Follin, jun., for his kindness in performing the integrations required for the determination of α, on a Reeves Analogue Computer. The work described in this letter was supported by the United States Navy, Bureau of Ordnance, under Contract NOrd-7386.

RALPH A. ALPHER
ROBERT HERMAN

Applied Physics Laboratory,
Johns Hopkins University,
Silver Spring, Maryland.
Oct. 25.

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Relative Abundances of Potassium and Argon in the Earth's Surface Materials

E. Bleuler and M. Gabriel[1] have recently shown that potassium-40 decays radioactively in two different ways. Apparently a potassium-40 nucleus can decay either by emitting a beta-ray, or by capturing one of its own *K*-electrons and emitting a gamma-ray. In the first case the resulting product is calcium-40, and the latter argon-40. 1·9 capture processes occur for every beta-ray emission.

The beta-ray emission of potassium-40 has been known for many years, and the accepted half-life of the reaction is $(7 \pm 1) \times 10^8$ yr. The effect of the *K*-electron capture process is to reduce the total half-life of potassium-40 to about $2{\cdot}4 \times 10^8$ yr. E. Gleditsch and T. Graf[2] have pointed out the importance of this fact in geophysical theory, and have shown, for example, that the heating effect of potassium-40 in the earth's crust $2{\cdot}4 \times 10^9$ years ago must have been about two hundred times greater than the total radioactive heating at the present day. So far as I am aware, however, the problem of the amount of argon-40 which would have been produced by the reaction in the life-time of the earth has not been considered.

Potassium is an abundant element in the earth's surface materials. If, following F. W. Clarke[3], we consider an outer spherical shell of the earth 10 miles deep, its composition is: atmosphere, 0·03 per cent; ocean, 7·08 per cent; solid crust, 92·80 per cent. The total percentage of potassium is about 2·4, and since the relative abundance of potassium-40 in natural potassium[4] is 0·012 per cent, the present percentage of potassium-40 in the shell is $1{\cdot}2 \times 10^{-4} \times 2{\cdot}4 = 2{\cdot}9 \times 10^{-4}$ per cent. Argon constitutes about 1·44 per cent of the atmosphere by mass; hence its percentage in the total shell is $0{\cdot}03 \times 1{\cdot}44 \times 10^{-2} = 4{\cdot}3 \times 10^{-4}$ per cent, or 1·5 the present amount of potassium-40.

If we take a figure of $2{\cdot}4 \times 10^9$ years as a reasonable estimate of the age of the crust, it follows that the original amount of potassium-40 would have been 2^{10}, or about 1,000 times greater than the present amount. Of this quantity, approximately two-thirds would have been transformed to argon; that is, the total quantity of argon present in the surface materials of the earth should be about 430 times the known amount of argon in the atmosphere.

It might be assumed that the bulk of the argon generated in the solid crust was retained in the crust, but even this assumption will only reduce the discrepancy. From the quantity of sodium retained in the ocean, F. W. Clarke[5] estimates that an amount of solid material equal to about 5 per cent of the postulated shell has undergone erosion. It is hard to imagine that, if during this process the sodium was extracted from the rock, the argon would not also escape, and this process would supply a quantity of argon more than twenty times that of atmospheric argon. If, on the other hand, we assume that the argon of the atmosphere[4], which is 99·6 per cent A^{40}, is derived from the eroded layer only, we easily arrive at an age of the crust of about $1{\cdot}3 \times 10^9$ years, which differs by a factor of about 2 from the accepted estimates of geological ages. A correction to these results should be applied for the amount of argon in solution in the ocean; but it can easily be shown that this correction is of no importance.

Two other possibilities may be considered: (1) that argon-40 is itself unstable and changes to some other element; or (2) that argon escapes from the atmosphere into space. Both processes seem to be highly improbable. At the lower end of the periodic table, the mass defect of the stable elements increases with atomic number, and this consideration alone seems to rule out the decay of argon-40 to any other stable element. Apart from this, argon is very commonly used in Wilson cloud chambers, and it is highly unlikely that its hypothetical decay would have escaped detection. The escape of argon from the atmosphere would seem also to involve the escape of nitrogen, oxygen and probably carbon dioxide. This seems very unlikely.

It is known, however, that cosmic rays produce atomic disintegrations; but again it can be shown that the amount of argon which could be destroyed by this process is probably exceedingly small. It is estimated by Powell and his co-workers that, at a height of 3,000 m., fifteen explosive atomic disintegrations occur per c.c. per diem in a nuclear photographic emulsion. This means that in $2{\cdot}4 \times 10^9$ years, $1{\cdot}3 \times 10^{13}$ atoms per c.c. would have been disintegrated, assuming, of course, that the cosmic ray intensity remained constant. There are, however, nearly 10^{23} atoms per c.c. of the emulsion; hence about one atom in 10^{10} of the emulsion would disintegrate. The effect on the average chemical composition of the emulsion is obviously insignificant. Argon, owing to its distribution throughout the atmosphere, may behave in a different manner; but it seems improbable that a factor of at least 10^9 could be introduced. Also we are faced with the problem of disposing of the large quantities of helium and hydrogen which would result from the destruction of the argon. These, of course, might escape from the atmosphere.

We are accordingly forced to conclude that either the assumed data for the breakdown of potassium-40 and its abundance in the surface materials are incorrect, or that the present estimates of the age of the earth are too great by a factor of two, unless some plausible explanation of the clash of data can be found.

Since writing the above, H. E. Suess[6] has published a letter in which he arrives at a similar result. He concludes that the proposed half-life of 2 × 10^8 yr. for potassium-40 must be incorrect.

J. H. J. Poole

Trinity College,
Dublin.
June 12.

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Structure of the Pigment of *Chromobacterium iodinum*

The dihydroxyphenazine obtained by catalytic reduction of the pigment of *Chromobacterium iodinum*[1] has been methylated. The resulting dimethoxyphenazine crystallized in yellow needles, m.p. 245–246° (found: C, 69·9; H, 4·4; $C_{14}H_{12}O_2N_2$ requires C, 70·0; H, 5·0 per cent). This compound differs from 1 : 4-dimethoxyphenazine[2], m.p. 185°. It has been shown already that synthetic 1 : 2- and 1 : 3-dihydroxyphenazines[3,4] differ from the natural product. The conclusion, therefore, is that the pigment contains the two hydroxyl groups in different benzene nuclei of the phenazine skeleton.

The condensation of 3-methoxy-*o*-quinone with 3-methoxy-*o*-phenylenediamine has yielded a mixture of 1 : 5- and 1 : 8-dimethoxyphenazines which was separated by chromatography, yielding:

(*a*) Yellow needles, m.p. 245–246°, not depressed by admixture with the dimethoxy phenazine described above (found: C, 70·4; H, 4·7; $C_{14}H_{12}O_2N_2$ requires C, 70·0; H, 5·0 per cent). The crystalline forms of the two specimens are identical.

(*b*) Yellow, hair-like needles, m.p. 253–254° (found: C, 70·2; H, 4·7; $C_{14}H_{12}O_2N_2$ requires C, 70·0; H, 5·0 per cent).

The problem of the orientation of the two methoxyl groups in (*a*) is now being investigated, and a full account of our work will be published elsewhere.

G. R. Clemo
A. F. Daglish

King's College,
Newcastle-upon-Tyne.
Sept. 29.

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Preparation of Phthalyl-L-Glutamic Acid

In a recent paper recording the preparation and properties of phthalyl-amino-acids, Billman and Harting[1] claim that the derivative obtained by heating L-glutamic acid with phthalic anhydride at 180–185° is the optically active phthalyl-L-glutamic acid.

While investigating the use of phthalylated intermediates as a means of synthesizing simple peptides containing glutamic acid, we have prepared both phthalyl-L-glutamic acid, m.p. 158–159°, $[\alpha]_D^{18°}$ in 0·33*N* sodium carbonate = −27·4° (found: C, 56·5; H, 4·0; N, 4·9; $C_{13}H_{11}O_6N$ requires C, 56·3; H, 4·0; N, 5·1 per cent), and the corresponding racemic acid, m.p. 189–190° (found: C, 56·5; H, 4·0; N, 5·0 per cent). The American authors have not quoted the rotation of their phthalylglutamic acid; but it is evident from its melting point of 188–189° that the derivative described by them is the DL-compound. However, we have repeated their preparation, and although the crude product has measurable optical activity, we have confirmed our earlier observation that the only compound which can be isolated on recrystallization is the racemic acid of melting point 189–190°. Phthalyl-DL-glutamic acid is more satisfactorily prepared by heating phthalic anhydride and a suspension of L-glutamic acid in boiling pyridine. The crude phthalamic acid obtained on evaporating the solvent is then heated with acetic anhydride to close the phthalimide ring, dehydration of the glutamic acid residue occurring simultaneously with the formation of phthalyl-DL-glutamic anhydride. From this the DL-acid is obtained simply by dissolving in warm water.

In order to avoid racemization, which may be due to oxazolone formation under the influence of the acetic anhydride, it is necessary to use a glutamic ester, for example, diethyl L-glutamate, which reacts with phthalic anhydride in cold ether. From the precipitated product, diethyl phthalyl-L-glutamate is readily obtained by the action of thionyl chloride, and hydrolysis with boiling 2*N* acid gives the phthalyl-L-glutamic acid, m.p. 158–159°.

Both phthalyl-DL-glutamic anhydride and the corresponding L-compound have been condensed with various amino-compounds, including amino-acids, and from the products the phthalyl group has been removed, under conditions which leave the peptide linkages intact, by an adaptation—already considerably exploited[2]—of the well-known hydrazine method.

A full account of these experiments will be published in due course.

Note added on October 22.—Phthalylglutamic anhydride differs from other acylglutamic anhydrides, for example, carbobenzoxy-L-glutamic anhydride, in reacting with ammonia to form the γ-amide, thus affording a direct synthesis of glutamine. Evidence for this important difference is found in the degradation of the phthalyl derivative with sodium hypobromite, eventually to 1 : 3-diaminobutyric acid, and in the evolution in the van Slyke estimation of 98 per cent of the nitrogen content of the product obtained after removing the phthalyl group.

D. A. Kidd

Dyson Perrins Laboratory,
Oxford.

F. E. King

University, Nottingham.
June 10.

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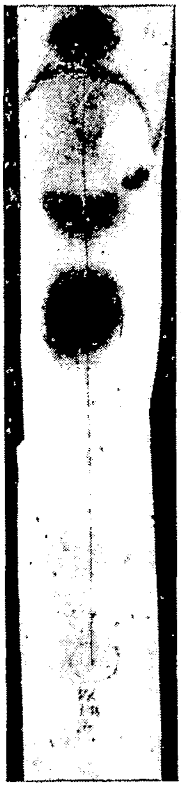
Paper Chromatography of the Noble Metals

The separation of amino-acids by partition chromatography on paper was first described by Consden, Gordon and Martin[1]. A large number of separations of organic compounds has been described since then. I have recently discovered that cations can be separated successfully if the solvent is adjusted suitably to prevent hydrolysis. The solvent selected for study was butanol saturated with *N* aqueous hydrochloric acid.



In this communication the separation of gold, platinum, palladium, copper and silver is described, which in the ordinary method of fire assaying is a tedious process, and, owing to the small amounts available for analysis, is an example where paper chromatography is eminently superior to chemical methods of analysis.

A mixture or alloy of the metals is dissolved in aqua regia. The solution is then diluted with an equal volume of water and one drop used for the chromatogram. The technique used is that of Williams and Kirby[2]: A cylinder of No. 1 Whatman paper, 28 cm. high and 26 cm. wide, is used, and drops of the solution to be analysed are placed 2·5 cm. from the bottom of the cylinder and marked in pencil. The cylinder is developed by letting it stand for 20–24 hours in a dish of butanol saturated with *N* hydrochloric acid inside a 5-gallon crock in an atmosphere saturated with *N* hydrochloric acid and butanol.

On ascent, two liquid fronts are formed, one being the front of dehydrated butanol and the second being the front of the aqueous phase, which follows about 4–6 cm. below. Since the aqueous front has a dark border, which does not fade on drying, this is used as reference for R_F values, and if a substance is extracted into the upper butanol layer it will have an R_F value of more than one.

The separation takes place as shown in the accompanying illustration. Silver is deposited on the point where the drop is applied ($R_F = 0$). Copper travels slowly ($R_F = 0{\cdot}1$). Palladium has an R_F value of 0·6, platinum of 0·72–0·80, gold of 1·05–1·13.

The spots of gold and platinum are yellow and that of palladium is orange. For the purpose of the illustration the paper was held over ammonia and then over hydrogen sulphide, producing a dark brown spot for gold and palladium and a lighter brown spot for platinum. Copper forms a black spot, which fades on drying, and silver also forms a black spot. Gold forms a tail of colloidal gold; but the amount lost is minute, as can be seen readily.

The method here described has the great advantage of separating amounts of the order of 0·1 mgm. and less of the metals quantitatively, and may supersede other methods used for the separation of these metals.

This communication is intended to be a preliminary report in the field of inorganic paper chromatography. Work on the copper and tin groups has already been completed and will be described soon. The other metals are at present under investigation; also the suitability of chromatography for large-scale preparations is being tried.

MICHAEL LEDERER

Chemistry Department,
Sydney Technical College,
Australia.

Aug. 3.

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A Fourth Order Reaction

IN a study of the reactions of metal complexes with hydrogen peroxide, in particular the system Fe^{3+}, $\alpha\alpha'$-dipyridyl which gives the "Katalasestoss" reported by Kuhn and Wassermann[1], we found it necessary to obtain data on the equilibrium and kinetics of formation of the red ferrous complex ion, $\mathrm{Fe(Dipy)_3}^{2+}$, formed according to the reaction:

$$\mathrm{Fe}^{2+} + 3\,\mathrm{Dipy} \rightarrow \mathrm{Fe(Dipy)_3}^{2+}.$$

A recent publication[2] shows that, so far as the equilibrium is concerned, the analogous complex with *o*-phenanthroline has many similar features.

The concentrations of $\mathrm{Fe(Dipy)_3}^{2+}$ in our experiments were measured colorimetrically. Its formation is an extremely fast reaction above *p*H 5 even when the concentrations of both reactants are 10^{-5} *M*. The rate is less in more acid solutions, and can be measured easily at *p*H 2–4. At *p*H 2–3 a large excess of the base can be used, in which case the reaction is first order with respect to Fe^{2+}. The first-order constants at different dipyridyl concentrations are found to be proportional to the cube of this concentration and inversely proportional to the cube of the hydrogen ion concentration; this dependence can be accounted for if only the free base reacts and not its conjugate acid, the pyridyl pyridinium ion $(\mathrm{Dipy.H})^{+}$. At *p*H 3–6, where comparable concentrations of Fe^{2+} and base had to be used to get measurable rates, the concentration-time data fit the expression for a fourth-order reaction. When the reaction goes to completion, the following rate equation holds over the entire *p*H range 2–6:

$$\frac{d}{dt}[\mathrm{Fe(Dipy)_3}^{2+}] = k_0\,[\mathrm{Fe}^{2+}]\ \mathrm{Dipy}]^3 = k_t\,[\mathrm{Fe}^{2+}]\,[\mathrm{Dipy}]^3\left(\frac{K_a}{K_a + \mathrm{H}^{+}}\right)^3, \qquad (1)$$

where k_0 is the observed velocity constant (*p*H-dependent), k_t the rate constant for the reaction between Fe^{2+} and free base, and K_a the dissociation constant of its conjugate acid. At 17° C. and $\mu = 0{\cdot}025$, $k_t = 9 \times 10^{14}$ $\mathrm{l.}^3$ $\mathrm{m.}^{-3}$ $\mathrm{min.}^{-1}$ and $K_a = 4{\cdot}2 \times 10^{-5}$. The value of K_a determined kinetically from (1) agrees well with the value we have obtained by *p*H titration experiments, which show in addition that $\alpha\alpha'$-dipyridyl is a mono-acid base (see ref. 2). Determinations of K_a at different temperatures give a heat of dissociation of 2·0 k.cal. for the conjugate acid.

In view of the improbability of four-body collisions, we propose the following mechanism involving two rapid successive equilibria and a final rate-determining step:

$$\mathrm{Fe}^{2+} + \mathrm{Dipy} \underset{}{\overset{K_1}{\rightleftarrows}} \mathrm{Fe(Dipy)}^{2+} \qquad \text{(i)}$$

$$\mathrm{Fe(Dipy)}^{2+} + \mathrm{Dipy} \overset{K_2}{\rightleftarrows} \mathrm{Fe(Dipy)_2}^{2+} \qquad \text{(ii)}$$

$$\mathrm{Fe(Dipy)_2}^{2+} + \mathrm{Dipy} \underset{k_f}{\overset{k_b}{\rightleftarrows}} \mathrm{Fe(Dipy)_3}^{2+} \qquad \text{(iii)}$$

where K_1 and K_2 are equilibrium constants and k_f and k_b are forward- and back-rate constants. When the reaction goes to completion, k_b can be neglected, and provided the concentrations of $\mathrm{Fe(Dipy)}^{2+}$ and $\mathrm{Fe(Dipy)_2}^{2+}$ are small, the above rate equation (1) follows. With this mechanism, k_t in equation (1) becomes $K_1K_2k_f$. Evidence that intermediates play a part in the reaction is afforded by our observation that with an excess of Fe^{2+} over base, the reaction does *not* go to completion even at pH 6·0, although it does so with equivalent concentrations. For example, with $3 \times 10^{-5} M$ dipyridyl and $6 \times 10^{-4} M$ Fe^{2+}, only 80 per cent of the possible amount of $\mathrm{Fe(Dipy)_3}^{2+}$ is formed. Using the above equilibria, it can be shown that, provided $[\mathrm{Fe}^{2+}] > 1/2K_1$, an increase in the $[\mathrm{Fe}^{2+}]$ will decrease the amount of $\mathrm{Fe(Dipy)_3}^{2+}$ formed.

Measurements of k_0 and K_a at different temperatures show that k_t, that is, $K_1K_2k_f$, is independent of temperature. This indicates that the heats of formation of the intermediate complexes and the activation energy for the formation of $\mathrm{Fe(Dipy)_3}^{2+}$ from $\mathrm{Fe(Dipy)_2}^{2+}$ are either all zero or cancel out.

In sufficiently acid solution not all the available Fe^{2+} is converted into the complex, even when dipyridyl is in excess. This is due to the low concentration of free base, and makes possible a determination of the overall equilibrium constant. This has the form:

$$K = \frac{[\mathrm{Fe(Dipy)_3}^{2+}]}{[\mathrm{Fe}^{2+}]\,[\mathrm{Dipy}]^3} \cdot \left(\frac{K_a + \mathrm{H}^+}{K_a}\right)^3,$$

where $K = K_1K_2k_f/k_b$. We find $K = 4 \times 10^{17}\ \mathrm{l.^3\,m.^{-3}}$ at 17° C., and $\mu = 0{\cdot}025$.

It was of interest to examine the dissociation of the complex, for we had observed fading of the colour in strong acids. This is presumably the reverse of reaction (iii) brought about by the removal of free base. The reaction is first order, but the constant is dependent on the acid used (hydrochloric, sulphuric or perchloric), and also on its concentration. Thus it increases from 6×10^{-3} to 10×10^{-3} min.$^{-1}$ as the acid goes from $0{\cdot}25\,N$ to $0{\cdot}5\,N$, reaching a steady value of about 12×10^{-3} min.$^{-1}$ for hydrochloric and sulphuric acids and about 9×10^{-3} for perchloric acid, all at 17° C. This value, combined with k_t for the forward reaction, gives a kinetic value of about 9×10^{16} for the overall equilibrium constant K, and compares as well as can be expected with the direct determination given above. The back reaction is very dependent on temperature, having an activation energy of about 28 k.cal. The dependence on the acid and its concentration, which is at variance with the above scheme, is being examined further. A full account of this work will be published elsewhere. The investigations are being extended to tripyridyl and tetrapyridyl complexes and their reactions with hydrogen peroxide.

J. H. BAXENDALE
PHILIP GEORGE

Chemistry Department,
University, Leeds.
Aug. 27.

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Occurrence of a Phosphate Ester of a Hydroxyamino-Acid

DURING a recent investigation of the dialysate of calf embryo muscle juice by means of paper chromatography, a very slow-moving spot has been noticed which does not appear to correspond with any substance previously recognized in such extracts. Fractionation of the dialysate on chromatograms of amberlite *I.R.*4 indicated that it was due to a weakly acidic substance: It was eluted from these chromatograms in the same fraction as phosphoryl aminoethanol, which, contrary to the finding of Outhouse[1], appears to be present in calf embryos. Thus it seemed worth investigating whether the unknown substance might be another phosphoric ester. This was done as follows.

The fraction from the amberlite column was separated on a one-dimensional paper chromatogram, using phenol/ammonia as solvent. By means of the 'washing off method' of Consden, Gordon and Martin[2], the substance in question was removed from the paper without treatment with ninhydrin. One sample thus obtained was hydrolysed with $6\,N$ hydrochloric acid at 100° for 24 hours and was then again subjected to paper chromatography. Two strong spots were formed, one being due to unchanged material, and the other having R_f values in phenol/ammonia and collidine similar to those of hydroxylysine. A second sample was treated at pH 8–9 with the phosphatase from rat intestinal mucosa. After chromatography, the only strong spot formed had the rate expected for hydroxylysine. Certain weak spots which are difficult to identify appeared both here and on the chromatogram of the acid hydrolysate. A third sample was also treated with the phosphatase, but in this case sulphuric acid, sodium molybdate and stannous chloride solutions were added in the proportions given by Kuttner and Lichtenstein[3]. A blue colour was formed. These three experiments indicate that the original substance is a difficultly hydrolysable phosphate ester.

In order to identify further the substance which appeared to be similar to hydroxylysine, an enzyme hydrolysate obtained as above was subjected to chromatography with phenol in an atmosphere containing acetic acid. As expected, the spot obtained had moved very much slower than in phenol/ammonia. This behaviour is regarded as characteristic of basic substances. Finally, another sample was run as a mixed chromatogram in phenol/ammonia with and without authentic hydroxylysine. The specimen used was obtained from Dr. C. Dent, who received it from Dr. D. D. van Slyke; sincere thanks are due to both. No separation was obtained. Therefore it seems most likely that the original spot must be due to a phosphate ester of hydroxylysine. In view of the possible similarity of this substance with that recently reported by Chargaff[4] as being present in an acid hydrolysate of ox-brain phosphatides, it seemed worth while to publish these findings at the present stage.

This work was done while I was holding a fellowship from the Donner Foundation, to which thanks are due.

A. H. GORDON

Biological Institute of the Carlsberg Foundation,
Copenhagen. Sept. 23.

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Antagonism between Basic Compounds (Spermine, Streptomycin) and Basic Bactericidal Substances

THE following bactericidal substances—trypaflavine ($5 \times 10^{-4} M$), methylene blue ($1 \times 10^{-3} M$), protamine sulphate ($2{\cdot}5 \times 10^{-4} M$), chinine ($2{\cdot}5 \times 10^{-3}$) and crystal violet ($1 \times 10^{-4} M$)—cause a strong and progressive inhibition of the respiration of bakers' yeast, suspended in glucose phosphate at 28° C. (cf. also ref. 1). Spermine and streptomycin, though also basic substances, even at high concentrations ($1 \times 10^{-2} M$ and $1 \times 10^{-2} M$ respectively) do not affect the respiration of yeast and thus have no direct bactericidal activity. It can be shown that all these substances, the inhibitors as well as spermine and streptomycine, compete for the same negative components of the yeast cell, when brought in contact with a yeast suspension[2].

According to Dubos[3] bactericidal substances such as basic dyes owe their bactericidal activity to two properties: the basicity or positive charge of the cation and the relatively large molecular weight, favouring the formation of sparingly soluble and feebly ionized compounds with negatively charged components of the bacterial cells.

Since all the substances we used are basic and have high molecular weight (protamine sulphate) or a relatively high molecular weight (spermine, trypaflavine, methylene blue, chinine, streptomycin, crystal violet), one wonders why some of these substances show a direct bactericidal activity and others not, the more that we have proved that they all compete for the same components of the bacterial cell[2]. Which is the property that the bactericidal substances possess and that spermine and streptomycin do not share?

It seems to us that a property described by Michaelis[4] for the basic dyes should be taken into account, namely, the occurrence of dimers, trimers and polymers in solutions of those substances. This polymerization is dependent upon the concentration. It is counteracted by the fact that these substances possess the same positive charge; but this aggregation or polymerization is, of course, favoured when the positive charges are held by negative components of the cell. It is evident that polymerization increases the effective molecular weight.

Why should we not admit that basic substances will show direct bactericidal activity when possessing a real high molecular weight, as is the case for protamine sulphate, or achieve a high molecular weight at definite concentrations by aggregation of their organic residues, the positive charges (cause of repulsion) being held by negatively charged components of the cells? This would be the case for methylene blue, trypaflavine, chinine and crystal violet, but not for spermine and streptomycin.

It might be expected that streptomycin and spermine, competing by virtue of their basicity with the bactericidal substances, but not being toxic, would be able to counteract the inhibition of respiration caused by these last substances. We have proved now that this is really the case: spermine at definite concentrations completely reverses the inhibition of respiration caused by trypaflavine, methylene blue, chinine, crystal violet and protamine; for example, in the presence of $2 \times 10^{-4} M$ spermine, trypaflavine ($2 \times 10^{-4} M$) does not cause any inhibition under the conditions of our experiments. For streptomycin we were obliged to limit our observations to methylene blue and trypaflavine, but here, too, the reversal was complete; thus in the presence of $1 \times 10^{-3} M$ streptomycin, methylene blue ($1 \times 10^{-3} M$) leaves the respiration of bakers' yeast untouched. Our experiments with spermine recall those of Silverman and Evans[5], who found that the toxic effect of atebrine upon the growth of *E. coli* is antagonized by spermine and other naturally occurring amines, but these authors postulated a growth-factor activity of these amines.

All our experiments were made at 28° C. by means of the Warburg apparatus, with yeast suspensions in glucose-phosphate medium (10 mgm. fresh bakers' yeast in a final volume of 2 ml.).

Full experimental details will be published in *Archives internationales de Pharmacodynamie et de Thérapie*.

We are indebted for several of the compounds used (spermine, clupeine sulphate) to the firm of Hofman-Laroche (Basle).

L. MASSART

Biochemical Laboratory,
Biochemical Centre,
University of Ghent.

June 21.

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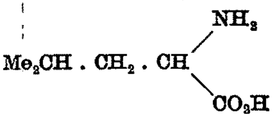
Structure of the Antibacterial Compound, Aspergillic Acid

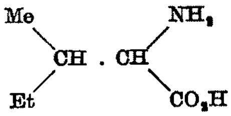
REDUCTION of aspergillic acid, $C_{12}H_{20}O_2N_2$, an antibiotic isolated from culture filtrates of *Aspergillus flavus*[1], gives in high yield a neutral reaction product, deoxyaspergillic acid, $C_{12}H_{20}ON_2$, to which the structure 2-hydroxy-3 : 6-di*sec*.-butylpyrazine has been ascribed[2]. We have previously described syntheses of 2-hydroxy-3 : 6-di*sec*.-butylpyrazine[3], and although we were unable to resolve the racemic compound, a comparison of its properties with those of deoxyaspergillic acid led us to conclude that the latter is a hydroxypyrazine derivative. Substantial differences in the intensity of light absorption in the ultra-violet, however, suggested that the two compounds differ more profoundly than in stereochemical orientation. Moreover, deoxyaspergillic acid has been racemized by treatment with alkali, and the racemate is distinct from 2-hydroxy-3 : 6-di*sec*.-butylpyrazine, which is itself unaffected by similar treatment with alkali.

Treatment of aspergillic acid with bromine followed by reduction of the bromo-substitution product with zinc and acetic acid[2] gives a product, $C_{12}H_{22}O_2N_2$. We find that hydrolysis of the compound $C_{12}H_{22}O_2N_2$ with hydrobromic acid gives a mixture of two α-amino-acids. Separation of the component α-amino-acids was achieved by fractional solution of



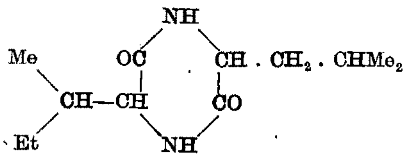
$Me_2CH\,.\,CH_2\,.\,CH(NH_2)CO_2H$

I

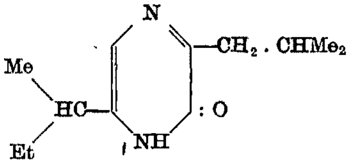


$(Me)(Et)CH\,.\,CH(NH_2)CO_2H$

II



III



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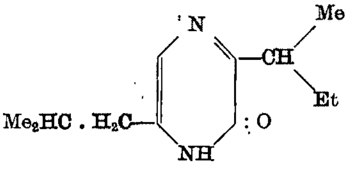

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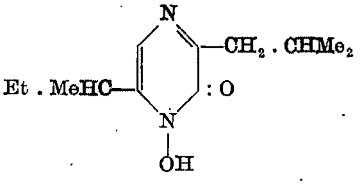
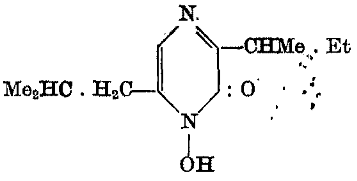


VI



VII

the mixed copper salts in water and methanol. Regeneration of the parent acid from the less soluble copper salt gave DL-leucine (I), identified as its 3 : 5-dinitrobenzoyl-derivative and by its degradation with ninhydrin to *iso*valeraldehyde. Regeneration of the acid from the more soluble copper salt gave *iso*leucine (or allo*iso*leucine, II), identified by its degradation to methylethylacetaldehyde by means of ninhydrin. The compound $C_{12}H_{22}O_2N_2$ is therefore an optically active leucyl*iso*leucine anhydride (III), deoxyaspergillic acid is either 2-hydroxy-3-*iso*butyl-6-*sec.*-butylpyrazine (IV) or 2-hydroxy-3-*sec.*-butyl-6-*iso*butylpyrazine (V), and aspergillic acid is either (VI) or (VII).

GEORGE DUNN
G. T. NEWBOLD
F. S. SPRING

Royal Technical College,
Glasgow.
July 23.

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Toxicity of Sulphydryl Compounds to Seeds

Audus and Quastel[1] have recently shown that sodium thiosulphate is toxic to seeds of higher plants, and it has been reported[2] that sodium ethyl xanthate is being used commercially as a weed-killer. The accompanying table shows the results of tests for toxicity to wheat seeds of a number of sulphydryl compounds, and may therefore be of interest.

Root fresh weight as per cent of control

Group	Substance	Concentration 0·0005*M*	Concentration 0·005*M*	Concentration 0·05*M*
A	thioacetic acid	77	—	—
,,	potassium thiocyanate	96	79	27
,,	sodium thiosulphate	81	79	39
,,	potassium dithio-oxalate	95	90	not tested
,,	potassium methyl dithiocarbonate	50	—	—
,,	potassium ethyl xanthate	90	83	—
B	*n*-propyl mercaptan	101	97	82
,,	*i*-propyl mercaptan	95	104	90
,,	ethyl mercaptan	94	75	27
,,	phenyl mercaptan	80	38	—
,,	cysteine hydrochloride	110	45	16
,,	thioglycollic acid	81	45	—
,,	*o*-thiolbenzoic acid	89	81	51

Wheat seeds were sown on tap-water agar containing the toxic agents in Petri dishes and incubated for four days at 24° C. The roots from each seed were then cut off and their fresh weight determined. Although most of the compounds tested showed some degree of toxicity, thioacetic acid and potassium methyl dithiocarbonate were outstanding in their toxicity; this has been confirmed in other experiments.

It has been suggested[3-5] that the biological activity of ethylenic compounds is greatest where the substituent groups are electron-attracting. Walsh[6] has commented on the similarity between —S— and —CH=CH—. We thought it possible, therefore, that the activity of sulphydryl compounds might be similarly explained. Ferric chloride gives colours with compounds of the type *R*SH and their salts. We have observed that the nature of the group *R* determines the colour. Groups, the phenyl derivatives of which give *meta* substitution when acted on by cationoid reagents, that is, groups which attract electrons, give red colours when their —SH compounds are treated with ferric chloride in water, ethanol or glacial acetic acid; the compounds listed in group *A* in the table fall into this category. *R*SH compounds with *R*-groups the phenyl derivatives of which give *ortho* or *para* substitution give green or blue colours with ferric chloride in water or alcohol and no colour in glacial acetic acid; those compounds listed in group *B* in the table fall into this category.

Though the most active two compounds, thioacetic acid and potassium methyl dithiocarbonate fall into the group with *R*-substituents of high electron affinity, there is no general tendency for those compounds with *R*-substituents of high electron affinity to be more toxic than those with *R*-groups of low electron affinity. An explanation of the variation in toxicity among these sulphydryl compounds has therefore, yet to be found.

P. W. BRIAN
MARY JAMIESON
J. C. MCGOWAN

Imperial Chemical Industries Ltd.,
Butterwick Research Laboratories,
Welwyn, Herts.
June 8.

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The Very Rare *Rh* Genotype R_yr (*CdE*/*cde*) in a Case of Erythroblastosis fœtalis

In a case of erythroblastosis fœtalis, the mother was found to belong to the rare *Rh* phenotype which includes the genotype $R'R''$. *Rh*-typing of her family makes it clear that the genotype is, in fact, *CdE*/*cde* or R_yr (or, in the latest nomenclature of Dr. Wiener, r^yr). The combination *CdE* has never previously been clearly demonstrated[1-5]. The claim of Stancu, Clark and Snyder[6] to have discovered *CdE* seems insufficiently documented for so important a claim.

Fisher[7] first stated that the combination *CdE* should be capable of existence. He and Race afterwards suggested[8] that its frequency in the English population would probably be less than 0·005 per cent, and that of the genotype *CdE*/*cde*, about 37 per million.

The case described is that of Mrs. K., whose seventh pregnancy ended at 7½ months in the birth of a baby which became severely jaundiced and died on the fourth day of kernicterus.

Mrs. K.'s blood group is *O MN P*; her red cells are, moreover, agglutinated by anti-*C* and anti-*E* but not by anti-*D*. Her serum contains both complete and incomplete anti-*D*. The blood of the husband is not available as he is abroad; he is known to be *D* positive. Mrs. K.'s mother and her third child are of the same rare *Rh* type (*CdE*) as herself. The *Rh* types of all members of the family who have been tested are given in Fig. 1, in terms of their reactions with anti-*C*, anti-*D* and anti-*E* sera.

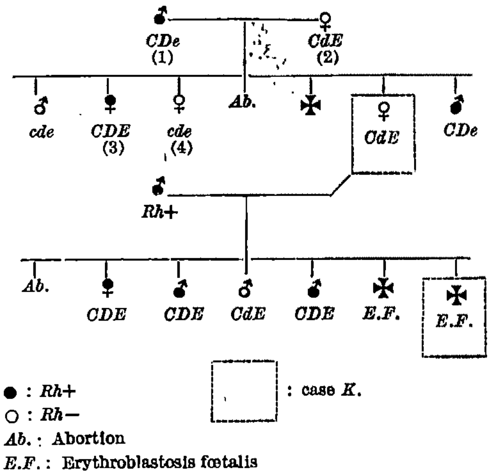

Fig. 1. The *Rh* types of Mrs. K. and her relatives (tested with anti-*C*, anti-*D* and anti-*E* sera)

Two sibs of Mrs. K. are *Rh* negative (*cde*/*cde*). Their parents must, therefore, both be heterozygous, with the combination *cde* on one chromosome. It is thus possible to fix the genotypes of all the surviving members of two generations of the family as shown in Fig. 2, and to identify *CdE* as an inherited combination on one chromosome. Race's table of antigen-antibody reactions can thus be completed (Fig. 3).

Only anti-*C*, anti-*D* and anti-*E* sera were available for most of the tests; Mrs. K.'s parents were, in addition, tested with anti-c kindly supplied by Dr. J. J. Van Loghem, jun., of the Centraal Laboratorium Bloedtransfusiedienst van het Nederlandsche Roode Kruis, Amsterdam. Mrs. K. and her children are now abroad and are not available for further tests.

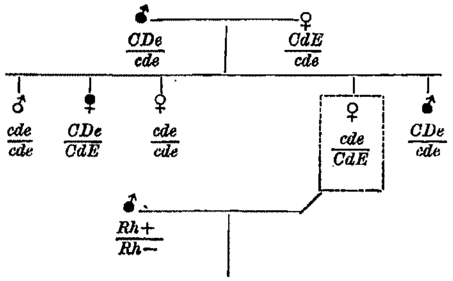

Fig. 2. The *Rh* genotypes of Mrs. K. and her relatives

		cDe	*cde*	*cDE*	*cdE*	*CDe*	*Cde*	*CDE*	*CdE*
		Rh_0	*rh*	Rh_2	*Rh″*	Rh_1	*Rh′*	Rh_z	Rh_y
Anti-*C*	Anti-*Rh′*	−	−	−	−	+	+	+	+
Anti-*D*	Anti-Rh_0	+	−	+	−	+	−	+	−
Anti-*E*	Anti-*Rh″*	−	−	+	+	−	−	+	+
Anti-*c*	Serum St.	+	+	+	+	−	−	−	−
Anti-*d*		−	+	−	+	−	+	−	+
Anti-*e*		+	+	−	−	+	+	−	−

Fig. 3. Fisher's synthesis of the *Rh* system

Gene combinations and their reactions with different antisera. The data within the inner line had been established by Race and Taylor by the end of 1943 and were the basis of the complete scheme proposed by Fisher. Murray, Race and Taylor[9] announced in 1945 the reactions of R_z with anti-*D* and anti-*E*. Mourant later in 1945 described anti-*e*. Diamond[10] in 1946 announced his discovery of anti-*d*, and this antibody was fully described by Hill and Haberman[11] in 1948. The discovery of R_y and its reactions are described in the present paper.

Dr. J. J. Van Loghem, jun., checked the *CdE* type of Mrs. K. and the presence of antibodies in her serum. Miss E. W. Ikin and Mrs. J. Woodward in the laboratory of Dr. A. E. Mourant in London carried out full *Rh* tests on the blood of Mrs. K. and her sibs (3) and (4) with the following results:

	Anti-*C*	Anti-*D*	Anti-*E*	Anti-*c*	Anti-*e*
Mrs. K.	+	−	+	+	+
(3)	+	+	+	−	+ (titre 1)
(4)	−	−	−	+	+ (titre 8)

Our data prove the existence of the combination *CdE* on one chromosome. Thus the eighth allelic combination *CdE* of Fisher's theory is recognized, and this ingenious synthesis may be considered as completely confirmed.

Clara Van den Bosch

Department of Pathology,
University of Louvain,
Belgium.

May 19.

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Cryptic Polyploidy and Variation of Chromosome Number in *Ribes nigrum*

THE examination of meristems in root tips and young ovules in the c_2-generation bushes grown from seed of colchicine-induced tetraploid *Ribes nigrum* ($2n = 32$) showed that the chromosome number varies greatly from one to another. The lowest number found was 4, all numbers between 4 and 32 being observed. Statistics on the frequency of the different chromosome numbers shows that the distribution is in its main features binomial, the peak lying at the diploid number $2n = 16$. All numbers divisible by four are more frequent than might be expected on random distribution.

If we accept the axiom that the haploid chromosome set is the smallest chromosome combination for the viability of an individual cell[1], we may assume on the basis of the above observations that the primary haploid chromosome number of the genus is $x = 4$, the recent species being accordingly derived tetraploids. This is in accordance with Stebbins' hypothesis[2,3] that many woody plants which have been regarded as diploid actually are polyploid. The meiosis of certain *Ribes* hybrids[4] indicates that hybridization and amphidiploidy have played a part in the speciation of this genus. The formation of two separate and independent spindles in one cell has been established as the cause of the variation in the chromosome number. The original chromosome complement is divided between the two spindles. The autonomy of the separately dividing groups is to be found already in the resting nucleus, which in this case is more or less constricted. Between the mitotic cycles of the two chromosome groups synchronization disturbances are relatively common.

The occurrence of the split spindle and the timing disturbances in the divisions are assumed to be connected with structural changes in the chromosomes arising during the colchicine treatment[5]. Chromosomes are then broken, especially in the heterochromatic segments[6]. The amount of heterochromatin is thus variable, and consequently the nucleic acid metabolism is unbalanced. It seems to be a pertinent fact that structural changes disturb the balance of the mitotic genes[7] which regulate the nuclear cycle.

The occurrence of the diploids ($2n = 16$) in the progeny of the tetraploid bushes proves that the hypoploid cells also affect the offspring. As Upcott[8] has proposed in the corresponding case of *Primula kewensis*, a strong selection seems, however, to be effective among hypoploid cells. Only the most viable chromosome combinations are able to survive as functioning gametes.

ANTERO VAARAMA

State Horticultural Institute,
Piikkiö, Finland.
June 4.

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Aural Sensitivity and Heart Beats

MOST mains-actuated radio receivers when switched on have a greater or lesser degree of mains hum, which is readily audible so long as the programme is inaudible. With my own receiver I have always been conscious of a rhythmic pulsation in intensity under these conditions, which I have been inclined to attribute to some slight lack of balance in the electrical components of the set. On inquiry, I find that many people are aware of this rhythmic effect.

When burning damp logs on the fire during last winter, I noticed a similar rhythmic pulsation in the sound emitted by steam escaping from the ends of the logs, as well as in the even higher-pitched hiss produced when drops of water from the wood fell on to the hot bars, the effect being slightly more marked in the latter case. Later, I noticed that the mains hum pulsation of the radio receiver coincided in time with that from the fire. On feeling my pulse (or temporal artery) I discovered that the rhythm was that of the heart-beat, the intensity of the sound heard diminishing in each case for the duration of the 'beat'. When their attention was directed to the effect, I found that other people also noticed the same rhythmic pulsation of intensity with the heart-beat. I have noticed the same effect with the hiss of an oxyacetylene welder, with the sound of water flowing through the supply pipes when water has been drawn from the main tank, with waves breaking on the seashore, and in other cases.

There seemed little doubt that the effect must be connected in some way with the ear-drum. Since the drum is richly supplied with blood vessels, it follows that, corresponding to each surge of blood through the arteries, the drum will swell slightly and have increased inertia, so that its amplitude of vibration under constant stimulation will be reduced. Thus when we are listening to a continuous source of sound of uniform intensity, an apparent diminution in intensity will be observed for the duration of each 'beat', and between beats the intensity will be greater and sensibly uniform.

Experiments with a beat-frequency oscillator fed to a pair of headphones were then carried out to see if the effect depends in any way on frequency. Whether the headphones were on the head or off (but still audible), no essential difference in the pulsation effect was noticeable at frequencies from 50 c./s. to the limit of audibility (14,000 c./s. for my left ear, and 12,000 c./s. for my right). Near the upper limit of audibility, however, the effect was distinctly more marked relatively than at somewha lower frequencies, as it had been found to be with the hiss from water on the hot fire-bars as compared with the sound of steam issuing from the logs burning in the fire. At any given frequency, the audible effec was practically independent of the intensity of the sound, except that above the threshold of pain found it impossible to detect any pulsation.

It was further observed that, when listening to a constant source of sound, the apparent intensity wa reduced by biting the teeth firmly together, especially at higher frequencies. By performing this action rhythmically, a pulsation in intensity analogous to that produced by heart-beats was readily detectable. This effect also took place at all frequencies and fo all intensities below the threshold of pain. It seems likely that it is caused by a variation in tension of the drum effected by the muscular effort of biting.

Finally, when sitting alone in a very quiet room at night, I find that I can actually hear my heart-beats. The sound is very faint indeed and resembles gasping. It seems reasonable to suppose that it is caused by the movements conveyed to the malleus by the ear-drum as it enlarges at each surge of blood through the arteries. The effect may be slightly accentuated by resonance in the external auditory meatus.

These results may be of interest in considerations of the minimum perceptible energy in the auditory process[1]. I am indebted for information to several scientific colleagues, and in particular to Dr. E. T. B. Francis, of the Department of Zoology.

ROBERT W. LAWSON

Department of Physics,
University, Sheffield 10.
Aug. 28.

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"Freedom and Obligations"

THE leading article, "Freedom and Obligations", in *Nature* of October 2, p. 507, contains a criticism of a charter for men of science, drafted by the Committee on Science and its Social Relations at its meeting in Paris during June 15–16. As two of the persons responsible for this draft, we wish to make the following observations.

We certainly are aware that freedom and rights cannot be defined in an absolute way, and that any formulation of them will bear references to the circumstances among which we are living. We also know, all of us, that we have obligations to fulfil. But we are convinced that time and again particular aspects of freedom must be brought to the foreground, in order to make clear the way present trends are deviating from what once was considered as the ideal of science, namely, free and open discussion of all outcome of research, as the best safeguard that science may serve mankind as a whole.

In the discussion at our meeting we did not overlook the position of scientific workers in industry. We are of opinion, however, that the sentence in the article in *Nature*, "The freedom of publication and freedom to discuss his work with other men of science must in industry be subject to some limitations", is an expression of a situation accepted in a certain historical period, but cannot be considered as a rule to which science should be subjected as a matter of principle. We believe that industrial enterprises should be considered and managed as 'public utilities', and that the idea of competition in view of the commercial aspects of industry cannot remain, in the long run, a guiding principle for the development of human society. We have not gone so far as was suggested by Prof. A. V. Hill in an address delivered on February 17, 1946, when he suggested that it should be a duty of scientific workers to refuse to co-operate in tasks in which they, or their representatives, are not allowed a reasonable share or partnership in the responsibility of deciding on the purpose, policy or probable result of their work. Neither did we ask, in the charter we drafted, for information on every detailed purpose. But we think it indispensable in the present period that every scientific worker should know whether his work is intended directly to serve the public welfare, or whether it should serve profit motives or purposes of competition, or military purposes, in order that he may realize in what position he finds himself with regard to his fellow citizens, and that he may consult his conscience in this respect.

It was mentioned at the meeting of our Committee that free discussion of work in progress cannot yet be always and everywhere allowed; but it was unanimously agreed that the charter should ask for publication of all results, and that freedom of discussion should be restricted as little as may be possible. We are well aware that in many enterprises such freedom will not be given at the present moment; nevertheless, we believe that it is necessary to remind scientific workers of what must be our goal and to stimulate fighting for this goal. We are afraid that otherwise the human mind—particularly in present circumstances—is too much apt to acquiesce in conditions which (to put it mildly) should be described as a return to the 'enlightened despotism' of the eighteenth century.

With regard to measures prescribed for scientific workers by Government institutions, we certainly do not profess disloyalty; but again we consider it a duty of scientific workers to have a clear idea of what is asked from them and for what purpose this is asked. We also believe that much open discussion is desirable and possible in connexion with the problem whether the present trends for enforcing secrecy do not go too far, and whether much of the present tension in the world would not have been reduced had not this unhappy trend for secrecy taken hold of it and stirred up fear and suspicion.

As regards the problem of loyalties overriding national loyalties, which is brought forward in the article in *Nature*, we do not wish to refer to political creeds which certainly are often misleading many people; but it may be remembered that the Roman Empire persecuted the early Christians likewise because they professed a higher loyalty than that to the State. Surely it will be accepted that both the idea that man has to consult his conscience in order to know his responsibility to God as his first duty, and the idea of a brotherhood extending over all national frontiers, have been a gain in the development of civilization. It may be true that international loyalty in the present world seems to have little force; but this should not prevent us from fighting for it in a domain of human activities which some time ago appeared to offer a unique ground for its development.

Scientific workers themselves must decide whether they will accept, as suggested in *Nature*, "the practice of the most advanced countries as a standard and as the most satisfactory solution to the problem"; we believe it to be important to point out clearly that there are aims reaching further, and that in the light of these aims the practice of the countries mentioned also may be critically analysed.

We realize that most of what has been brought forward here by us will not have the same weight for everybody; but we wanted to state that such problems as have been mentioned in the article in *Nature* had indeed been before us. We should like to add that we consider the article in *Nature* a valuable contribution to a discussion which we can only welcome, and it is to be hoped that it may call forward comments from various sides.

J. M. BURGERS (President)
M. FLORKIN (Secretary)

Commission pour la Science et ses
Relations Sociales,
Van Houtenstraat 1, Delft.

RIVER RESEARCH IN EAST AFRICA

By Dr. VERNON D. van SOMEREN, M.B.E.

An important step forward in the conservation and development of the river fisheries in East Africa was taken on September 11, when the Governor of Kenya Colony, His Excellency Sir Philip Mitchell, formally opened the River Research and Development Centre near Nyeri Station in Kenya, in the presence of many people connected with fish and fishery problems.

Financed by grants from the Kenya Government and the Development and Reconstruction Authority of the Colony, this Centre has been built by the Kenya Game Department under the direction of the fish warden, Mr. Hugh Copley. The Centre consists of a research laboratory, a trout hatchery, and an administration centre situated on the banks of the Upper Sagana River, on the lower slopes of Mount Kenya. The staff at present consists of one biologist (Dr. V. D. van Someren), one assistant fish warden (Major D. F. Smith) and a hatchery superintendent, the whole being administered by the head offices of the Game Department in Nairobi.

The function of the Centre is twofold, namely, river fishery research and practical fish breeding, neither of which has hitherto been investigated scientifically in the Colony. On the fishery research side, the first object is to provide a scientific background for developing the trout fishery resources of East Africa. Both rainbow and brown trout were first introduced to Kenya about forty years ago, and since then the trout fisheries have been developed as a considerable sporting and tourist asset, most of the rivers now being stocked. The practical management of these fisheries has so far been run successfully on an *ad hoc* basis; but it has been felt for some time now that any further advance must be based on scientific research into river productivity and fishery management. Deterioration in growth-rate of trout, for example, has taken place in several of the rivers since their initial stocking, and this is but one aspect of the problem which is being investigated. Afterwards, such research will be carried further to investigate fully the indigenous fisheries of the lower reaches of the rivers where trout will not live. In some rivers there exist native fisheries for *Tilapia*, *Barbus*, eels, catfish and the like, and research would undoubtedly improve the yield of such food fish for the African population.

Other research aspects of the Centre's work include the large-scale systematic rearing of aquatic insect nymphs and larvæ, since the majority of such in East African rivers are as yet unnamed. The food productivity per unit area of river bottom is being investigated in relation to the population of fish. The food and growth-rate of the fish themselves are also under study, and the rivers present many interesting ecological features in the distribution of fish and other aquatic life, since they may rise at an altitude up to 14,000 ft. and finally discharge at sea-level.

It is the intention that this Centre should work in close co-operation with the Wray Castle Laboratory of the Freshwater Biological Association in England, and to this end Dr. Winifred Frost, of the Wray Laboratory, has already spent six months working at the Centre on East African river eels and trout fisheries. Close liaison will also be maintained with the East Africa Inland Fishery Research Institute at Jinja in Uganda, now in course of construction, and it is possible that amalgamation of the two may later take place, with the added advantage of staff interchange.

On the educational side, short vacation courses in freshwater biology will be held for pupils of the Kenya secondary schools and probably also for African biology students from Makerere College in Uganda. The first vacation course for girls of the Kenya High School has already taken place.

The laboratory has accommodation for visiting scientific workers, and it is hoped that students from overseas will take advantage of the facilities to study, not only fishery problems, but also other aspects of the biological, physical and chemical phenomena in East African rivers. Guest-house accommodation has been provided for such visitors at the Centre.

Practical trout breeding will go hand-in-hand with research, the hatchery being designed to accommodate up to 150,000 ova. This is the first such hatchery to be built in East Africa, and will serve the three East African territories and farther afield if required. Some of the first batch of fry reared have already been sent to the Sudan. Biological work in connexion with the proposed Government fish culture farm for indigenous fish will also be undertaken.

The biology, breeding and growth of fish and other aquatic life in these high-altitude regions, with a sub-tropical climate and little variation in seasons, present many interesting problems compared with temperate climates. Over a period of years, the results of research should be not only of practical economic importance but also of fundamental biological interest.

ROAD RESEARCH IN SCOTLAND

As an initial step in the founding of a Scottish branch at East Kilbride, near Glasgow, of the Road Research Laboratory, were a conference and exhibition held at the Royal Technical College, Glasgow, on September 24, under the auspices of the Road Research Organisation of the Department of Scientific and Industrial Research in association with the Institution of Civil Engineers (Glasgow and District Association), the Institution of Municipal Engineers (Scottish Branch), the County Surveyors' Society (Scottish Branch) and the Scottish Accident Prevention Council. Sir Patrick Dollan presided over the conference; the chair at the morning session was taken by Colonel T. U. Wilson, county surveyor of Lanarkshire, and at the afternoon session by Mr. C. S. Sherriff, chairman of the Scottish Accident Prevention Council.

The conference and exhibition were arranged to make the work of the Road Research Organisation better known to Scottish road engineers, and to obtain from them further information on problems and difficulties peculiar to Scotland. In his opening remarks in the morning session, which was devoted to road materials and methods of road construction, the director of road research, Dr. W. H. Glanville, stressed the need for developing sympathetic understanding and co-operation between the practising engineers, who apply the results of research, and the scientific workers in the laboratory: he explained that the new laboratory would begin as a small organisation; but he hoped it would grow as the problems to be attacked were disclosed and as its usefulness was proved; it would not be a small-scale replica of the main laboratories near London, but would have a character of its own, developing to meet the special needs of Scotland. On the 'materials' side it would be equipped to carry out the basic tests and measurements relating to the study of soils and to the use of stone, bituminous materials and concrete; but its initial function would be to provide Scottish road engineers with a centre of information about the activities of the Road Research Organisation.

The three papers at the morning session dealt with soils, concrete and bituminous materials, and were given by the officers in charge of these sections of the work of the Organisation, Mr. D. J. Maclean, Mr. F. N. Sparkes and Dr. A. R. Lee. Mr. Maclean dealt with the physical properties of soil and its behaviour as part of the road structure, notably with the performance of different types of roller for compacting soil, with the settlement of embankments, with improvements in soil stability by the use of cement and other materials, and with studies of the structural failure of roads; he gave special attention to peat as being a soil of particular importance in Scotland. Mr. Sparkes described studies made in the laboratory of the materials used in making concrete—aggregates, sands, and cements—and their proportioning to produce concrete mixtures of the desired strength and workability; he dealt also with the testing of concrete both as laboratory specimens and road slabs, the development of suitable joint filling and sealing compounds for concrete roads, and the study of the efficiency and mode of operation of concrete mixers, vibrating equipment and other forms of constructional plant. Both Mr. Maclean and Mr. Sparkes dealt with the Organisation's laboratory and field researches bearing on the problem of the 'design' of road pavements, that is, the determination of the minimum thickness of pavement required on a soil of known bearing-power to carry a given volume and weight of traffic.

As a problem of particular application to Scotland, Dr. Lee dealt with the carrying out of satisfactory surface-dressing work in inclement weather, describing the laboratory work on the adhesion of bituminous binders to roadstones in the presence of water, and the field studies on the determination of the correct rates of application of the binder and on the improvement of binder adhesion by the treatment of the stone. Other investigations dealt with more briefly were concerned with the study of binder oxidation and with the determination of the combination of the constituents—aggregate, sand, filler and binder—in a bituminous surfacing mixture to make the best use of locally occurring materials.

In the discussion, Mr. Burnett, the Ministry of Transport divisional road engineer for Scotland, and Mr. Barry, county surveyor of Ayrshire, laid stress on the importance of studying problems arising in the construction of roads on peat, Mr. Burnett being also interested in the possibility of soil stabilization in the construction of roads in the Highlands. Mr. Robertson, county surveyor of Dumfriesshire, felt that most Scottish problems were the same as for the rest of the country, but desired more information on typical Scottish soils; he supported Dr. Lee in favouring tank spraying of the binder in surface dressing, but wanted smaller units with better manœuvrability for Scottish conditions. Mr. Murray, county surveyor of Wigtownshire, pointed out that more local authorities owned their own quarries and plant and used direct labour in Scotland than in England, and he felt that researches on plant would be useful.

In opening the afternoon session, which was devoted to road safety and traffic flow, Sir Patrick Dollan quoted figures showing the serious nature of road accidents and welcomed the present attack upon this problem by the Road Research Organisation. Dr. Glanville explained that whereas the Materials Group had been in being more than fifteen years, road safety research was quite a new venture; much of the subject was complicated and statistical in character, and the great need was for facts instead of opinions. The laboratory at East Kilbride would at first add to the information obtained by the parent laboratory but would deal with problems peculiar to Scotland as they emerged.

The three papers at the afternoon session dealt with road layout-and-traffic problems, with vehicles and skidding, and with statistical aspects; they were given respectively by Dr. R. J. Smeed, deputy director (Road Safety), Mr. G. Grime and Dr. F. Garwood. Dr. Smeed pointed out that a proper understanding of road safety must necessarily involve a detailed study of traffic behaviour in relation to road layout. He described the various forms of traffic counter and vehicle-speed measuring device the Laboratory was developing, and summarized some of the results obtained by parties of observers working in and near London. As a smaller investigation which had already yielded results of practical value, he instanced the work with models on pedestrian crossings; this had shown the superiority of longitudinal alternate black and white stripes 1 ft. in width over various other ways of marking the road surface.

In discussing vehicles, Mr. Grime dealt in detail with the problem of dazzle in night-driving as a major cause of accidents: field investigations had shown that low-mounted pass lamps could illuminate an adequate length of road only if they were tilted upwards in such a way as to cause dazzle to oncoming drivers. As a consequence of a survey conducted by the Laboratory with the help of police authorities, new regulations dealing with the mounting of pass lamps would be introduced by the Ministry of Transport next year. In dealing with skidding, Mr. Grime described the apparatus and method used for making routine road tests for local authorities, and summarized briefly the more fundamental work being carried out on the mechanism of skidding and on the influence of road slipperiness on road accidents.

Dr. Garwood dealt largely with methods proposed for studying the statistics of personal injury accidents to be supplied by the police according to the scheme outlined in the final report of the Ministry of Transport's Road Safety Committee. He appealed to local authorities for their co-operation in obtaining additional statistical material.

In the discussion, Mr. Bruce, city engineer of Glasgow, suggested that parked vehicles were often a contributory cause of accidents. Mr. Whyte, of Stirling Highways Committee, suggested that figures might show that certain types of bus were more accident-prone than others, due to causes inherent in the design. Dr. Fiddes, of the Department of Forensic Medicine, University of Edinburgh, stressed the importance of the personal factor in accidents, and felt that an inquiry would be useful into the value of various types of propaganda.

At the conclusion of the conference, the members inspected the exhibition of work in progress at the Road Research Laboratory. The impression left by the proceedings was that a useful step had been taken towards an objective which is regarded as a vital one in all branches of industry at the present time, and which was stated by Sir Henry Tizard at the British Association meeting at Brighton as being that of "applying what is already known". It was evident also that the characteristics of soil and climate peculiar to Scotland would provide many interesting problems for the Scottish branch of the Laboratory.

RADIOACTIVE AND STABLE ISOTOPES FOR RESEARCH PURPOSES

AFTER the announcement of the starting up in August 1947 of the British low-energy pile, known as G.L.E.E.P., at the Atomic Energy Research Establishment at Harwell, numerous inquiries were received regarding the availability of radioactive isotopes for research purposes. The Ministry of Supply has now issued a statement showing the present position, both with regard to radioactive isotopes already produced at Harwell or now available in Great Britain from American sources, and also with regard to separated stable isotopes and mass-spectrometer facilities at present available for research purposes in Great Britain.

Production of Radioactive Isotopes at Harwell. Radioactive isotopes have now been produced at Harwell for some months in the low-power pile in order to provide for the immediate needs of research workers in science and industry. The average number of samples of radioactive material made in the last few months has been about 120 per month, of which about two-thirds have been for users outside the Establishment, and the production from the small pile is now nearing its maximum.

The slow neutron flux available in the pile for isotope production is of the order of 10^{10} neutrons/sq. cm./sec., and the pile is run continuously at high power for about sixty hours each week. Standard irradiations are made in the core of the pile, where there is a mixture of fast and slow neutrons. The thermal column is also available and provides nearly pure thermal-neutron fluxes of about 10^7–10^8 neutrons/sq. cm./sec., with some gamma background. The specific activities of isotopes produced by (n, γ) reactions can be calculated approximately from the published tables of activation cross-sections[1]. At the present early stage, it is not possible, however, to guarantee the exact specific activity of any individual sample irradiated, since the neutron flux varies considerably according to the position of the sample in the pile during irradiation.

As an example of the specific activities attained, samples of sodium-24, potassium-42 and bromine-82 have been prepared having specific activities of the order of 2·0, 0·3 and 2·5 mc. per gm. of element. These isotopes have up to the present been the most useful to biological workers in Great Britain, particularly since the short half-lives preclude their import from the United States. A much greater variety of elements has been irradiated for physicists and chemists. Isotopes resulting from (n, p) reactions or from β-decay chains, particularly phosphorus-32 and iodine-131, are also prepared in small quantities, either carrier-free or with high specific activities. At present, however, the demand for these separated isotopes far exceeds the supply.

In order to make the best use of the limited slow-neutron fluxes in this low-power pile, users are encouraged to have preliminary discussions of any unusual problem with the Isotope Information Office at Harwell. All allocations of radioactive isotopes are made subject to the approval of the Isotope Allocation Committee (see below).

For irradiations of any material in the low-power pile, a standard handling charge of £3 3*s*. (or £2 2*s*. for repeat orders) is made for each four-week period or part thereof, and there is no charge based upon activity. For separated isotopes, which are nearly carrier-free, it has been found convenient to fix charges equivalent to those made for the same material by the United States Atomic Energy Commission, except that when the quantity available is limited some reduction of the handling charge is made.

When the larger pile at Harwell begins to operate at full power, ten to twenty times higher neutron fluxes will be available, and the conditions in the pile will be such that the specifications of the materials available will be very similar to those published by the U.S. Atomic Energy Commission[2]. It is expected that the quantities of isotopes produced will be sufficient to meet all expected demands for scientific, industrial and medical purposes in Great Britain.

Some radioactive isotopes, particularly when they are short-lived, will be distributed directly from the Establishment at Harwell. Where, however, production involves chemical extraction or where subsequent processing or synthetic work is necessary, the processing, packaging and distribution will ultimately be undertaken by the Ministry of Supply Radiochemical Centre at Amersham; a statement on the services to be provided by the Radiochemical Centre in the distribution of both natural and artificial radioactive substances will be issued in the near future.

Facilities for Neutron Irradiations at Harwell. It is possible to irradiate small quantities of material in the pile, including some biological materials. Particulars of the neutron flux available and other relevant details are given above. These irradiations are usually carried out along with the preparation of isotopes.

Availability of Radioactive Isotopes from the United States and Canada. The U.S. Atomic Energy Commission announced in September 1947 that radioactive isotopes were being made available for medical, biological and scientific research purposes in foreign countries. Arrangements were accordingly made by the British Government under which the Ministry of Supply is able to purchase certain isotopes to supplement those being produced at Harwell. Small quantities may also be purchased from the Canadian National Research Council.

In order to comply with Treasury requirements on expenditure of dollars and with the arrangements made with the American authorities, requests for these isotopes must be sponsored by an appropriate authority: for medical and biological research, and for therapeutic uses, the Medical Research Council (inquiries to the Secretary, Medical Research Council, 38 Old Queen Street, S.W.1); for agricultural and veterinary research purposes, the Agricultural Research Council (inquiries to Mr. W. G. Alexander, 6a Dean's Yard, Westminster, S.W.1); for research in other branches of science, and for industrial research, the Department of Scientific and Industrial Research (inquiries to the Secretary of the Department, 24 Rutland Gate, S.W.7). A number of consignments of isotopes have been received under this arrangement, mostly for medical research purposes.

Availability of Stable Isotopes. Following discussions last year between the Department of Scientific and Industrial Research, the Medical and Agricultural Research Councils and the Ministry of Supply, the Ministry purchased from the Eastman Kodak Co. at Rochester, N.Y., a quantity of the N^{15} isotope of nitrogen at 200 dollars per gram of N^{15} at a concentration of 30 per cent in the ammonium radical of ammonium nitrate. Part of the material obtained has already been allocated to the Medical Research Council and also to one or two investigators sponsored by the Department of Scientific and Industrial Research. The remaining material, amounting to several grams of N^{15}, is at present held at the Atomic Energy Research Establishment and can be made available for research workers whose research is sponsored by the appropriate body referred to above. A few grams of enriched C^{13}, in concentration ranging up to 50 per cent, has also been purchased from the United States for medical research purposes in Great Britain.

With regard to production in Britain, it is understood that commercial production of enriched N^{15} is being undertaken by Genatosan, Ltd., at Loughborough, and that the firm will offer this isotope for sale generally. A plant for the production of enriched C^{13} by the use of the distillation-exchange process using liquified carbon monoxide is nearing completion at Harwell. This is expected to meet British requirements for some time to come. In addition, a thermal diffusion plant capable of enriching the O^{18} isotope of oxygen by a factor of 100 is nearing completion, and it is expected that quantities of this material will become available at Harwell in about three months time.

Electromagnetic separation equipment is also being built at Harwell for the production of small quantities of many other separated isotopes for research purposes. Isotopes of the very high purity attained are essential for many research purposes in nuclear physics.

Mass Spectrometer Facilities. One of the difficulties attending the use of stable isotopes at present in Great Britain is the lack of facilities for assay; and until the position is relieved by the construction of further mass spectrometers, full use should be made of the instruments which are available. The Medical Research Council has two instruments operating at the National Institute for Medical Research, Hampstead, and is prepared to do assay work and to advise in the preparation of samples from biological material. The Atomic Energy Research Establishment is also prepared to do a limited amount of assay work on gas samples prepared in standard 'break-seal' tubes obtainable from the Establishment.

Allocation of Isotopes among the various Users. In order to allocate the available isotopes among the users in various fields of research, an Isotope Allocation Committee has been set up, under the chairmanship of Sir John Cockcroft. The membership of the committee includes representatives of the Medical Research Council, the Agricultural Research Council and the Department of Scientific and Industrial Research, the latter representing universities and industrial interests. This Committee will decide questions of allocation of isotopes in short supply, taking into account the urgency of the investigation in question and the facilities available for its conduct. It will be necessary for this Committee to be satisfied that adequate precautions are being taken in the handling and disposal of radioactive materials.

This Committee will also decide on priorities and allocation of stable isotopes produced at Harwell while these are in short supply.

Fuller information about facilities at present available can be obtained from the Isotope Information Office, Atomic Energy Research Establishment, Harwell, Nr. Didcot, Berkshire.

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[1] Seren, Friedlander and Turkel, *Phys. Rev.*, **72** (10), 888 (Nov. 1947).

[2] See *Rev. Sci. Instr.*, **17** (9), 348 (Sept. 1946); also "Radioisotopes for International Distribution—Catalogue and Price List, Sept. 1947"—Isotope Branch, U.S. Atomic Energy Commission, P.O Box E, Oakridge, Tennessee.

UNESCO AND A WORLD SOCIETY

THE United Nations Educational, Scientific and Cultural Organisation was created on November 16, 1945, and now, nearly three years later, comes a Ministry of Education pamphlet reporting on its progress*. In its constitution the purpose of the Organisation was declared to be "advancing through the educational and scientific and cultural relations of the peoples of the world the objective of peace and of the common welfare of mankind for which the United Nations was established and which its charter proclaims".

Since its inception, the Organisation has been attacked because it has failed to stir the imagination of the people and, in consequence, remained quite unknown to the vast majority. These are criticisms which the Unesco secretariat admits, but insists that they were inevitable during the preparatory stages of the Organisation. For three years the policy has been to build a solid foundation, and the officials have deliberately eschewed the kind of publicity which would make the Organisation appear to be a patent medicine or a political stunt. Now they believe the preparatory work has been done and the time has come to arouse public interest in an agreed programme. The demand for information is rapidly increasing, and the present pamphlet is the beginnings of a campaign in which, by means of literature and speakers, it is hoped to make Unesco a living force and a household name in Britain.

With this pamphlet at least the campaign for popular sympathy and collaboration has made a good start. The origins of Unesco are placed in historical perspective, with the theme emerging that "we are now in process of becoming members of a world society conscious of the singleness of man and of the universe". Nor does this high-sounding phrase mean that the Organisation is dominated by any spirit of complacency. It is frankly recognized that it may not achieve its declared purpose, but it will still have made an effective contribution to the growth of a world society as the successor to the International Institute for Intellectual Co-operation and, more immediately, the Conference of Allied Ministers of Education.

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* Ministry of Education Pamphlet No. 12: UNESCO and a World Society. Pp. 46. (London: H.M. Stationery Office, 1948.) 1*s.* net.

"UNESCO and a World Society" shows how the Organisation is constituted, the function of its subdivisions and the range of its activities. All this is clearly set out, as is also the controversy between those who believed that the Organisation should be limited and concentrated for the intellectual few, and those who declared that to help the minority is not the way to save peace and that the Organisation is not for the pedants but for the people. The design of the Organisation shows how these differing opinions have been fairly reconciled.

Unesco has also been criticized for arranging meetings between men of science to discuss 'obscure' topics on the grounds that the sole purpose of the Organisation is to contribute to peace and security; the critics assert that the Organisation should undertake nothing that cannot be demonstrated on the blackboard to contribute directly to peace. Its position is defended in "the belief that everything contributing effectively to human sympathy through intellectual and spiritual forces is U.N.E.S.C.O.'s business". This being the case, one is tempted to ask why the Organisation has not concerned itself with those sports organisations which have already done so much to bring people of different countries together. Through the Anglo-Netherlands Sports Association, for example, contests of all kinds take place throughout the year between representatives of towns like Sheffield and Nijmegen, Hull and Rotterdam, and Rotherham and Amersfoort. During the interchanges much is done, both officially and unofficially, to give the guests a real impression of the educational, industrial, social, economic and civic life of the town they are visiting. Here is a popular educational movement of peoples which is directly contributing to understanding and which Unesco might develop for its own sake. More interest, too, might be shown in the rapidly developing schemes for the exchange of employees between industrial organisations like the members of the British Iron and Steel Federation and similar industries overseas.

The rest of the pamphlet contains details of the various committees, of work already accomplished by the Organisation and a summary of its immediate programme for Britain. It is a record of increasing activity which needs to be more widely known, and shows that the present publicity campaign will not have begun too early. T. H. HAWKINS

ANNUAL EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY

THE ninety-third Annual Exhibition of the Royal Photographic Society is again being held in two parts. The second part, which contains the scientific exhibits, opened on October 9 at the Society's House, 16 Prince's Gate, S.W.7, and closed on October 30. The whole exhibition will be shown at the Museums and Art Gallery, New Walk, Leicester, during the period November 6–December 5.

The section on Nature photography again contains many high-speed flash photographs, taken both by day and by night. The value of the method in studying fast movements is well shown by photographs of birds in flight and of the tongue action of toads and chameleons. It can also result in pictures displaying surprisingly beautiful designs. There is a photograph, of a robin alighting on a twig, in which the individual wing feathers are spread fanwise in a manner that could not be seen in any other way. (This photograph, with many others from the Exhibition, is reproduced in "The Year's Photography", the September issue of the *Photographic Journal*.) Of special interest are the several instructive series showing the life-histories of various creatures and plants. These are all well annotated; but the descriptions of the life and habits of the Natal *Peripatus* and of the one-day life of the stinkhorn deserve special mention. It is remarkable how much the presence of a caption, even on an individual picture, increases the interest. There is a picture of a young grey seal among many other equally superb pictures which remains in the writer's memory simply because it is the one with a short descriptive caption.

Many of the scientific photographs are liberally provided with descriptive matter, but there are woeful exceptions. Among these are a pair of excellent photomicrographs of the living spermatozoa of a mouse, one taken with phase contrast and the other by ultra-violet light. Others in the same series show the chromosomes in bean-root cells at different stages in mitosis. These are presumably phase-contrast pictures; but it is not clear in the catalogue, and only the catalogue numbers appear on the exhibits. Another pair of pictures illustrates normal and pathological nerve cells (according to the catalogue), but there is no indication of which is which. Information is also entirely lacking in several pictures labelled "Molecular Design". The writer presumes that these were intended for the pictorial part of the Exhibition—they have no scientific implication as shown.

There is an excellent series comparing results obtained with different kinds of microscope—normal optical, phase-contrast, interference and electron. Another exhibit describes a method of recording the colour aberrations of high-power objectives. A straight-line object illuminated by mercury–cadmium light produces an elongated line spectrum on the photographic plate by means of a grating and prism placed behind the eyepiece. The line object is tilted at a small angle to the normal object plane, so that the position of sharp focus of the spectrum lines of different wave-length varies according to the chromatic aberrations of the system.

Two exhibits illustrate a new method of micro-radiography applied to the investigation of complex alloyed steels. Variations in composition give rise to a fine banded structure, and the identification of the elements responsible is possible by selection of the exposing radiation. Another series, illustrating a technique for resolution testing in autoradiography, demonstrates the possibilities of the autoradiography of plant or animal tissue containing radioactive tracers. Pinhole radiographs of the internal surface of the copper anode of a magnetron enables the distribution, direction and speed of the bombarding electrons, about which little is known in detail, to be determined (see *Nature*, **161**, 244; Feb. 14, 1948).

Nuclear plate photographs illustrate the natural disintegration of radium and radiothorium, a meson track 400 μ long and the effects of selective development on nuclear tracks. Lowering the *p*H of the developer reduces the background relative to the tracks, and addition of bromide restrains the development of alpha tracks before affecting fission tracks.

Among the exhibits deserving special mention is one of lightning flashes taken during a thunderstorm. Owing to the Clayden effect, a flash occurring at the beginning of the exposure appears as a black line on a grey background, while one occurring at the end of the exposure is white. Some high-speed oscillograms demonstrate that it is now possible to record photographically traces made at a writing speed no less than four per cent of the speed of light. There are also some fine cloud studies and a number of large-scale photographs of geological formations taken from the air.

Some of the exhibits are also reproduced as lantern slides, which provide an interesting comparison with the prints. Unfortunately, they are on different floors. The lantern slides also include some beautiful colour transparencies of crystals in polarized light and of photo-elastic stress patterns of loaded beams and other structures.

The medical photographs are not numerous, which is perhaps just as well for the visitor's peace of mind in view of the extreme degree of clarity achieved in the reproduction of detail.

PHYSICAL CHEMISTRY IN PHARMACY

At the British Pharmaceutical Conference held at Brighton in August, the chairman, Dr. N. Evers, gave an address entitled "The Importance of Physical Chemistry in Pharmacy". He claimed that the importance of this aspect of pharmacy has not been sufficiently appreciated in the past and that the pharmacist requires a wide knowledge of physical and chemical properties of materials. Dr. Evers said the pharmaceutical industry is probably concerned with a wider range of materials than any other, even including the food industry; and that the most important asset which the pharmacist possesses as a result of his training and experience is his familiarity with the properties of materials and his knowledge of their behaviour over a range of different circumstances.

In recent years an ever-widening range of new materials has been offered for the use of the pharmacist by the synthetic chemist; substances which, if used with knowledge and skill, can be made to produce almost any desired properties in the product. In order to make the most effective use of these substances, the pharmacist requires a knowledge of the relevant physical chemistry. It should not be necessary to rely on the manufacturer of such products for suggesting suitable formulæ, because only the user is in a position to know exactly what he requires of his product. It is all the more desirable, therefore, that he should possess the knowledge of physical chemistry which will enable him to produce new preparations by the use of such substances, either for the presentation of new drugs or for new methods of presenting old ones.

Applications of Physical Chemistry

Without introducing examples which are recondite or unusual, any attempt to make a list of physico-chemical phenomena which are encountered by the pharmacist could not fail to include the following items:

Solubility
Ionization
Hydrogen ion concentration
Buffer action
Mass action and reaction velocity
Osmotic pressure
Dialysis
Surface tension
Emulsification
Vapour pressure
Diffusion
Colloids
Adsorption
Ion exchange
Chromatography
Rheology
Viscosity
Thixotropy
Properties of gels and mucilages
Properties of suspensions
Aerosols
Melting and solidification
Surface properties of powders
Electrolysis
Electrophoresis
Radioactivity
Photochemistry

This list does not include the applications of physical chemistry in analytical chemistry, but only phenomena which may be encountered in pharmaceutics.

Large-scale manufacturing pharmacy employs many physico-chemical processes such as evaporation, distillation and drying. The design of plant for such processes involves problems which can safely be left to the chemical engineer; but the pharmacist who uses the products must have a sufficient knowledge of the underlying principles of the processes used to enable him to make a choice of the most suitable method from the point of view of both the effect on the product and of cost. For example, in a new process of drying, such as freeze-drying, there may be no previous experience to guide him, and each problem requires its own solution to be worked out from physico-chemical considerations.

The use of adsorbents in the pharmaceutical industry seems to provide endless problems for research. The purification of active principles by adsorption is not a process which has been much developed. It was used in the carbon adsorption process for penicillin, where incidentally it was found that comparatively few types of carbon were really effective adsorbents. Carbon has been used for the adsorption of pyrogens and 'Permutit' for the removal of traces of adrenalin from cortical extracts. Possibly the new base-exchange resins may have some uses in this type of work. They have been used, for example, for the conversion of calcium penicillin to sodium penicillin. Chromatographic separation is not particularly suitable for large-scale work, and probably has its chief uses in the research laboratory and in the purification of highly active substances which are only produced in small quantities.

The sterile filtration of injections bristles with physico-chemical problems mainly connected with the adsorption of active principles by the filtering medium. Even sintered glass is not entirely guiltless in this respect, and there are instances where no method of sterile filtration can be used without loss of potency. There seems no doubt that in some cases the filtering medium exerts a chromatographic effect, and that an initial adsorption may occur which is afterwards washed out.

Rheology

The science of rheology is defined by its chief exponent, Dr. G. W. Scott Blair, as concerned with the "deformation and flow of matter". The two lectures given by Dr. Scott Blair recently to the Pharmaceutical Society gave an indication of the scope of rheology and its importance in pharmacy. It is concerned with the properties of solids and liquids such as viscosity, surface tension, thixotropy, elasticity, hardness or softness, and those vague attributes which we know as 'consistency', 'firmness', 'springiness', 'toughness', 'tackiness', 'body' and other such terms. Many of these properties are not measurable in a quantitative manner, and the human thumb is the most valuable piece of apparatus available for assessing them. The formulation of a product of the desired rheological properties is therefore largely a matter of experience. Nevertheless, these vague rheological properties are produced by a combination of well-known physical properties, and a man with a knowledge of the physical chemistry involved is definitely at an advantage.

Physical chemistry is not easy to make attractive. It is not so teachable as organic chemistry. It requires a knowledge of mathematics, which is repugnant to many minds, or, because of a lack of early training in mathematics, the student cannot appreciate what he is taught. Is the lack of interest in physical chemistry due to the fact that pharmaceutical students do not appreciate its importance in their work ? Are the courses often merely general courses in the subject, in which no attempt is made to adapt them for pharmaceutical students or to bring home the applications of what they are taught to the practice of pharmacy ? Presumably the text-books used are well-known general text-books on the subject, in which pharmaceutical applications are not considered. Surely what is needed is for some genius to arise who will produce a classical text-book of physical chemistry for pharmaceutical students. No student should be taught applied physical chemistry before he learns the fundamentals of the subject, but physical chemistry should be taught to students of pharmacy in the same way as organic chemistry is taught, with a bias towards medicinal compounds.

ARTIFICIAL HUMAN INSEMINATION*

THIS is a disappointing document. The Commission was asked "to consider the practice of human artificial insemination with special reference to its theological, moral, social, psychological and legal implications". But the Archbishop in his preface states that it is not to be taken as a "Church document", though he does not explain what exactly such a document is.

The two sections on the psychological and sociological aspects of the problem are admittedly based upon surmise, for there is no evidence on the subject available either in Great Britain or the United States, and for this reason it might have been well to omit them altogether ; as it is, very little weight can be attached to them.

The real importance of the report lies in two sections : one on the legal aspects, and the other on the theological principles. Both are able and clear, and obviously much thought has been given to them. It is, however, surprising that the religious statement comes at the end. One would have expected it at the beginning, where it should have constituted the major part of the report. For it is in this section that the Christian will look for an authoritative statement and for guidance, and it is here that a Committee appointed by the Archbishop of Canterbury is best qualified to speak. It will no doubt be accepted as the Church's view on the subject for many years to come, and for this reason alone could well have been expanded. Here the question arises : Why does the Archbishop state that it is not to be considered as a "Church document" ? Would it not have been better if this section of the report, at any rate, had been drafted in such a way that it could have been taken as such ? If there had been any chance of the Church as a whole not accepting it, or of its altering its views, then it would certainly have been better for the report not to have made the definite recommendation that steps should be taken "to frame legislation to make the practice [of artificial insemination—donor] a criminal offence" but to have withheld judgment on this point for a little longer. It does not seem possible to have it both ways, for when a committee appointed by the Archbishop advises that a certain practice be made a criminal offence, then such a recommendation, to carry weight, should bear with it the full authority of the Chair of St. Augustine.

The lawyers have produced much the most vigorous section in the report, condemning artificial insemination from the donor as adultery, and from them comes the first suggestion that it be made a criminal offence. They admit, however, that the questions which the practice raises have not yet come before the English courts, and so far as English law is concerned they are only able to quote a speech of Lord Dunedin in the House of Lords, concerning Russell *v.* Russell, 1924 : "and fecundation *ab extra* is, I doubt not, adultery——". They quote, however, a Canadian case, Orford *v.* Orford, which occurred as far back as 1924, and in which a wife alleged that she had been artificially inseminated without her husband's knowledge ; but they omit to mention that no practitioner either here or in Canada or the United States would countenance such procedure, the consent of both partners being a fundamental requirement.

Since the publication of the report there has, however, been a case in the Supreme Court of New York State which has a direct bearing on the problem. In it the judge, Mr. Justice Greenberg, was asked to declare that a child whose mother had been artificially inseminated with the husband's consent was illegitimate. This he refused to do, saying that it would be "inhuman, inhumane and contrary to the highest concepts of sociology[1]. Further, he declared the child to be legitimate and the husband to be the legal father."

The question of the artificial insemination of unmarried women is raised, but it is very difficult to believe that the Commission had any evidence that it has been practised in Britain, for all responsible opinion is against it. Another point that might in fairness have been stated clearly is that the child of a married woman is presumed to be legitimate unless proved to be otherwise ; a very difficult proof to produce, and the lack of which would make it impossible to enforce any law against donor insemination, when it has been performed with the husband's consent, unless, of course, the medical practitioner who performed the insemination himself gave information, thereby laying himself open, as the lawyers suggest, to a charge of criminal conspiracy, which is indeed unlikely to happen. This again raises the question whether such law would have the backing necessary from the public to make it effective.

The legal section is in strong contrast with the rest of the report, where obvious efforts have been made to keep a balanced and charitable judgment. This is a pity, because unless the practice is made illegal—and it is very doubtful if this will be done—artificial insemination is likely to continue on the very small scale that it has in the past; in which case the law should be amended and added to in order to safeguard the interests of the small number of parents, medical men and children involved, where these are threatened. There would seem, too, to be a parallel here with the law regarding abortion. This is illegal except where the mother's health is endangered. Would it not be possible that artificial insemination—donor might be made illegal, too, except on the same grounds?

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* A Report of a Commission appointed by His Grace the Archbishop of Canterbury. (S.P.C.K.) 2*s.* 6*d.* net.

The findings of the Commission are that "assisted insemination" between husband and wife may be justified and, with one dissentient, that artificial insemination—husband may also be justified; but that artificial insemination—donor is wrong in principle and contrary to Christian standards. It is further recommended that "early consideration should be given to framing of legislation to make the practice a criminal offence".

It is pleasant to turn to the minority report by Dr. W. R. Matthews, the Dean of St. Paul's, who did not feel that he could sign the report. While everyone may not be in complete agreement with his views, all can admire the spirit which inspires them. He admits that he, like almost every normal person, finds the subject repugnant; but he does not, therefore, think that this necessarily makes it wrong. He says of the Commission: "We should have done better if we had been content to state what we believe to be the proper attitude of Christians to A.I.D. in the present circumstances, while reserving the question of its absolute condemnation in all circumstances to further study"—an opinion which many puzzled people of goodwill are likely to endorse.

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[1] *Lancet*, 463 (Sept. 18, 1948).

THE JOHN INNES HORTICULTURAL INSTITUTION

THE John Innes Horticultural Institution is perhaps best known in the scientific world for its great part in genetical work, under its three successive directors, Bateson, Hall and Darlington. While its contributions to science in the field of cytogenetics have been so outstanding, sight must not be lost of the more directly horticultural research in the applied sphere which has steadily progressed at the Institution and which has resulted in advances of knowledge no whit less important. Throughout, the work has been a model of what applied research should be, the scientific approach to the problems of the practical grower. The work of M. B. Crane on compatibility and incompatibility in fruits illustrates this conception of applied research in a striking manner; not only does it constitute an outstanding advance in scientific knowledge, but also it is the foundation of all modern systems of orchard planning. His "Fertility Rules in Fruit Planning" (Leaflet No. 4 of the new collected edition of the John Innes Leaflets*) is the *vade mecum* of all growers laying out new plantations.

No less important to the horticulturist is the work of W. J. C. Lawrence on the preparation of soil composts for glasshouse plants. The aim throughout the work has been the standardization of materials and methods so that growers anywhere may rely upon reproducible results of proved excellence. It is a further and a large step in the direction of what is, after all, the goal of every grower—complete control over every phase of a plant's growth to the greater benefit of man's nutritional and æsthetic needs. Those who cavil at new scientific ideas as 'interference with Nature' should pause for a moment to consider how every operation the gardener undertakes is 'interfering' with 'natural' processes.

In this collected edition of leaflets, prepared, as the preface states, "in order to put the grower, the gardener, and the seedsman into touch with the latest results of research", a new leaflet on seed production has been added. This is of first importance to the horticulturist because it summarizes information which is difficult to find in print elsewhere. The classification of field and garden crops by degrees of cross-pollination, the methods of isolation by time and distance, and the distinction between the needs of commercial and stock seed are vitally important to all who embark upon the difficult work of seed growing.

The John Innes Institution has done great work for the horticulturist, and when it has settled into its new home at Bayfordbury, with the enormously greater potential facilities it will have, we may look forward to a new series of these practical, yet wholly scientific, leaflets.

R. H. STOUGHTON

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* The Fruit and the Soil: Collected Edition of the John Innes Leaflets. Edited by C. D. Darlington. Pp. viii+62. (London: Oliver and Boyd, 1948.) 3*s*. 6*d*. net.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 15

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. L. Rosenfeld: "Conceptions of Force in Physics" (Wilde Memorial Lecture).*

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "What Fundamental Principles should be Illustrated in Electrical Engineering Courses, and at what Stage should they be Introduced?" (to be opened by Prof. J. T. MacGregor-Morris).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Capt. D. P. Mason: "New Discoveries in British Antarctica".

Tuesday, November 16

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. S. J. F. Philpott: "Psychology as a Science", I.* (Second Lecture will be given on Thursday, November 18.)

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Basil F. J. Schonland, F.R.S.: "Recent Scientific Developments in South Africa".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. A. Muir: "Soil Survey and Soil Classification".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. S. F. Birch: "Recent Advances in the Chemistry of Hydrocarbons". (Further Lectures on Tuesdays, November 23, 30 and December 7.)

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Measurement of Telecommunications Efficiency" (to be opened by Mr. W. West).

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. J. Kendall, F.R.S.: "Leo Hendrik Baekeland and the Development of Phenolic Plastics" (Baekeland Memorial Lecture).

INSTITUTION OF THE RUBBER INDUSTRY (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Dr. W. D. Rae: "Dielectric Heating of Rubber".

ROYAL STATISTICAL SOCIETY, TEES-SIDE SUB-GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the Cleveland Scientific Institution, Middlesbrough), at 7.15 p.m.—Mr. L. T. Wilkins: "Incentives and the Young Worker". (To be repeated on Wednesday, November 17, at 6.30 p.m., at the Newcastle Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne.)

Wednesday, November 17

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at Radiant House, Bold Street, Liverpool), at 2.30 p.m.—Mr. S. N. Duguid: "The Fight for Fuel Efficiency". (To be repeated on Wednesday, December 8, at the Engineers' Club, Albert Square, Manchester, at 6.30 p.m.)

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. F. H. Ludlam: "The Physics of Clouds".

ROYAL MICROSCOPICAL SOCIETY (at B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. A. F. W. Hughes: "The R.M.S. Film Library".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Scientific Man-Power" (to be opened by Dr. C. P. Snow and Mr. P. H. Brind).

Thursday, November 18

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting to consider the Annual Report of Council; Mr. H. R. Marston: "The Scope and Activities of the Nutrition Laboratories of the Australian Council for Scientific and Industrial Research, Adelaide".

LONDON MATHEMATICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting; Dr. R. Rado: "Quantitative Covering Theorems".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. E. K. Rideal, F.R.S.: "Selected Topics in Colloids". (Further Lectures on November 25, December 2 and 9.)

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. C. W. Phillips: "The Excavation of the Sutton Hoo Ship Burial".*

BRITISH INSTITUTION OF RADIO ENGINEERS. LONDON SECTION (at the London School of Hygiene, Keppel Street, London, W.C.1), at 6 p.m.—Mr. D. H. Hughes: "V.H.F. Radio Equipment for Mobile Services".

CHEMICAL SOCIETY, SOUTH WALES BRANCH (in University College, Cardiff), at 7 p.m.—Prof. Wilson Baker, F.R.S.: "The Chemistry of Penicillin".

TEXTILE INSTITUTE, BELFAST SECTION (at Queen's University, Belfast), at 7.30 p.m.—Dr. R. H. Sloane: "The Electron Microscope".

UNIVERSITY OF LONDON (at Wye College, Wye, Kent).—Mr. R. L. Wain: "The Chemist and Problems in Plant Protection".*

Friday, November 19

INSTITUTION OF CHEMICAL ENGINEERS (in the English Theatre, the University, Edmund Street, Birmingham), at 4.30 p.m.—Prof. F. H. Garner: "Extractive Distillation".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Dr. G. N. Harvey: "Magnetic Compass Problems, a Fresh Approach".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. K. Baumann: "Heat Engines" (Thomas Hawksley Lecture).

ROYAL INSTITUTE OF CHEMISTRY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. J. C. Earl: "Some Experimental Studies in the Chemistry of Nitrogen Compounds" (Streatfeild Memorial Lecture).

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER SECTION (at the Midland Hotel, Manchester), at 6.30 p.m.—Dr. E. Krahenbuhl: "New Principles in the Continuous Dyeing of Wool".

PLASTICS INSTITUTE (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. A. A. K. Whitehouse: "Polystyrene".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. A. B. D. Cassie: "Physics in the Wool Industry".

SOCIETY OF INSTRUMENT TECHNOLOGY, MIDLAND SECTION (at the Arden Hotel, New Street, Birmingham), at 7 p.m.—Mr. Eric E. Hancox: "Thermocouples".

SOCIETY OF GLASS TECHNOLOGY, NORTH-WEST SECTION (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Prof. W. E. S. Turner, F.R.S.: "The Fundamental Basis of Glass Smelting".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. F. E. Simon, F.R.S.: "Power Sources and Power Utilization".

Thursday, November 18—Friday, November 19

SCIENTIFIC INSTRUMENT MANUFACTURERS' ASSOCIATION (at Caxton Hall, Westminster, London, S.W.1).—Symposium on "The Applications of Electronics to Research and Industry".

Saturday, November 20

ROYAL AERONAUTICAL SOCIETY (joint meeting with the HELICOPTER ASSOCIATION, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Helicopters".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Dr. E. Ashworth Underwood: "Artists, Anatomists and Anatomical Illustration".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

VETERINARY SURGEONS (6), and a FIELD and RESEARCH OFFICER, in the Department of Veterinary Services, Southern Rhodesia—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (November 19).

LECTURER (Grade I) IN ELECTRICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 1 (November 20).

MECHANICAL ENGINEERS (3, Senior Principal Scientific Officer Grade) in the Royal Naval Scientific Service, for (*a*) design and development of torpedoes, (*b*) design and development of fire control directors for H.M. ships, (*c*) for charge of the engineering division at H.M. Underwater Detection Establishment, Portland—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2305 (November 25).

PHYSICISTS (Senior Scientific Officer and Scientific Officer Grades) in Ministry of Supply Research and Development establishments in S.E. England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.365/48A (November 27).

INTERNATIONAL WOOL SECRETARIAT WOOL RESEARCH SCHOLARSHIPS—The Registrar, The University, Manchester 13 (November 30).

HAROLD JOHN COTES FELLOWSHIP IN PROTEIN ENZYMOLOGY—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (November 30).

LECTURER IN ZOOLOGY in connexion with teaching to veterinary students in the University of Glasgow and Glasgow Veterinary College—Mr. James Austin, County Buildings, 149 Ingram Street, Glasgow, C.1 (November 30).

AERODYNAMICISTS (Senior Scientific Officer and Scientific Officer grades) for Ministry of Supply posts in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.364/48A (November 30).

DIRECTOR OF RESEARCH—The British Gelatine and Glue Research Association, Sardinia House, 52 Lincoln's Inn Fields, London, W.C.2 (November 30).

LECTURESHIP IN VERTEBRATE ANATOMY in the Department of Zoology of University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (November 30).

LECTURER IN THE DEPARTMENT OF ANATOMY of the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 15).

READERSHIP IN PHYSIOLOGY at London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 16).

SENIOR LECTURER IN BIOCHEMISTRY in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 31).

TUCKER-PRICE SCIENTIFIC RESEARCH FELLOWSHIP for research in mathematics, science or an allied subject—The Secretary, Girton College, Cambridge (January 15).

HEADSHIP OF THE COLLEGE—The Clerk, National College of Rubbe Technology, Northern Polytechnic, Holloway Road, London, N.7.

TECHNICAL ASSISTANT (Development) in the Directorate of Ordnance Factories (Filling), under the Ministry of Supply—The Technica and Scientific Register (K), York House, Kingsway, London, W.C.2 quoting F.911/48A.

SENIOR EXPERIMENTAL OFFICER (Chemist, male) in the Plan and Animal Products Department for laboratory work in connexio with investigations of Empire raw materials of plant and anima origin—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

CHEMISTS (2, male) for works in a N.E. Scottish town, preferably with some experience in electro-chemical and physical chemistry—The Ministry of Labour and National Service (K), York House, Kingsway, London, W.C.2, quoting F.812/48A.

ORGANIC CHEMIST to take charge of a small group for fundamental work on the organic chemistry of cellulose—The Acting Secretary British Rayon Research Association, 58 Whitworth Street, Manchester 1.

ASSISTANT (with Inter.B.Sc. or equivalent) FOR ANALYTICA LABORATORY—The Assistant Secretary, British Coal Utilizatio Research Association, Randall Road, Leatherhead.

TECHNICIAN (Grade II) IN THE DEPARTMENT OF ANATOMY—Th Secretary, University College, Gower Street, London, W.C.1, quotin Anatomy/2.

GEOLOGIST IN THE DEPARTMENT OF WATER DEVELOPMENT, Tanganyika—The Director of Recruitment, Colonial Service, 2 Sanctuar Buildings, Great Smith Street, London, S.W.1.

CHEMISTS or ENGINEERS (2) as Experimental Officers in a Ministry of Supply Research and Development Establishment near London for work in connexion with the design and use of electronic and othe instruments required for the investigation of combustion and allie processes—The Technical and Scientific Register (K), York House Kingsway, London, W.C.2, quoting F.903/48A.

CHEMISTS (Senior Scientific Officer, Scientific Officer, Experimenta Officer and Assistant Experimental Officer grades) in Ministry o Supply Research and Development Establishments near Londo (majority of posts are in the physical and analytical fields)—Th Technical and Scientific Register (K), York House, Kingsway, Londo W.C.2, quoting F.900/48A.

CHIEF ANIMAL PHYSIOLOGIST, a BACTERIOLOGICAL CHEMIST, an an EXPERIMENTAL ENGINEER, in the Dairy Research Institute, Masse Agricultural College, Palmerston North, New Zealand—The Hig Commissioner for New Zealand, 415 Strand, London, W.C.2.

FARM MANAGER for the Headquarters Station of the East Afric Agriculture and Forestry Research Organisation, near Nairobi—Th Under-Secretary of State, Colonial Office (Research Department) Sanctuary Buildings, Great Smith Street, London, S.W.1.

SENIOR LECTURER IN CHEMISTRY—The Clerk to the Governors Chelsea Polytechnic, Manresa Road, London, S.W.3.

LECTURER IN CHEMISTRY to Intermediate B.Sc. stage—The Principal, Medway Technical College, Gardiner Street, Gillingham, Kent

ASSISTANT CONTROLLERS (Engineering) (Ref. No. 27323/8A), an ASSISTANT CONTROLLERS (Radio) (Ref. No. 27323/8), in the Department of Telecommunications, Federation of Malaya and Singapore—The Director of Recruitment, Colonial Service, Sanctuary Building Great Smith Street, London, S.W.1.

NATURE

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MATERIAL AND ETHICAL PROGRESS

THE need for restoring the balance between man's material and his spiritual advance has been a recurring theme in scientific discussion, and in the writings of such men as Louis Mumford and K. Mannheim, since the memorable presidential address given by General Smuts at the centenary meeting of the British Association. Papers contributed by Prof. B. Dobrée, and by Dr. D. M. Emmet, Prof. T. W. Manson and S. Hird at two discussion groups on "Science, the Universities and the Modern Crisis" arranged by the Manchester Literary and Philosophical Society in 1944–45 are specific examples of this trend of thought. More recently, Sir Henry Tizard struck the same note as a minor theme in his own presidential address at Brighton, and Lord Samuel's evening discourse on "Science and Philosophy" called imperatively to science to join philosophy and religion in promoting a synthesis which would be adequate to redeem this age from past calamities and rescue it from present dangers.

The approach to this problem of balance or of synthesis has been made from various sides: from that of education, as in the Manchester discussions; of philosophy, as with General Smuts and Lord Samuel; and of religion, as in an important section of the recent report of the Lambeth Conference. It has also been approached from that of human relationships. The importance of such relationships in industry and in the State give special interest to the study of the critical problems in human relationships to-day at the "Present Question Conference" held in Birmingham last year. The addresses and discussions at that Conference have recently been published*. They follow the discussion at an earlier conference of the question "Is the present chaos caused by lack of scientific planning or by failure to recognize the reality of spirit?" It is to be hoped that addresses and discussions at the Conference last August on the problem of leadership in a free society, which are in sequence with those contained in the present pamphlet, will likewise be available at an early date.

In introducing the three lectures, by Dr. J. H. Oldham, Mr. Herbert Read and Mr. G. W. Knight, which, with the subsequent discussions, comprise this pamphlet, the editor maintains that we are concerned less with a problem to be solved than with an idea to be experienced, and that the creative power in the soul of man which in a mechanical age makes it possible for him to become a person is the same principle that in earlier ages has given life and order to society. Dr. Oldham, pointing out that the answer to the question regarding human relations depends on one fundamental belief about the essential nature of man, proceeds to a penetrating analysis of the implications of a free and tolerant society and its maintenance in the face of threatened domination by impersonal forces and central direction by 'social engineers' or planners. In the modern period of history men have come more and more to think of themselves as individuals in a world which it is man's primary business to understand, explore and subordinate to his own purposes. We have now to ask whether this is the only attitude, or even the most important attitude, of man to his world.

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* Question: a Journal. Vol. 1, No. 1, July 1948. The Critical Problem in Human Relationships Today. By G. Wilson Knight, Herbert Read and Dr. J. H. Oldham. Pp. 87. (London: Hammond, Hammond and Co., Ltd.) 2*s*. 6*d*. net.

Dr. Oldham suggests that this is the point on which some of the most creative minds to-day are working; and he develops the conception of Martin Buber and Nikolai Berdyaev, implicit, perhaps, too in the writings of Jacques Maritain, that there is a fundamental difference in our relations to things and our relations to persons. He acknowledges the influence of the German philosopher Eberhard Grisebach on his thinking, and emphasizes the implications for social and political life of this truth: that man is fundamentally a person and that he finds his satisfaction and happiness, not in solitariness but only in a living relationship with other persons. The critical issue is whether our present preoccupation with things is to be made instrumental to the growth of true community, or whether we are going to be increasingly subject to the domination of things. Both individualism and collectivism are, in fact, a complete denial both of the person and of community.

The task of restoring the balance of human life, which is immensely complicated by the technical developments of our civilization, involves learning or re-learning personal relationships in the family, the neighbourhood and the workshop at the level of our own personal attitude or behaviour. Next, we have to develop ways in which, by the formation of human associations, persons educate and discipline themselves, through relations of mutual responsibility and mutual obligation towards one another. Only in these small groups are full and lasting relations between persons possible. In spite of Dubreuil's experiments, even in industry the implications of the Western Electric investigations associated with the name of Prof. Elton Mayo are not widely appreciated. The human problems of an industrial civilization are, as he pointed out in his last book, the key to industrial relations and to the development by man of the skill to live with his fellows as persons in genuine human relationship.

Beyond this we have to provide opportunities for people to learn in co-operation with others those wider aspects of citizenship which concern our general life. Here alone can we develop the real core of resistance to totalitarianism. The development of a hierarchy of groups—families, towns, counties, regions, trade unions, universities—with healthy and vigorous lives of their own, is the surest way of resisting effectively the encroachments of central authority and thus maintaining a free society. The preservation, not merely of freedom of the human spirit, but also of those other freedoms, of utterance and investigation, upon which that spirit is nourished, ultimately depends upon the existence of such groups. Moreover, they offer, too, an invaluable means of reaching that decision which may have to be made as to which in practice are the vital freedoms to preserve and which must be surrendered to preserv the others. Local associations with a strong, healthy independent life of their own are the only means securing a body of citizens alert to detect an protect those points at which freedom is threatene and who will not be deceived by the casuistry totalitarianism into surrendering those freedoms whic are essential to the growth of the human spirit. Th pattern of Dr. Oldham's thought can be traced i Lord Lindsay's "Religion, Science and Society in th Modern World", as well as in Prof. Elton Mayo's an Dr. K. Mannheim's books.

Mr. Read's paper, on "The Moral Principle i Education", has for its theme that in education w must give priority to all forms of æsthetic activit because in the making of beautiful things the emotio crystallize into what are in effect social patterns, th patterns assumed by human relationships. M Knight gives a fresh interpretation of the positi aspects of Nietzsche. Both offer a profound an more constructive contribution than any of th miscellaneous papers in "Civilisation"[*], a collecti of essays by J. Prévost, L. de Broglie, A. J. Toynbe H. Nicholson, R. Speaght, M. de Corte, Aldo Huxley and others, through which runs the *leit mot* of a dying civilization—a pessimism almost entire unrelieved by any birth-pangs of a new age, or eve the hope of a new civilization.

It is true that here also it is recognized that me need to renew their belief in the eternal values, an that civilization must have spiritual foundation but however searching the criticism of the wea nesses of civilization, it is pervaded by a spirit defeatism rather than by any firm confidence th man will triumph over the new barbarism. T brilliance and confidence that mark the no le searching analysis of Charles Mayer in "L'Homme vaut que par le progrès"[†] are absent. Devastati and disconcerting as is Charles Mayer in some of t criticisms of this age which he puts into the dialog between the Parisian citizen Durand and the phil sopher-scientist Neon, there is unwavering faith the ability of man's spirit to transcend and transfor his material environment. As André Maurois remar in his preface, Mayer's central theme may be su marized: "Il faut cultiver notre esprit".

In upholding the idea of progress, in which many in this generation have lost faith, Mayer rang over a wide field and is often stimulating and su gestive in his comments on such diverse themes freedom, science and morality, feminism, unemplo ment, education, capitalism, private property, medi practice, scientific research and social institutio He writes with a refreshing forthrightness, and th who are moved to contest any of the scientific pr ciples of a progressive materialism or the princip of a progressive conception of the individual and society with which he concludes the first two pa of his book, can scarcely fail to appreciate the lucid and liveliness of his argument. It is a book wh carries a message of hope and, materialist as he

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[*] Civilisation. Edited by F. Berge. Chemins du Monde, No (Paris: Éditions de Clermont, 1947.) 100 francs.

[†] L'Homme ne vaut que par le progrès. Par Dr. Charles Ma Pp. 401. (New York: Éditions de la Maison française, Inc., 1945.)

Mayer reaches, but for different reasons, a belief in the same values as those put forward in the Lambeth Conference report. The social order is indeed, as the Encyclical Letter puts it, all the time being made by the thoughts men think, the loyalties they honour and the deeds they do or leave undone. The world is adrift because it is defying the moral law and repudiating that divine authority which is the basis first of justice and then of peace.

Here then is a fresh challenge to seek out at all levels those new forms of social organisation which are necessitated by the power for the better ordering of the world which the new discoveries and technical inventions of our time have given us. The very condition of survival is the transcendence of outworn experiments in the way of living and social institutions. We have to concentrate anew man's moral and spiritual capacities to employ the material instruments as servants of new possibilities for human well-being. Free institutions cannot be safeguarded solely on a secular basis; and democracy demands for its working those qualities of self-restrained discipline such as have flowered in the training provided by Christian fellowship; while, as the Lambeth report wisely reminds us, we must not allow the State to disregard or throw away the experience and goodwill which are found in voluntary social service.

The diverse issues raised in these three publications never obscure the challenge which they offer to fundamental thought regarding the moral and spiritual values on which alone the rebuilding of Europe and our own recovery can be based, and through which we must find the means to avert the menace which Russian communism offers to the human spirit. With hat challenge to thought, Mayer and Oldham at least point out ways in which we can begin to work out new means, alike in industry and in society as a whole, of safeguarding the freedom of the human spirit and establishing the human relationships which will remove the strain and stress handicapping our ffort at even economic recovery. These are issues which touch the scientific man himself very closely, for they form part both of the strategy and the tactics by which men must secure the conditions in which the human spirit can express itself freely and creatively in science and art and human affairs. The area within which that freedom is possible is steadily being narrowed. Independently of the merits or demerits of particular proposals for the nationalization f industry, the passing of increasingly large areas of conomic life under State control has repercussions on human freedom which ought to be weighed before and not after those measures are implemented.

Here, indeed, is a practical issue to which not only men of science but also professional associations, ade unions, the churches, the universities and other roups should address themselves as a matter of urgency. These publications give a valuable lead; ut there is much to be done before we can elaborate ther the strategy or the tactics of freedom and pply them successfully to particular issues of the y. Dr. C. E. Raven, vice-chancellor of the niversity of Cambridge, remarked recently that creative freedom is the governing concept of university life. It is a vital element in the life of any free community. But any such community that hopes to survive to-day must not think of freedom as a passive state in which we can do as much or as little as we like. As the Queen remarked at Cambridge in reference to Dr. Raven's words, freedom is something more—a force, a dynamic organism which enlivens everything it touches. It is a culture of the mind produced and nourished by the processes of education. Not the least responsibility of men of science to-day, individually and collectively, is to join with all those forces which are seeking to safeguard the free society, and to renew the moral and spiritual forces upon which the creative power of Western civilization depends.

DR. ROBERT BROOM: NATURALIST

Special Publication of the Royal Society of South Africa

Robert Broom Commemorative Volume. Edited on behalf of the Society and the Bernard Price Foundation of the University of the Witwatersrand by Alex. L. du Toit. Pp. v+257. (Cape Town: Royal Society of South Africa, 1948.) 22*s*.

The Royal Society of South Africa has honoured Dr. Robert Broom, of the Transvaal Museum, Pretoria, on the occasion of his eightieth birthday, by publishing a volume of papers by many men on subjects to our understanding of which he has so greatly contributed. After a delightful introduction by General Smuts, we are given a short biography and some personal reminiscences by D. A. Roberts; then follow a number of articles dealing with fossil reptiles, the field of study within which so much of Broom's work has lain.

Beginning with accounts of the structure of the mammal-like reptiles of South Africa, designed to elucidate the mode of origin of mammals, Broom passed on to earlier forms, which include their ancestors, and in so doing revolutionized our ideas of phylogeny, and gave the clue to our present classification. This series ends with a most valuable discussion of the climatic setting of the Karroo reptiles by Mr. du Toit.

Then follows a series on the fossil men and man-like apes of Africa, works which owe their existence to the early recognition by Broom of the rightness of Dart's views about the position in the anthropoids of the young skull of *Australopithecus*.

Inspired by this find in a cave in the Transvaal, Broom examined very many caves and by dogged persistence found those marvellous fossils which he has so accurately interpreted as members of a new family of the Hominidæ, giant apes, adapted to life in semi-arid lands, walking erect like men, with man-like teeth, but with an ape's brain. The discovery and description of these animals is beyond all question the most important contribution to our knowledge of the primates, other than man himself, which has been made for a hundred years or more.

But Broom has also made additions of fundamental importance to our understanding of the human races which have in the past inhabited South Africa. Here again he gave the impetus to the active interest in this subject in South African universities, shown by several papers in the commemorative volume, in which the authors, whether they agree or differ, are at one in starting their arguments from Broom's fundamental works.

Broom's first interest was in embryology, and it is appropriate that the volume should include papers in this field.

Broom has always held that taxonomy in the restricted sense of specific discrimination is not only valuable and necessary, but also demands from the man who does it altogether exceptional judgment. Throughout his working life, Broom has described new species—hundreds of them in fact—and it is pleasant to find new species here described.

The volume contains—unusually but most fortunately—a paper by Broom himself in which is described a whole series of small Theriodonts of very great interest.

A bibliography of Broom's published scientific work which ends the volume includes a list of 402 papers, beginning in 1885, when he was nineteen years old, with a paper on the volume of mixed liquids, in the *Proceedings of the Royal Society of Edinburgh*, and continuing until to-day, so that it needs addition.

Broom's life-work is unparalleled by that of any-one now living. In its range, in its mere mass, it recalls the great Victorians, Owen, Huxley and Lankester; and in its quality, in the extent to which modern work in many fields can be traced back to it, and in the verve and vigour which it shows, it is indeed worthy to be compared with that of these great men of the past. D. M. S. WATSON

THE ANATOMY OF CO-OPERATION

Managers, Men and Morale

By Wilfred B. D. Brown and Winifred Raphael. Pp. vii+163. (London: Macdonald and Evans, 1948.) 10*s*. 6*d*. net.

PERHAPS the most outstanding event in the industrial story of Britain in the 1940's is the advancement in the technique of co-operation between master and man—or, between managers and employees, to put it into its modern wording. Admittedly that story has not everywhere been characterized by undisturbed harmony; but as to the extent of the progress achieved, and its soundness in fact, there can be little room for doubt. In the main, the achievement has been in the realm of formal relations between organised parties, that is, procedures for negotiation and continual consultation between representatives: employers' federations and trade unions on an industry basis, or managers and shop stewards at the individual factory level. Yet there has been an advance, too, in the more informal pattern of consultation that is inherent in the everyday contact of manager and supervisor with the men and women under their jurisdiction—an advance measured chiefly in widespread recognition of this factor as an element in executive responsibility. This fact of employee relationships is, many authorities are coming to agree, of greater significance in the conduct of industry than the formalized pattern characterized by a meeting of 'sides' across a table, more often glaring than smiling, and more often interested in their own respective good rather than in the pursuit of a common task.

It is with this subtler yet more essential form of co-operation that the present book is concerned. "Our theme has been that the practice of management should be based on certain fundamental hypotheses concerning the reactions of the human being to his social environment. . . . We have been organising the production of goods and services for two hundred years with ever increasing success if we measure our achievements in terms of production; but with a most noticeable lack of success if we measure in terms of the effect of our organisation on those engaged in the process of production. Indeed, it almost looks as if the degree of co-operation, pride in work and happiness, arising out of the association of human beings in industry, is less to-day than it has ever been. People have more material possessions to-day, but less psychological satisfaction from their association with the results of our organising."

The framework of the book has been erected to provide for a full study of the fundamentals of co-operation at all levels—the board of directors, the senior executives, the specialist managers and staff, the supervisors and the operatives themselves. The authors frankly disclaim any pretence to a 'text-book', and the chapters devoted to each of these manager-levels are in no sense a review of the detailed practices of management. They are, instead, a scrutiny of the means of creating and maintaining a sense of common task; they describe the anatomy of co-operation, not just the skeleton, but the nervous system as well, and their illustrations draw chiefly on the nervous system in action. Witness this momentous paragraph from the introductory chapter: "If we attempt to achieve efficiency in the hope that happiness will follow, we are usually putting the cart before the horse. Nobody can work efficiently while suffering a sense of injustice, grievance or frustration. Good work cannot be turned out under such conditions. It is clear, therefore, that the task of the manager is to achieve efficiency *through* happiness. It is useless to look at the group we command and say to ourselves: 'I have done everything that a man can reasonably be expected to do to make these people happy, and consequently they should be happy. Now I can forget that issue and concentrate on efficiency.' A manager must continually observe his subordinates and courageously face the facts. I they are not happy, it is useless to escape from the responsibility which that fact imposes upon him by assuring himself that they ought to be happy. Hi job is to find out why they are dissatisfied; then to do everything possible to eliminate the causes o their dissatisfaction."

To say that this book will be misunderstood and misinterpreted is to pay a compliment to the far-sighted approach of its authors. One reader ha commented—and many may sympathize with him—on the curtailment of the authority of management that their teaching represents, as though replacin woolliness of discussion for the firmness of decision. But such readers have not grasped the essentia principles of the study or the real implications o what the authors are saying. A little more unkindly one could say that they have overlooked a fairly lucid passage in Chapter 7: "We are not trying t suggest in any way that authority should be shared The final say must rest with the executive, wh bears the ultimate responsibility. But Mary Parker Follett was abundantly right when she talked about 'de-personalizing orders'. An order must be seen to be the 'law of the situation' if it is to be readily accepted. It will create resentment if it appears to be the whim of the manager. The object of discussing a problem with a group is to find out what the situation is, rather than to put upon them the responsibility of making a decision." There is, in fact, quite a possibility that some readers will squirm at the strikingly autocratic tone in which it is suggested (in Chapter 4) that a managing director might introduce functional experts into his firm.

There are a lot of things that could be said about this book—mostly good things !—and there are a lot of points that could very usefully be taken up for examination or emphasis. In the compass of a short review, however, further comment is perhaps best confined to a selection of the more fundamental issues. The chapter on "The Outside Consultant" is an unusual feature in a serious book on management ; this is an excellent chapter, objective and balanced in its appraisal of the part that the expert consultant can play in the advancement of the practice of management. It has a special relevance to immediately contemporary conditions and is a welcome recognition of the value of the soundly established professional consultant in a new domain.

Chapter 7, "Attitudes in Industry", is again a new feature, describing recently developed techniques for assessing public opinion within a factory on matters that reflect the outlook and competence of management and so are pointers to the level of morale. A kind of 'Gallup poll' of an industrial organisation would be a popular description of the process, though the techniques described are of far less importance than the recognition, which they imply, of influence that the impact of management can exert on the human tone of the organisation. In one sense, this chapter points to a method of diagnosis or study of the anatomy of co-operation, and underlines the authors' own conception of the scientific method in industrial relations—"Management," they say elsewhere in the book, "is a problem of human relations. By definition the manager attains his objective through the government of others. His principal task is therefore that of establishing good relations with those others, both his subordinates and his seniors. If management is to be scientific, it must call upon the knowledge and experience of those who are expert in group relations." This is different only in wording from F. W. Taylor's plea that among the factors in the industrial situation which should be made the subject of systematic analytical study are "the motives that influence men"—a thought which puts the notion of scientific management in a setting very different from that habitually attributed to it.

From scientific method to the establishment of principles is in logical sequence, and so it is fitting that the concluding chapter should refer to targets "embodying certain principles of organisation". Regrettably, the authors have allowed themselves to be deluded into reproducing "principles [which] are to be read as a description of what is actually done in one organisation"—a conception that is difficult to square with the customary connotation of 'principle'. But if the title 'target', as used in the chapter heading, is given to these lists they undoubtedly stand as valuable prescriptions for the betterment of management.

If there is any serious criticism of this study, it is its unmitigated 'producer interest' ; its whole content is aimed at the well-being of those whose lot in life casts them in the processes of manufacturing. Admittedly, the book is not meant to be a study of economics ; but there are many points at which certain assumptions have obviously been made as to the purposes of industrial activities and their relative role in the scale of social values. Those assumptions have clearly been made in terms of the prior interests of the producers—of the workers and managers engaged in manufacturing industry. Specific evidence is difficult to cite, the only clear case being the relegation of consumer interests to the fifth place out of six items to which surplus revenue should be devoted (p. 155).

The existence of purchasers is thinly recognized in the first principle set out as a basis on which a worker can identify himself with the purposes of an industrial community (p. 93), though economists (as well as citizens who have lived through the years 1945–48) would argue that only a price mechanism could determine what manufactures are of no value to consumers because they are either 'a fake' or 'useless' or 'gimcrack'. Consumers—who are really just the workers and managers without their overalls—have unaccountable bases of preference !

It is high time that the professional manager and the technologist recall to mind that the primary purpose of the economic system, of all industrial activities, is the provision of the goods and services that the consumer wants. This can very safely be stated as principle No. 1. E. F. L. BRECH

TRAINING THE WORKER

Principles and Practices of Vocational Education

By Prof. Arthur B. Mays. (McGraw-Hill Series in Education.) Pp. viii+303. (New York and London : McGraw-Hill Book Co., Inc., 1948.) 21*s*.

IT is becoming more and more clear to most people connected with British industry that the way out of the present economic crisis will not be by the introduction of new machines. For some time to come industry has to make do with the bulk of its present capital equipment, and, now that the labour force is stretched almost to its maximum, any real increase in production can only come by a change in methods. This will involve considerable modification of the attitudes of many managers and workers, and to-day various agencies are seeking ways whereby time-honoured behaviour patterns can be changed swiftly and efficiently. Among the ways which have been and are being increasingly used to add to overall efficiency is what industry has come to call 'education and training'. Simple as this may sound, it is surprising that, even in 'enlightened' firms, the process of providing a man with specific training to do a job is often regarded as something which hinders rather than helps production. Engineers, of course, have to be trained ; so have chemists. They may even need a four-year preliminary course before their training starts. But the semi-skilled and unskilled workers can pick up their jobs by being put alongside Joe and Tom. In the Services men are given their training before being assigned to a unit ; in industry many men and women have to learn their jobs by picking up all that cannot be concealed from them.

It is therefore refreshing to pick up a book in which a professor of industrial education indicates not only methods of training different grades of workers, but also carefully examines principles upon which vocational education should be based. The more these principles and practices are disseminated, the more quickly will employers and employees realize that 'education and training' can do much to promote the well-being of workers and, concurrently, industrial efficiency.

Much of the book is devoted to education for the more humble jobs, although one section is given over to a discussion on vocational education at the university-level and another to the preparation of teachers. Probably the most important chapter is that in which the author considers the significance of vocational education in democracy and its relation to industrial productivity. Starting with the late Theodore Parker's dictum that "democracy meant not 'I am as good as you are' but 'you are as good as I am' ", Prof. A. B. Mays emphasizes that modern ideals of democracy call for equality of opportunities for all levels, classes and individuals. "Men to-day require not only that their preachers and lawyers be given opportunity for proper training but that their cooks and chauffeurs also find such opportunities. Not only the engineer, the doctor and the architect but the factory workers, the nurse, and the carpenter must be given a fair chance for vocational education." Nor does the factory worker mean just the skilled fitter, turner or other craftsman. Under the handicraft system of the pre-industrial revolution era these men were mainly responsible for production. To-day, they are mainly concerned with the maintenance of equipment, and most productive processes are performed by unskilled and semi-skilled workers. In industrial training programmes all grades of workers should be included, and Mays makes suggestions for each grade which are similar to those already in practice in a small number of firms in Britain.

It is significant that Mays advocates drastic changes in existing attitudes to the selection, training and status of foremen, and suggests that, if the teaching function of the factory foreman were to become more widely recognized, many of the problems of providing adequate training for unskilled and semi-skilled workers would solve themselves. Much of the chapters on organisation and administration would not be appropriate to British education or industry, but even here Mays' principles are sound, and reinforce the opinion that this is an important and, for British readers, a well-timed book.

T. H. HAWKINS

A NEW THEORY OF LEAF FORMATION

La théorie des hélices foliaires multiples

Fondements d'une théorie phyllotaxique nouvelle. Par Prof. Lucien Plantefol. Pp. 154. (Paris: Masson et Cie., 1948.) 400 francs.

IN this book, which has appeared in parts in recent numbers of the *Annales des sciences naturelles botanique*, the author proposes a new theory of leaf formation, after rejecting as erroneous nearly all previous work. He considers that the positions in which leaves arise depend on a number of generating centres (*centres génératrices*) in the stem apex above them, which form leaves successively along a number of foliar helices winding in *one* direction around the apex or axis. But since these generating centres might get out of time one with another, he also postulates an organising centre (*organisateur*) in the apex to control them. Thus the organising centre is like a conductor, and the generating centres are the players which follow its beat. All these must be within the stem apex, which may be only 150 μ across, or even less.

But what are these foliar helices along which the generating centres act? It is well known that in sections of spiral buds, and less easily on some mature organs, there can be seen two sets of leaf spirals or helices, the parastichies, winding in opposite directions, and that the numbers of these two sets are commonly successive numbers of the Fibonacci series 1, 2, 3, 5, 8, etc. The helices which the author intends are some of these; but which they are and on what principle he selects them is a more difficult question. For he selects only those winding in one direction, and claims that they are of varying numbers in monocotyledons, but usually only two in dicotyledons The only grounds for choosing two in dicotyledons seem to the reviewer to be that the number two occurs in both of the lowest and commonest Fibonacci systems, those with parastichies $1 + 2$ and $2 + 3$ as well as in the decussate system $2 + 2$, and that higher Fibonacci systems are reached by passing through the lowest Fibonacci systems in development.

The theory has something in common with that of Church (1904), whom the author does not mention For Church supposed that the apex forms leaves at the *intersections* of spiral paths, forming continuations into it of the two observed sets of opposite parastichies. He thus did not need to postulate any centra organising centre to regularize matters during constant phyllotaxis, since the uniform growth of the apex would suffice for that. For this reason and also because it is based on *all* the parastichies observed Church's theory seems much preferable for those who favour any theory of this kind at all.

Although the author seeks to account for the sequences and positions in which leaves are formed at the apex, he offers no evidence of what those positions actually are, his whole book containing n illustration of an apex or bud section. Instead h tries to infer from observations on mature organs i what positions the leaves must have been formed But such inferences may be quite wrong, and in pa ticular in certain lilies which the author discusses he clearly does not know what actually are those positions of leaf formation which he seeks to explain He also seems to think that all previous workers have supposed that there was some causal significance in the genetic spiral, which is the spiral drawn throug the leaves in their order of development. But th was not the opinion of Church, nor of those workers who, following Hofmeister, believed that th positions in which leaves arise are somehow determined by the existing leaves just below them. Th evidence in favour of this last opinion is scarcely di cussed. With one point the reviewer agrees: that th divergence angles between the centres of successive leaves in spiral phyllotaxis are not simple fractions 360°. One may confidently expect that if the autho who has won distinction in plant physiology, wi study shoot apices rather than mature organs, h will contribute something of 'greater value' to th theory of leaf formation.

MAGNETISM

SECTION A (Mathematics and Physics) of the British Association conducted a symposium on magnetism at Brighton on September 13, with Sir Lawrence Bragg, president of the Section, presiding over the meeting. Three papers were presented; the first two dealt with materials and the last with a problem in metal physics. The title of the first, by D. A. Oliver, was "Recent Advances in Anisotropic Permanent Magnet Alloys"; that of the second, by N. F. Astbury, was "Anisotropic Silicon Iron"; while the concluding paper, by D. Shoenberg, was entitled "Magnetic Properties of Superconductors". A discussion followed the first two papers and the last one.

Mr. Oliver (William Jessop and Sons, Ltd.) recalled the discovery in 1938 of the effect of inducing anisotropic permanent magnet properties into a cube of 'Alnico' by cooling from 1,200° C. in a strong magnetic field[1]. The subsequent developments by Dutch[2,3] and British[4] workers gave rise to the 'Ticonal' and 'Alcomax' series of alloys which contain more than twenty per cent of cobalt. The successive advances were outlined and special mention was made of the work of Tetley, Edwards and Hoselitz and of the staff of the Philips research laboratories at Eindhoven. Axial and planar[5] anisotropy were distinguished; for the usual, or axial, type of anisotropy it was noted that $(BH)_{\max}$ products of 5 millions (gauss, oersted) are now approached commercially (and occasionally exceeded in the laboratory) when the properties are measured in the preferred direction. This energy value was compared with 1·6 millions for the older (isotropic) 'Alnico'[6]. Typical magnetic constants for 'Alcomax II' are remanence (B_r) 12,500 gauss, coercive force (H_c) 550 oersted, and $(BH)_{\max}$ $4 \cdot 3 \times 10^6$. (The maximum stored magnetic energy in ergs per c.c. is equal to $(BH)_{\max}/8\pi$.) Investigations have recently been conducted along the lines of eliminating chemical impurities, and certain improvements have resulted. The latest research by the Permanent Magnet Association, in collaboration with the British Electrical and Allied Industries Research Association, has shown that niobium (columbium) additions are advantageous for increasing coercivity[7]. With intensive development by the Permanent Magnet Association a new experimental alloy has resulted having tentative constants as follows: (B_r) 11,200 gauss, (H_c) 750 oersted, $(BH)_{\max}$ 4·3 millions. This new material may prove especially advantageous when space considerations limit, in a given piece of equipment, the maximum permissible length of magnet part. Mention was also made of the recent (unpublished) researches by Dr. A. J. Bradley on the iron–nickel–aluminium system. These are throwing much light on the actual structures associated with optimum magnetic properties. The earlier mechanism put forward by Bradley and Taylor[8] in 1938 has been confirmed and extended. Two body-centred cubic phases are the principal ones; the iron-rich being disordered, the nickel–aluminium-rich being ordered after prolonged annealing at 850° C.

Alloys in an optimum magnetic condition show little definition under the microscope when polished and etched (Fig. 1). However, following prolonged annealing at 850° C. for sixteen days and after careful polishing and etching, a clear structure is visible at a high magnification (× 2,000, Fig. 2). Furthermore, evidence has been obtained for cubic mozaic blocks having an edge length of $2 \cdot 5 \times 10^{-5}$ cm. or simple multiples of this dimension. Micro-segregation is present in so far as the nickel–aluminium-rich phase concentrates near the centre of each mozaic block, while the iron-rich phase is found on the exterior. These blocks are subject to magnetostriction biasing effects when the alloy is heat-treated by controlled cooling in a strong magnetic field, and final atomic rearrangements during tempering may be expected to occur in their vicinity. Single domain characteristics may be ascribed to each elementary mozaic block, and the coercivity effects can largely be explained on the lines of the recent theory put forward by Stoner and Wohlfartl.[9]. It is, however, important to recall that the segregation processes are incomplete when the best permanent magnet properties have been established. Then the predominantly

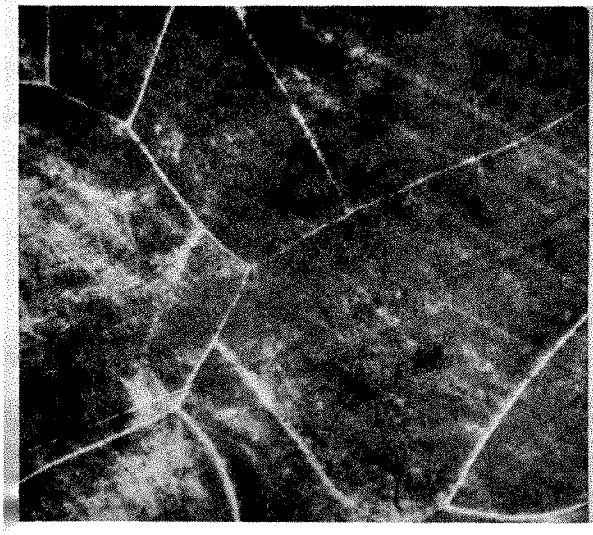

Fig. 1. Typical photomicrograph (× 50) of Fe_2NiAl in optimum magnetic condition. Note poor details after polishing and etching; no improvement with increased magnification. (After Bradley)

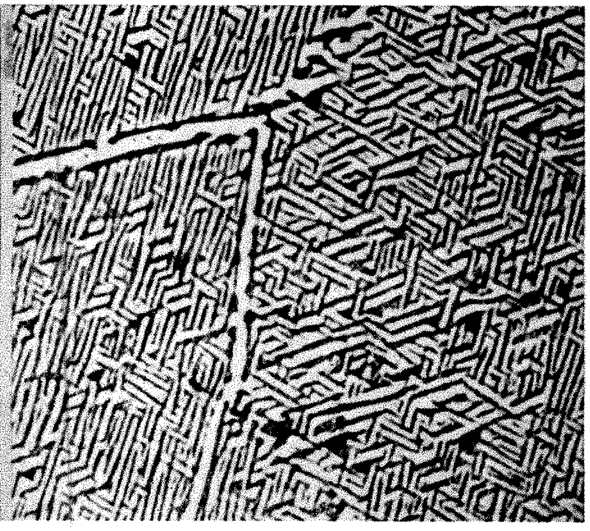

Fig. 2. Photomicrograph of alloy near composition Fe_2NiAl after annealing for 16 days at 850° C. Transformation point, 950° C. Polished and etched; magnification, × 2,000. Black: iron-rich magnetic; white: NiAl-rich non-magnetic. (After Bradley)

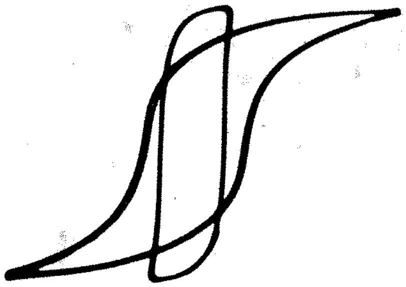

Fig. 3. Comparison of hysteresis losses for oriented and normal hot-rolled silicon–iron sheet. ($B_{\max}$ = 10,000 gauss; f = 50 c./sec.) Inner loop: 'Crystalloy' (oriented); outer loop: 'Stalloy'. (After Astbury)

iron-rich 'islands' can be regarded as subjected to compressive forces induced by the distribution of the largely non-magnetic nickel–aluminium-rich phase. The explanation of all the phenomena present is still imperfect but much progress has been made.

Mr. Astbury (Joseph Sankey and Sons, Ltd.) outlined the many important matters of detail in the achievement of highly oriented, cold-rolled 3 per cent silicon–iron electrical sheet-steel having low overall energy losses when subjected to alternating magnetization. The process, originally associated with the name of Goss, involves a sequence of cold reduction and intermediate heat-treatment which results in a well-defined rolling texture. These operations are followed by a high-temperature anneal, when the rolling texture, predominantly [110] (001), changes on recrystallization to [100] (011), which is similar to a single crystal having the magnetically favourable [100] direction along the rolling direction and the diagonal (011) plane in the strip surface[10]. Under the best conditions, losses of 0·28 watts/lb. at 50 cycles per second and an induction of 10,000 gauss have been obtained, associated with a maximum A.C. permeability of 22,000. The reduced losses and higher permeabilities are evident from the curves of Fig. 3, which compare at an induction of 10,000 gauss the normal hot-rolled silicon sheet ('Stalloy') with the new oriented material. Losses have been halved, and the initial and maximum permeabilities have been greatly increased.

The texture of the finished strip being all-important, four methods for its determination were outlined: (1) X-ray crystallographic methods, (2) optical methods (using reflexions from crystallographic etch pits), (3) strain anisotropy methods, and (4) magnetic methods. Typical results were shown, together with the final derived pole-figures. Finally, this able survey was concluded with a description of the best methods for arranging the lay-out and joints of practical magnetic circuits using anisotropic sheet materials so as to give maximum effective permeability and minimum overall losses.

In the discussion which followed, Dr. K. Hoselitz (Permanent Magnet Association) stated that changes in magnetization occurred by rotation and by boundary movements. In a permanent magnet material it was necessary to inhibit boundary movements, while in a soft magnetic material they should be encouraged; the presence of strain and non-magnetic inclusions prevented boundary movements. In the calculation of coercive force when rotations only are considered, high values were obtained; suggestions were made for refining the calculation Prof. L. F. Bates (University of Nottingham) expressed his interest in high-coercivity alloys and sai so much more could be explained if domain vecto were assumed to rotate only through angles n exceeding 90°. They had studied recently[11] the dependence of the value of Young's modulus (E) upo magnetization for the pure metals, iron, nickel an cobalt and for the permanent magnet alloy 'Alnico For nickel, under certain conditions, the change i E was 7 per cent; for 'Alnico' it was only 0·02 pe cent. Furthermore, the damping coefficient fo 'Alnico' rods in mechanical vibration were noted t be very small (of the order, logarithmic decremen equal to $2 \cdot 5 \times 10^{-4}$). The proposal was made tha these alloys might have uses as magnetostrictiv elements in filter circuits. Finally, mention was mad of remarkable time-lag effects in the measure hysteresis loop for 'Alnico' (in the vicinity of H_c He pointed out that time-lag phenomena might pla an important part in the heating and cooling effect observed[12] when a ferromagnetic metal is magnetize step-by-step. Dr. M. McCaig (Permanent Magne Association) referred to some experiments on th magnetostriction of anisotropic permanent magne alloys. He concluded that in such alloys domai magnetostriction is normally along the neares crystallographic 'easy' direction to the preferre direction. Prof. W. G. Burgers referred to Fig. taken from Bradley's recent researches and pointe out that Dr. J. L. Snoek[13] in 1939 observed th two-phase character of single crystals of Fe_2NiAl by a doubling of certain spots in the X-ray photographs. He considered the recent work greatl extended the earlier findings.

Dr. Shoenberg (Royal Society Mond Laboratory Cambridge) pointed out that superconductors behav magnetically in exactly the opposite way to ferromagnetic materials in so far that they tend to exclud from themselves all lines of magnetic force. Th phenomenon[14] is only observed within a few degree Kelvin of the absolute zero (less than 10° K.), an so far has remained an obdurate problem in met physics, defying theoretical solution. Kamerling Onnes first discovered the effect about 1911; bu most of the work on magnetic properties has bee carried out since 1933. It was certainly a matter f surprise to observe that the resistance of some meta such as mercury and lead disappeared complete when a certain temperature, called the 'critic temperature', was reached. Below this temperatu the resistance is certainly less than 10^{-15} of its valu at room temperature. When a magnetic field applied, screening currents are induced on th surface of the superconductor which are just stron enough to exclude lines of force from the metal owing to the zero resistance these currents cann die away, and the metal behaves as if it had ze permeability or diamagnetic susceptibility − 1/4 Even more remarkable, however, is the fact that the metal is cooled in a magnetic field, the lines force are suddenly excluded when it becomes supe conducting. This cannot be a consequence of ze resistance, so that the effectively zero permeabili must be regarded as a fundamental property. A interesting experiment due to Arkadiew was d scribed. If a powerful short permanent magnet released over a large superconducting metal surfa curved in the form of a shallow trough, the magn floats in stable equilibrium above the surface of th metal (curved sides to the trough of metal ensu stability in the finite case). The explanation given was that corresponding magnetic image-poles of like sign are induced in the pool of superconducting metal which therefore repel one another. The surface currents in a superconductor are associated with a penetration (λ) of about 10^{-5} cm. This value of penetration varies with temperature below the critical temperature, and, from the observed variation, information can be inferred about m/n, where m is the effective mass of the electron and n is the electron density. It was hoped that by studying the penetration effect, much further illumination will be thrown on the superconducting state.

In the brief discussion which followed, Prof. Bates elicited the nature of the Russian experiments which showed that the gyromagnetic ratio for a superconductor was unity, and this eliminated the action of electron spins in explaining this phenomenon. In reply to Mr. Oliver, Dr. Shoenberg explained that the superficial superconducting current probably fell off exponentially from the surface through the penetration distance; this had never been verified experimentally to his knowledge. D. A. O.

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RELATION OF BIOLOGY TO PROBLEMS OF CIVIL ENGINEERING

IN an age when the boundaries of science continue to expand rapidly, and even the general practitioner of a subject tends to 'know more and more bout less and less', such a conference as that on 'Biology and Civil Engineering", held at the Institution of Civil Engineering during September 21–23, has everything to commend it. The engineer preoccupied with inanimate matter is reminded, or made ware of, the influence of plant and animal life on his structures, in both harmful and helpful contexts. The biologist, for his part, is shown the creatures of is study in a severely practical and workaday etting.

Of the thirteen papers presented during the three days of the Conference, four were general papers dealing with various aspects of soil erosion and floods in relation to vegetal cover and to man's use (or abuse) of such cover. In the two contributions from New Zealand[1,2] there is presented, with many fresh facts from recent survey work of the Soil Bureau (Department of Scientific and Industrial Research), telling and circumstantial picture of land degradation under faulty practices and of current plans for rehabilitation. The point is made—and needs pressing elsewhere—that a country like New Zealand, possessing a 'youthful' topography, an erodible rock and soil mantle, and an erosive climate (intense downpours, strong winds and prolonged severe frost) could ill withstand any interference with its protective cover, much less the assault of too intensive sheep farming, combined with burning, over the past century; the less so since the natural vegetation had evolved in the absence of fire, grazing mammals and burrowing rodents, all of which were introduced by the European settler. Cleared and burnt forest, whether lowland conifer-broadleaf or highland beech (*Nothofagus* sp.), could not be held to sown pasture after the initial potash fertility had been dissipated, but reverted to shrub (typically *Leptospermum scoparium*) and bracken fern (*Pteridum esculentum*), which further firing and over-grazing would sometimes reduce to low-production swards of native oat grass (*Danthonia* sp.). The interrupted biological chain: imported rabbit – imported stoat and weasel – native bird depletion – reduced forest fruit dispersal: which has prevented tree species from re-occupying shrub land, is of special interest here. The valuable and extensive tussock grasslands suffered similar depletion and regression, including invasion by introduced species like gorse, sweet briar and broom, and such worthless native perennials as cotton plant (*Celmisia spectabilis*) at higher levels and *Nassella trichotoma* at lower. Reclamation work initiated under the Soil Conservation and Rivers Control Act of 1941 emphasizes the special value of willow and poplar in stabilizing slopes and in the structural plugging of gullies; and is making trial of seeding and fertilizing pastures from the air.

The other two papers discussed in some detail the more fundamental aspects of erosion, that is, of 'accelerated', which is essentially man-made, erosion. Long-term run-off experiments at the Agricultural Research Institute of the University of Pretoria are cited[3] to confirm the unique soil-holding value of *close-growing* vegetation—but not of clean-cultivated row-crops like maize—even at a high rate of run-off; also recent work by Ellison and others on the specific effect of falling rain-drops, which demonstrates their disintegrating action on soil aggregates (independently of any subsequent loss from run-off) and confirms the finding of earlier workers, like Lowdermilk, on their damaging potency for sealing over, in the space of two–three minutes, the soil surface pores. The point is made that whereas "erosional damage cannot be completely prevented by any other means than by the efficient use of vegetation", man's food and cash crops may necessarily fall far short of Nature's ideal covering, and consequently "the engineer must step in and help out the agriculturist with engineering methods of control, even if these . . . are only temporary and relatively ineffective".

Unfortunately, many of the necessary data for applying such methods are lacking or defective; for example, a reliable index of the erodibility of soils, safe velocities of flow over different types of vegetation and, especially, a dependable formula for expected water releases from small watersheds. Here it is remarked that the current trend is to apply probability analyses directly to actual measurements of rates of run-off, rather than use the rational formula $Q = CIA$, which seasonal variations in, for example, vegetal cover are apt to confound. These and other difficulties in applying the formula are discussed.

In the complementary paper[4], the protective action of vegetation, and especially of forest, against wind and weather is analysed in terms of the rough hydrological equation :

$$\Sigma = P - [I + E + T],$$

or discharge (streamflow) equals precipitation minus vegetal offset. Salient findings are that "vegetal cover removes more precipitation, physically and organically, than does evaporation from bare soil, that it both creates and maintains storage opportunity in the ground below it, and that it ensures conditions under which clean surface water can be absorbed at especially high rates". The modern forester and hydrologist, nevertheless, make no extravagant claims, for it is concluded that "vegetation should be looked upon as a *moderator* rather than a preventer of floods, as exercising a more important role as a filter and retardant, ensuring the minimum of soil loss and releasing flood water that is comparatively free from detritus, and hence of minimum destructiveness to human welfare".

The first of these findings is interestingly traversed, so far as transpiration is concerned, in a specialist paper[5] from Rothamsted, which quotes the results of recent experiments there on evaporation from grass, bare soil and open water surfaces. It is contended that the evaporation from vegetation is likely to depend more on the acreage than upon the integrated leaf area, since the large amount of latent heat necessary to cause it must come almost entirely from solar radiation. Measurements over a number of years show that evaporation from plentifully watered grass fluctuates with the weather in the same way as evaporation from an open water surface, but averages 20 per cent less in summer, 40 per cent less in winter and 30 per cent less in equinoctial months, most of this reduction being ascribable to the closing of stomata at night and their intrinsic resistance to vapour diffusion. These factors, it is suggested, may be applicable to any continuous leafy cover, for example, forest. Calculated values of evaporation from grassland, assessing soil moisture deficits on a basis of about 3 in. of available water, are shown to accord closely both with direct soil moisture readings and with recorded dates on which field drains started to run.

The remaining papers were concerned with the role of vegetation in certain special branches of civil engineering. To the railroad engineer[6,7] it is an invaluable, if somewhat tricky, ally in stabilizing his cuttings and embankments. Interesting points brought out include : (1) the increasing use of sewage sludge as a top dressing in place of soil, and as a quick stabilizer of slipping slopes ; (2) the recent recourse to carefully and widely blended seed mixtures for grassing ; (3) the marked promise of bituminous surface treatments—adapted from wartime aerodrome experience—for grassing slopes. The cold bitumen emulsion is sprayed in a thin skin over the soiled and seeded surface, preferably with a dressing of sand before and after, and results in a quicker and more deeply rooted flush of grass remarkably free of competing weeds. As regards other forms of vegetation, stabilizers now largely favoured include the common ivy and traveller's joy (*Clematis vitalba*) on steep chalk, the hardy and adaptable *Cotoneaster henryana*, an evergreen shrub brought from Central China, and locust (*Robinia pseudoacacia*), rowan, birch and oak among the trees, the locust proving particularly useful on clays.

In quite another context, vegetation still plays an indispensable part in the stabilizing of sand dunes[8,9] Among interesting features of present-day practice are the use of tree lupins and, in America, of sea-oat (*Uniola paniculata*) in place of marram grass as initial binders ; the sowing of annual lupins both to nurse other vegetation and to add stabilizing humus ; and the trials recently begun of seeding lupins and grass from the air. The management of stable dunes as forest rather than pasture finds general favour with the experts, who also stress the need for perpetual vigilance in maintaining an unbroken seaward front.

Vegetation is seen in quite a different light by the roads and buildings engineers[10,11] wherever clay below foundations gets invaded by roots. These, by their varied seasonal demands for moisture, cause large volume-changes in clayey soils and so endanger overlying structures. The problem is world-wide, but modern shallow foundations and the exceptional drought of 1947 have brought it into prominence in England, particularly on the heavy clays of the south-eastern half, which possess a liquid limit of some 70–80 per cent of dry weight. A series of levelling points established in June 1947 at Garston at various depths in grass-covered heavy boulder clay revealed a maximum vertical settlement of about 2½ in. On bare ground it will not exceed ½ in. ; near fast-growing trees it may exceed 4 in. For buildings on such clays, a minimum foundation depth of 3 ft. and no trees within root radius are considered prudent rules ; but with stability and amenity so much in conflict, an alternative under active investigation is the use of short-bored pile foundations spanned by beams carrying the external walls. In the case of roads, recent surveys by the Road Research Board show that damage is not likely to be serious except with trees, and then only in urban areas where they are set in paved footways or where the rainfall distribution is affected by concentrated building. Tentative recommendations include the avoidance of fast-growing species, like poplars, within 50 ft. of the carriageway on heavy clays ; the need for co-operation of biologists at the soil survey stage of all road planning is also stressed. Much more research is needed, discussion showed, on the precise water changes caused by root spread. A cheap, root-impenetrable membrane, to be introduced near foundations, should not, it is considered, be beyond modern scientific resource.

In the concluding papers[12,13], vegetation of a special sort—planktonic algæ—is viewed as a chronic and complex polluter of stored water and of the filters purifying it for human use. In open reservoirs, the abstracting of nutrients or of 'limiting' substances, like phosphates, from the replenishing source does not, in the opinion of the authors of the first paper, offer a full solution, nor does algicide treatment (which is liable to recoil biologically). For lowland Britain in particular, they stress the paramount need for minimizing thermal stratification with its inevitable de-oxygenating of the deeper water and the contaminating reactions that follow its seasonal disruption and overturn ; even in its absence, chemical stratification of biological importance may exist. To this end, the following suggestions for optimum reservoir design are, *inter alia*, offered (1) intake filters of 40–50 micron fineness to reduce accession of organic matter (the plankton pabulum) (2) orientation to maximum wind force ; (3) introduction of booms and baffles ; (4) multiple levels of draft; and (5) suitably located scum spillways. That the key to the pollution problem is better circulation of the water-mass finds support in the interesting case of the 60-ft. deep Hollis Reservoir in Trinidad[13]. Here there are marked wet and dry seasons, intense rainfall, small variation in temperature, whether diurnal or annual, and, owing to its sheltered position, very little wind. As a result, vertical water circulation is restricted to the upper 10–14 ft., with no seasonal overturn, and the consequent heavy bottom build-up of plankton may extend to within 5 ft. of the surface during the dry season. Further, the sub-aerobic layer at the 20–35 ft.-level, which includes *Anabœna*, *Merismopedia*, and *Oscillatoria* blue-green algæ, suffers an extensive upheaval whenever an influx of cold water from heavy rains under-penetrates it; this is followed by the death *en masse* of its plankton content, with dire results—particularly from *Oscillatoria*—for water purity and filterage. F. R.

[1] Newnham, W. L., "Soil Erosion and Soil Conservation in New Zealand".

[2] Healy, A. J., "Biology and its Relation to Soil Erosion and Soil Conservation".

[3] Vorster, J. A., "Soil Erosion and Some Problems Connected with its Control".

[4] Ford Robertson, F. C., "The Influence of Vegetation on Floods".

[5] Schofield, R. K., and Penman, H. L., "The Principles Governing Transpiration by Vegetation".

[6] Toms, A. H., "The Effect of Vegetation on the Stabilization of Artificial Slopes".

[7] Moran, B. J. J., "The Use of Vegetation in Stabilizing Artificial Slopes".

[8] Chapman, V. J., "The Stabilization of Sand Dunes by Vegetation".

[9] van der Burgt, J. H., and van Bendegom, L., "The Use of Vegetation to Stabilize Sand Dunes".

[10] Ward, W. H., "The Effect of Vegetation on the Settlement of Structures".

[11] Croney, D., and Lewis, W. A., "The Effects of Vegetation on the Settlement of Roads".

[12] Mackenzie, E. F. W., and Greenshields, F., "The Influence of Algal Growths on Certain Aspects of Civil Engineering Design".

[13] Atkin, D. J., "Seasonal Fluctuations in Plankton Distribution in a Tropical Impounding Reservoir".

THE SIGNALS RESEARCH AND DEVELOPMENT ESTABLISHMENT, CHRISTCHURCH

THE Signals Research and Development Establishment of the Ministry of Supply held three 'open days' during September 22–24. This was the first time that S.R.D.E., as it is known, has opened its doors to the public to exhibit the work carried out there. It was fortunately possible for Mr. J. Freeman, Joint Parliamentary Secretary to the Minister of Supply, to attend and address the visitors on September 23.

S.R.D.E. has its origin in the Wireless Telegraphy Experimental Establishment which was formed at Aldershot in 1904. It was transferred to Woolwich in 1916 and became the Signals Experimental Establishment. Early in the Second World War, it was renamed the Signals Research and Development Establishment, and was moved to its present location in Christchurch in 1943.

The No. 10 Set is probably the best known of its war-time achievements. This is a multi-channel radio set, the first communication set of its kind to use centimetre waves. The set played an important part during the advance across the Netherlands and Germany. Field Marshal Montgomery paid a special tribute to it in a message he sent to the Radio Convention arranged by the Institution of Electrical Engineers in March 1947. S.R.D.E. also carried out pioneer work on what is now known as 'miniaturization'. During the War, radio sets became more and more complicated. At the same time, the Army was demanding smaller and lighter equipment. This problem could only be solved by giving detailed consideration to each of the very numerous components in turn, searching for new materials of superior properties, and ensuring that every part of a component was essential and was bearing its maximum safe load. The result was that some equipments were reduced in size to as little as a quarter or even a fifth of their previous bulk.

Another problem arose when the British armies commenced to fight in tropical jungles. Equipment which had given satisfactory service in Europe and North Africa rapidly succumbed to attack from moisture and fungus. Moisture barriers had therefore to be devised in all packaging for transport, and either round the complete items of equipment when in use, or else round the individual components in the equipment (thus providing either sealed sets or sealed components in unsealed sets). Time did not allow tests on these developments to be carried out in the jungle, so the jungle had to be brought to the Establishment, in the form of tropical chambers and similar testing facilities.

Pulse Code Modulation and Digital Computation

In the earliest forms of telegraphy, communication was made by on-off keying. This simple system is the basis of the very topical pulse code type of modulation which has created so much interest recently both in Great Britain and in the United States. An experimental equipment was shown demonstrating the transmission of speech using this method of modulation. In this system the instantaneous amplitude of the speech wave-form is sampled at discrete time-intervals (6,600 times per second in the equipment shown) and the amplitude of each sample is transmitted as a coded series of on-off pulses. At the receiver the incoming pulses enable the successive samples of speech to be built up to the level originally measured at the transmitter. With a five-unit code the amplitude of each sample can be indicated to the nearest of 2^5 or thirty-two levels.

Since the transmitted signals are merely on-off pulses, minimum demands are made on the linearity in the transmission equipment, whether radio or cable. Until the condition is reached where noise or interference obliterates a number of the received pulses, the latter can be reconstituted at the receiver to correspond exactly with those originally transmitted. For the same reason, in long links, unmutilated pulses can be regenerated at repeaters so that any cumulative effect of noise or interference can be eliminated. The speech quality obtained with various numbers of amplitude-levels was demonstrated. With only four levels the received speech was intelligible though of poor quality. When the full thirty-two levels were employed, good telephone quality was obtained.

Electronic counting techniques are becoming popular in many applications to electronic control systems. An example of a counting circuit developed at S.R.D.E. was shown in the form of a frequency-dividing circuit operating on the stepping counter principle. Designed to replace the multi-vibrator in such applications as frequency-standardizing equipment and quartz crystal clocks, it is capable of stable division ratios as high as 30 in a single stage incorporating a pentode and double-diode. When used with a suitable input amplitude limiter, it is insensitive to wide variations of input frequency and amplitude, and will tolerate changes in high-tension supply voltages of ± 15 per cent when dividing by 30 and proportionally greater changes at lower ratios, thus dispensing with the need for stabilized power supply.

Research on Radio Materials

Researches in the physics of materials were demonstrated by two exhibits, one dealing with nuclear magnetic resonance and the other with an investigation on the properties of thin films deposited on metals. The phenomenon of nuclear magnetic resonance arises from transitions between the quantum states of nuclear spin orientation relative to an applied magnetic field. The energy-level differences are such as to bring the radiation concerned into the low radio-frequency band. The method first described by Bloch[1] was used to show the hydrogen (proton) resonance in water at a frequency of 6 Mc./s. The sharpness of resonance is limited by magnetic reactions within the substance and, as the resonant frequency is directly proportional to the applied magnetic field, to non-uniformity of this field. However, values of Q as high as 50,000 for proton resonance in water have been obtained.

Nuclear magnetic resonance will undoubtedly be of value in the calibration and control of magnetic fields—by reference to frequency standards. The converse possibility also exists of using the effect to provide continuously variable oscillations and filters of relatively high stability in which the magnetic field is controlled by indirect means. It is the last aspect which is of particular interest to S.R.D.E.

Telemetry

The successful prosecution of research into the characteristics of high-speed projectiles can only be achieved by staging a large number of test flights, during which an accurate and detailed knowledge of the behaviour of a projectile and its mechanism is obtained. Equipment was shown which was developed specially for transmitting this essential data to the ground by radio link and recording it at the receiver in a form convenient for subsequent analysis. Typical of the quantities telemetered are accelerations, pressures, temperatures, electrical currents and voltages, positions of moving parts and the timing of events. In the S.R.D.E. telemetry equipment, the various parameters to be measured are dealt with in sequence at the transmitter in the projectile. The signal is received on the ground, where electronic switching circuits are provided so that the different data may be recorded on separate tracks by cathode ray tube photography. The equipment has been designed to be as versatile as possible; for example, in the receiver, which incorporates cathode ray tubes, facilities are provided for recording the same measurement simultaneously on the traces of separate tubes. In addition to increasing the reliability of the equipment, this procedure allows related parameters to be recorded in close proximity, so making interpretation of the results as simple as possible.

Quartz Crystals

Examples were shown of the different types of quartz crystal units used for frequency-control in Army signals equipment from 1928 to the present day. The results of research into the effects of X-ray irradiation of different cuts of quartz crystals were also shown.

The 'S' Spring

A new mechanical principle, as yet but partially explored, was illustrated by the 'S' spring. A stri of thin spring-steel is clamped at each end and the clamps are twisted in opposite directions, thu forcing the strip into an S-like form. By altering th angles of twist of the clamps the stiffness of th centre of the spring can be varied continuously fro a positive, through zero, to a negative range o values. Moreover, the movement of the centre poin is almost linear. A vibration table, capable of carryin loads of 100 lb., and supported on four 'S' springs was shown in action in the Durability Testin Section.

Radio Sets

(*a*) *Field Pack Sets.* A number of different type of portable transmitter/receiver sets, including thos used during the War, were shown. The most recen set is the Wireless Set No. 88, a compact equipmen weighing only 11 lb. with its batteries, designed fo use by infantry. It operates in the very high frequency band, is frequency-modulated, provides fou crystal-controlled channels and gives a range o 1½ miles over average country.

(*b*) *H.F. Radio Equipment.* A number of high frequency receivers were exhibited. One of these the *R*209, is a small communication receiver usin 'miniature technique', and contained in a complete sealed case. The receiver was shown working submerged in a water-tank. The receiver station of radio teleprinter station using carrier-frequency shi was demonstrated taking long-distance traffic.

(*c*) *Stabilized Oscillators.* For some years S.R.D.E has worked on the problem of stabilizing oscillato without using quartz crystal control. A stabilize oscillator having a constancy approaching that of crystal-controlled circuit was demonstrated. Nov vapour-pressure thermostats which have been foun necessary for maintaining constant the temperatu of the master oscillator were also shown.

Line Equipment

In the Line Laboratories a comprehensive arra was shown of Army teleprinters, switchboards, carri telephone sets and testing instruments. A pa ticularly interesting instrument is the pulse fau locator. This sends a radio pulse along a line in whi a fault, either a disconnexion or a short circuit, suspected. The pulse is reflected at the fault, becau this causes a discontinuity on the transmissi characteristics of the line, and returns to the s The time taken by the pulse to do the journey measured and the distance to the fault determine

Electro-Acoustics

Demonstrations were given illustrating the ada ability of the ear. Recordings showed that spee which had been seriously distorted in a number ways can still be intelligible. This was followed recordings taken over some transmission syste which apply various forms of controlled distortion order to improve intelligibility under adverse c ditions or to achieve economies in the transmissi path.

An exhibition of Army telephone instruments showed the evolution from the early sets to the latest efficient light-weight telephone set which is carried in a small webbing-pouch by the lineman.

Equipment and Component Testing

S.R.D.E. has a very well-equipped laboratory for testing component parts and complete sets. Every imaginable climatic test can be applied—heavy and tropical rain, sand-storms, low temperatures and pressures, even tropical storage, which includes typical fungi and mould growths. The rigours which Army sets must withstand were also demonstrated by vibration, bumping and dropping tests. Microscopy and X-ray examinations are used to assist in locating faults.

The G.O.C. Southern Command provided a display of R.E.M.E. mobile workshops. These are lorry vehicles provided with work-benches, test equipment and repair facilities ingeniously arranged to make the most of the limited space. By means of these workshops, Army signals equipment is maintained and kept in good repair in the field. R.E.M.E. personnel were shown at work repairing radio and line sets.

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[1] Bloch, F., *Phys. Rev.*, **70**, 460 (1946).

OBITUARIES

Prof. F. Weidenreich

THE distinguished anatomist Dr. Frank Weidenreich died after a short illness in New York on July 11, 1948, at the age of seventy-five. Although he was known to the present generation primarily for his work in the field of human palæontology, he had in the early part of his career gained a considerable reputation as a histologist. After taking his doctorate of medicine in the University of Strassburg in 1899, he joined the staff of the department of anatomy and studied under Prof. Schwalbe, and in 1904 he was appointed professor of anatomy. His interests at that time were concentrated on the blood-forming tissues of the body and he contributed a series of papers on the histology of the spleen and the blood-lymph system. Some of these papers, it is interesting to note, are still quoted as standard references.

At the end of the First World War, Weidenreich was compelled to vacate his position at Strassburg, and in 1921 he was appointed to the chair of anatomy at the University of Heidelberg. From that date he seems to have transferred his attention to problems of physical anthropology, mainly, it would appear, as the result of studies which he made on the structure of bone in relation to function. In 1921, he published an extensive monograph on the comparative anatomy and evolution of the human foot, and in 1926 he entered the field of human palæontology by a comprehensive study of the famous Ehringsdorf skull.

In 1928, Weidenreich was elected to the chair of anthropology at Frankfurt. This he held until 1935, when the difficulties of the political situation in Germany became too great. It was then that Weidenreich was invited to take the chair of anatomy at Peking Union Medical College, recently vacant by the death of Dr. Davidson Black. This appointment was combined with the directorship of the Cænozoic Research Laboratory of the Geological Survey of China. Dr. Weidenreich's energetic studies of the skeletal remains of the early type of fossil man, *Sinanthropus*, excavated at Choukoutien, are too well known to need recapitulation here. He produced a series of magnificent monographs, richly and profusely illustrated, which proved of the greatest value to anthropologists everywhere. Their value has now been even more enhanced by the fact that almost all the original material on which these monographs were based—material of supreme importance to the student of human evolution—was lost during the Japanese invasion of China.

Dr. Weidenreich himself was forced to leave China in 1941 in order to escape the invasion. He made his way to the United States, and was there offered hospitality in the American Museum of Natural History. Here he continued his researches, and published a number of articles in which he strove to integrate the results of his earlier studies in a constructive account of what to him appeared to be the probable sequence of human evolution. Shortly before his last illness, Dr. Weidenreich was engaged on an intensive study of the Solo skulls discovered in Java a few years before the War, and brought to America after the cessation of hostilities by Dr. von Koenigswald. This study was still unfinished, but it was rapidly approaching completion—sufficiently so, it is to be hoped, to make possible its publication in some form.

Weidenreich's life was one of intense and continuous intellectual activity, the more remarkable since his work was so often interrupted by the disruptive effects of wars and political dislocations. But he had an indomitable spirit, and his long series of scientific publications bears witness to the energy with which he pursued his intellectual inquiries, regardless of obstacles which would certainly have frustrated a lesser man. W. E. LE GROS CLARK

Dr. J. W. S. Macfie

BY the death of Dr. J. W. S. Macfie at the age of sixty-nine, tropical medical research has lost a worker of outstanding ability and high character. He was educated at Oundle School and at the Universities of Cambridge and Edinburgh, taking the degrees of B.Sc. and M.B., Ch.B. (1906), and later the D.Sc. After residence at the Radcliffe Infirmary, Oxford, and work in physiology under Sir Charles Sherrington, he took the diploma of the Liverpool School of Tropical Medicine in 1910 and joined the West African Medical Staff. He investigated sleeping sickness in Nigeria and took charge of the Medical Research Institute there. In 1914 he became successively pathologist in charge and director of the medical laboratory at Accra, Gold Coast, and held this post until his retirement in 1923, with an interval from 1917 to 1919, when he worked in Liverpool with Prof. Warrington Yorke and others on malaria. Shortly before his retirement he designed the plan of the present Medical Research Institute at Accra. He afterwards studied in Liverpool and London, accompanied Dr. Melly with the British Red Cross to Abyssinia in 1935, and during the Second World War had war duties in London and went to Egypt, Palestine and Syria as malariologist in the R.A.M.C. He was awarded the Mary Kingsley Medal by the Liverpool School of Tropical Medicine.

Macfie was a keen investigator with original ideas and a critical mind ; his laboratory technique was of a high standard, and his experiments seldom needed repeating. His researches in tropical medicine included protozoology (trypanosomes, malaria parasites, amœbæ), helminthology (schistosomes, filariæ, hookworms, guineaworm), entomology (mosquitoes, Ceratopogonine midges and other arthropods), and fungi (*'Nocardia'* or *Discomyces*). His articles and annual reports were written in a clear and attractive style, at times with a whimsical touch, and illustrated with excellent photographs taken by himself; an examination of paper money in Accra, for example, was recorded under "Filthy Lucre". He was much in favour of closer association between research workers in the Colonies and those in Britain, and even thought that a tour of duty might well be shortened by a month to be spent in one of the home laboratories.

It was my privilege to work with Macfie and his friend and colleague, the late Dr. Alexander Ingram, at the Accra laboratory nearly thirty years ago, and I then formed a very high opinion of his personal qualities. He was devoted to research, while not neglecting routine, and his outlook was quite uncommercial and free from self-interest. Though rather shy and reserved, he would firmly resist any moves which he thought would impair the efficiency of his department. The Gold Coast Government once offered him £500 in recognition of his work; but he declined it, saying that the laboratory work was done by the whole staff, and suggested that the money be given to assist further research. His health was never good and he could not stand a long tour of residence; but every day was filled with work and he grudged the loss of time when, as sometimes happened, interruptions were too frequent. He entered little into the general social life at Accra, but liked to entertain a few friends; as he was an excellent host and good companion, such occasions were very enjoyable. He took a great interest in original work by junior men, and would write helpful and encouraging letters to those working alone in out-stations. He was kind and sympathetic to his servants and staff and was liked and respected by them as, indeed, he was by all who knew him. His "Ethiopian Diary" is characteristic of the man. J. F. Corson

Mr. G. H. Gabb

George Hugh Gabb, who loved to style himself the 'Father of the Scientific Antiquaries', died on August 11, aged eighty years. He was educated at Bishops Hatfield School and later studied chemistry at the Polytechnic. He was for some time analyst to Welford and Son, and in 1892, in conjunction with Dr. Faber, he invented and put on the market the first type of humanized milk. Later he set up as a consultant on his own account. He retained an interest in public health, and, during a part of the period when he was a councillor of St. Pancras, was chairman of the Public Health Committee.

In 1885, Gabb became interested in the history of science and began to acquire his remarkable collection of scientific antiquities. He was at once a fine craftsman and a connoisseur. He had great understanding and sympathy with the instrument-makers and studied their crafts, thus becoming a master-hand at the treatment and conservative restoration of masterpieces. His understanding of the quality of early work enabled him unhesitatingly to detect forgeries and 'reconstructions'. As one of the first of collectors at a period when there was little interest in old scientific instruments, he was able to make a collection which consisted of really first-class specimens in perfect condition. Among his discoveries were the astrological astrolabe of Queen Elizabeth (*c.* 1570), the earliest dated English theodolite (1574) and the earliest known dated telescope (1646). His collection was acquired in 1937 by Sir James Caird, who presented it to the National Maritime Museum. Gabb was also an expert in the field of scientific iconography, and discovered many unknown or lost portraits of men of science, ranging from Galileo to Dalton. He was a severe critic in such matters and discredited many portraits accepted as genuine. His interests covered a wide field. He was an enthusiastic photographer, and the last survivor of a small group of X-ray workers who were experimenting in the years 1896–97; among his long succession of exhibits at the Royal Society's conversaziones was an X-ray photograph of his hand, made in February 1896.

Gabb was a remarkable character—a very typical collector, who would stick at nothing to acquire the instruments he coveted. He was by no means blind to his own qualities in this field, and his amusing conversation was not a little marred by its egocentric character. None the less, he was a mine of information and gave to his 'antiquarian sons' treasures of technique which could have been learnt nowhere else. To the Royal Society he left £1,000 to provide for a Leeuwenhoek Lecture on some subject in the field of microbiology; to the Science Museum a number of instruments of historical interest; to the University of Oxford, for the Museum of the History of Science, a collection of drug-jars and some sixty engravings and portraits; and to the Royal Institution a number of letters and relics of Michael Faraday.

We owe a great debt to George Hugh Gabb for his preservation for posterity of so many of the fast-disappearing relics of the great men of science on whose shoulders we stand. F. Sherwood Taylor

Dr. J. H. Shaxby

Dr. J. H. Shaxby, who died at Cardiff on September 29, was born at Ashford, in Kent, on May 23, 1879. After his schooldays at Canterbury, he studied at Aberystwyth and then at the Royal College of Science, London, where he became a demonstrator in physics and where he lost an eye in a laboratory accident. In 1904 he joined the staff of the Physics Department at Cardiff and eventually became director of the Viriamu Jones Physical Research Laboratory. In 1924 he relinquished that post when he was appointed lecturer in special sense physiology in the Physiology Department of the School of Medicine at Cardiff, a position which he held until he retired in 1946, but without severing his connexion with the Department. Among many other activities, he was a member of the Physiology of Hearing Committee of the Medical Research Council and was chairman of a committee of the Physical Society on Defective Colour Vision.

Shaxby's scientific interests covered a wide field. An early book of "Elementary Electrical Engineering" (1907) was followed by studies in Brownian movement. Then his service as an X-rays officer in the First World War led to papers on methods for localizing foreign bodies by X-rays. After the War he returned to more purely physical problems with work on vapour pressures and the isothermals of vapours, on the properties of powders, on the diffusion of suspended particles, and on the relation between density and temperature in fluids. An earlier interest in colour vision became dominant after about 1930 and culminated in two ingenious theoretical papers (*Phil. Mag.*, 1943 and 1946); but during the same period Shaxby was also much occupied with the physiology of hearing, and in particular with phenomena at the threshold of audition, and with the binaural localization of sounds. During 1932–35 he undertook long-range reception of gun-fire noises for the Air Ministry, and in 1937 he became interested in geomagnetic surveying, for which he invented a device for varying the sensitivity of the magnetometer.

This sketch by no means exhausts Shaxby's many interests even in the field of science. As a man, he was a most lovable and loyal colleague with whom it was a pleasure and a privilege to work.

T. GRAHAM BROWN

WE regret to announce the following deaths:

Dr. S. C. Bradford, until 1938 chief librarian of the Science Library, South Kensington, and founder, with the late Prof. A. F. C. Pollard, of the British Society for International Bibliography, on November 13, aged seventy.

Mr. R. Elmhirst, director of the Scottish Marine Biological Laboratory at Millport, whose forthcoming retirement was announced in *Nature* of October 30, p. 688, on November 13, aged sixty-four.

Prof. Karel Kavina, director of the Botanical Institute of the Prague Technical University for many years and known for his "Atlas of Fungi" (1927), a second enlarged edition of which appeared this year, aged fifty-eight.

Mr. E. Platt, geologist and leader of the Falkland Islands Dependencies Survey at Admiralty Bay, King George Island, South Shetlands, on November 9.

NEWS and VIEWS

Royal Society: Medal Awards

H.M. THE KING has been graciously pleased to approve the following recommendations made by the Council of the Royal Society for the award of the two Royal Medals for 1948:

Prof. Harold Jeffreys, for his distinguished work in geophysics and his important contributions to the astronomy of the solar system;

Prof. James Gray, for his distinguished researches in cytology, ciliary movement and particularly his anatomical and experimental studies of animal posture and locomotion.

The following awards of medals have been made by the president and council of the Royal Society:

Copley Medal to Prof. A. V. Hill, for his distinguished researches on myothermal problems and on biophysical phenomena in nerve and other tissues.

Rumford Medal to Prof. F. E. Simon, for his outstanding contributions to the attainment of low temperatures and to the study of the properties of substances at temperatures near the absolute zero.

Davy Medal to Prof. E. L. Hirst, for his outstanding work in the determination of the structure of sugars, starches, plant gums and especially of vitamin C.

Darwin Medal to Prof. R. A. Fisher, for his distinguished contributions to the theory of natural selection, the concept of the gene complex and the evolution of dominance.

Hughes Medal to Sir Robert Watson-Watt, for his distinguished work in atmospheric physics and in the development of radar.

British Astronomical Association:
Dr. J. G. Porter

MR. F. M. HOLBORN retired from the presidency of the British Astronomical Association on October 27 and was succeeded by Dr. J. G. Porter. Dr. Porter is well known in astronomical circles, not only in connexion with his broadcast talks, but also for his work for the Computing Section of the Association, of which he has been director for many years. He has also carried out investigations on the speeds of meteors and has shown that these bodies are members of the solar system, none of the cases that he has dealt with showing hyperbolic velocities; this would seem to dispose of the results of the Harvard College Observatory Expedition to Arizona some sixteen years ago.

Los Angeles State and County Arboretum:
Dr. Frans Verdoorn

DR. FRANS VERDOORN, managing editor of *Chronica Botanica*, has been appointed director of the Los Angeles State and County Arboretum at Arcadia, California. He will assume the directorship of this new arboretum in the immediate future. It is planned to develop a modern arboretum and botanical garden at Arcadia with various educational and research departments. Dr. Verdoorn will continue to edit *Chronica Botanica* and other journals. Some of these will be published in the future by the Los Angeles State and County Arboretum, while others will be transferred to a commercial publisher.

Dr. Verdoorn, a native of the Netherlands, went to the United States in 1940. Formerly known for his work in cryptogamic botany, he has lately been occupied chiefly with historical studies and international relations work. He was an assistant at the Buitenzorg Botanic Gardens, Java, in the 1930's and has been a research fellow at Harvard University since 1940. During the war years he did much work on Latin America and South East Asia for various government agencies. He received the first Mary Soper Pope Medal in 1946, and has just been appointed chairman of the International Phytohistorical Committee.

Control of Nationalized Industries

IN an address on "The Consumer in Relation to Non-Competitive Industry", delivered at the fifty-second Oxford Management Conference of the British Institute of Management held at Scarborough on October 16, Mr. Herbert Morrison said that increasing use of economists is being made in the work of government; but his address was chiefly concerned with the administrative policy pursued to protect the consumer in industries where full competition does not operate—a field which is not coterminous with that of public ownership. While under the competitive system the threat of withdrawal of custom could be a spur to efficiency, the corresponding safeguard with socialized industries should be their sensitiveness to public complaint. The consumer, he said, is entitled to demand that such industries avoid extravagant administration, attain a high degree of efficiency, pass to the consumer a substantial share of the results of higher productivity and have sufficient regard to the legitimate wishes of the consumer in matters of quality and variety.

Most of Mr. Morrison's address was devoted to an outline of the general organisation of the various public boards controlling certain industries in Britain, in which he stressed particularly the safeguards provided for the interest of the consumer. We have to rely on the various boards, Mr. Morrison said, to hold the balance fairly between consumer and worker, and he concluded that the consumer would be primarily dependent for a fair and reasonable level of price on the efficiency of the boards and their ability to keep both management and workers 'on their toes'. Such public boards should provide a reasonable safeguard against gross discrimination between consumers, but the address contained little evidence that the conditions Mr. Morrison specified are, in fact, being observed. It cannot now be seriously contended that even the Post Office passes on to the public the advantages in speed and efficiency which technical improvements have made possible, and the difficulties experienced in raising questions in the House of Commons regarding the public boards suggests that new means must be sought of making them sensitive to public opinion.

Australian Council for Scientific and Industrial Research

DESPITE grave misrepresentation of its motives, the Executive Committee of the Australian Council for Scientific and Industrial Research appears to have convinced the Commonwealth Government that scientific work for war purposes should be conducted under the Ministry of Supply or the Ministry of Defence rather than under the Council. The contention is that the conditions of secrecy and military security essential nowadays for war-work will require an atmosphere in which the normal activities of the Council on behalf of primary and secondary industry simply cannot flourish. The Council has for twenty-two years operated under an Act, originated by Viscount Bruce, giving it a high degree of freedom and independence; for many reasons it is believed that, in existing conditions, the two contrasting lines of work cannot be effectively controlled by the one body.

In providing for the transfer to another Commonwealth agency, under public service board control, of the small amount of work bearing on defence at present conducted in the laboratories of the Council for Scientific and Industrial Research, a Bill now before Parliament unfortunately goes further and opens the way for subjecting any or all of the Council's activities to public service board procedure and regulations. Strong exception is being taken by scientific men and societies in Australia to this action, which is regarded as a serious threat to the spirit and successful working which have characterized the Council for Scientific and Industrial Research in the past.

Australian Journal of Scientific Research

A NEW periodical of high standard, the *Australian Journal of Scientific Research*, has recently been launched by the Australian Council of Scientific and Industrial Research, Melbourne, in collaboration with the Australian National Research Council (see *Nature*, August 7, 1948, p. 210). It is being issued quarterly in two series, Series A (Physical Sciences) and Series B (Biological Sciences), the price of each being 7*s*. 6*d*. The editor and chairman of the editorial board is Dr. N. S. Noble, and the other members of the board are Profs. W. J. Dakin, E. J. Hartung, L. H. Martin and J. G. Wood.

The first number (March 1948) of Series A contains seven papers on physical, chemical, metallurgical and meteorological subjects, indicating the variety of researches undertaken or sponsored by the Australian Council of Scientific and Industrial Research. These include: an analytical treatment, by G. H. Godfrey, of the distribution of light intensity in the Fraunhofer diffraction pattern of continuous light sources, in which attention is directed to certain diffraction effects which have not been previously recorded but which are in agreement with the theory; a study, by V. D. Hopper and A. M. Grant, of the effect of a horizontal wall on the motion of oil drops, of radii 5–15 μ, falling in air, in order that the corrections to be applied in the precise determination of the electronic charge by the oil-drop method may be accurately made; observations on a strong variable source of radio frequency energy in the constellation of Cygnus; a microscopic and X-ray examination of the deformation or recrystallization of a duplex brass; and the testing of molecular layers of the silicones on various metal surfaces for their boundary lubricating properties.

German Scientific and Technical Periodicals

THE Foreign Office of Great Britain has recently compiled a list of more than three hundred German scientific and technical periodicals which have resumed publication. The list is divided into the following sections: agriculture and forestry; mathematics, physics and chemistry; medicine; natural science; and technology and industry. Very short notes, including the price where listed, are given with each periodical. Inquiries regarding the list should be made to the Foreign Office (German Section), Room 211, King Charles Street, London, S.W.1.

Financial Aid for Delegates at Conferences

THE British Council has a small fund for the assistance of overseas delegates wishing to attend national or international conferences held in the United Kingdom on scientific subjects including agriculture, engineering and medicine. Except in special circumstances, fares to and from the United Kingdom will not be paid, and the grants are mainly designed to cover subsistence of the delegate for the duration of the conference up to a period of two weeks. Conveners of conferences to be held during the period April 1, 1949–March 31, 1950, should apply to the Director, Visitors Department, British Council, 3 Hanover Street, London, W.1, giving full details including the number of delegates requiring assistance and their nationalities. Such information should be lodged preferably not later than January 15, and replies will be made by the end of February.

World Federation for Mental Health

THE World Federation for Mental Health, formed at the time of the international congress in London last August, has now been officially recognized for consultative purposes by the two United Nations bodies—the World Health Organisation and Unesco. The president of the World Federation, Dr. J. R. Rees (Great Britain), has expressed the hope that this consultative arrangement will lead to a further recognition of the importance of mental health in efforts to establish a healthier and happier world society. Dr. Rees also announced that the Federation has accepted the invitation of Unesco to send an observer to its general conference which opened at Beirut on November 17. The Federation is being represented by Dr. M. K. el Kholy, of Egypt, the member for the African Continent on the Executive Board.

The World Federation already comprises twenty-one mental health associations of different nations, and others are expected to be admitted to membership in the near future. Dr. André Repond, of Switzerland, now vice-president, in accordance with the by-laws of the Federation, will succeed Dr. Rees as president next year. Prof. H. C. Rümke, of Holland, is chairman of the Executive Board, which will meet in Amsterdam in January. Arrangements are also now being made for the Assembly of the World Federation to be held in Geneva next August, when delegates from all over the world will be present.

P. F. Frankland Memorial Lecture

THE Birmingham and Midlands Section of the Royal Institute of Chemistry is endeavouring to collect £1,500 to establish a memorial lecture in honour of Percy Faraday Frankland, who occupied the Mason chair of chemistry in the University of Birmingham with great distinction during 1894–1918 and who died two years ago. The lectures will be delivered in Birmingham at intervals of three to four years and will deal mainly with original work; they will be published and may be expected to make a notable contribution to chemical literature. All money subscribed goes to the endowment; cheques drawn in favour of "P. F. Frankland Memorial Lecture", crossed a/c payee, should be sent to Mr. E. M. Joiner (secretary, Birmingham and Midlands Section, Royal Institute of Chemistry), 15 Halton Road, Sutton Coldfield, Warwickshire.

Lantern Slides of Diagrams, Formulæ, etc.

IN *Nature* of June 29, 1946, p. 879, and several earlier issues, correspondents described methods they had used successfully for writing on glass. Mr. E. H. Leach, University Laboratory of Physiology, Oxford, states that any ink to which a drop or two of a solution of a synthetic detergent ('Teepol' type) has been added can be used for writing on any clean glass surface. Indian ink appears to be the most suitable. Some proprietary brands of ink appear to contain synthetic detergent and require no further addition. Glassware and microscope slides can be marked with such inks.

Hawaiian Libraries

MANY people are unaware that excellent libraries exist in Hawaii in conjunction with that country's museums, university, research institutions and archives of the Government. For information on the holdings of these libraries a "Union List of Serials in Hawaii" is being prepared; the Committee on the Union List, Hawaii Library Association, Honolulu, Territory of Hawaii, invites pre-publication orders at 3 dollars a copy.

Conference on Organised Information Services

THE Northern Branch of Aslib has arranged a conference on the general theme of the value of organised information service to industry, commerce and education, to be held at the North of England Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne, on December 7. The chair will be taken by R. Trevor Jenkins, technical manager, Vickers-Armstrongs, Ltd., Elswick and Scotswood Works, Newcastle-upon-Tyne. The conference will be opened at 10 a.m. by the Lord Mayor of Newcastle-upon-Tyne. Dr. V. E. Parke will speak on "Intelligence: Some Fundamental Principles", and will be followed by Mr. E. Austin Hinton on "Industrial, Technical and Commercial Information: The Contribution of the Public Library". In the afternoon session, at 2.30 p.m., Mr. R. O. MacKenna will speak on "Information Service from the point of view of the Universities", and will be followed by Mr. T. S. Nicol, who will deal with the point of view of professional associations. Miss J. Scurfield will speak on "The Regional Library Bureaux"; Miss E. M. R. Ditmas will deal with the work of Aslib, and Mr. R. Brightman with that of the Northern Branch. Conference tickets can be obtained (5*s*. each) from the local organising secretary, Mr. M. G. Cahill-Byrne, Vickers-Armstrongs, Ltd., Elswick Works, Newcastle-upon-Tyne, 4.

Comet 1948 l

DR. R. D'E. ATKINSON, who led the Royal Observatory eclipse expedition, cabled confirmation of a bright comet seen in the southern sky early in November. During the eclipse on November 1 a photograph showed that the comet was 1° 33′ from the centre of the sun, and it was then very bright with a tail. It has been seen in different parts of the southern hemisphere since then. Its brightness has been estimated as mag. 2. Its daily motion is approximately −8·1m. in R.A. and −51′ in declination. It is doubtful whether it will be seen from the British Isles. The latest description from the Cape Observatory states that the object is diffuse with central condensation or nucleus, and that the tail exceeds 1° in length; hence some of the Press reports about the length of the tail were probably exaggerated.

The Royal Observatory, Cape Town, has communicated the following parabolic orbit and ephemeris computed by Hirst and Stoy:

Elements

T	1948 Oct. 27·460 U.T.	
ω	106° 00′	1948·0
Ω	209 44	
i	22 48	
q	0·1296	

Ephemeris
0h. U.T.

1948	α 1948·0	δ 1948·0
Nov. 14	12h. 37·4m.	−25° 53′
18	12 04·4	28 40
22	11 30·9	31 04
26	10 56·1	32 57

Announcements

THE following higher degrees have been conferred by the University of Aberdeen: Ph.D., on G. F. Walker, for a thesis on "The Clay Mineralogy of some Aberdeenshire Soils"; M.D., on H. McL. Raffan, for a thesis on "Poliomyelitis in Aberdeenshire".

ERRATUM. Dr. Oscar Hechter states that the reference in the communication "Spreading Phenomenon and Inflammation" (*Nature*, October 30, p. 701) to earlier work (par. 4) should be to footnote 1, and not footnote 2 as appeared in his manuscript.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Clinical Potentialities of Certain Bisquaternary Salts Causing Neuromuscular and Ganglionic Block

Two members of the polymethylene $\alpha\omega$-bistrimethylammonium series[1] ($[N^+(CH_3)_3.(CH_2)_n.N^+(CH_3)_3]\ 2I''$) appear to possess activities which may be suitable for clinical use—the C 10 derivative ($n = 10$) to produce neuromuscular block, the C 6 derivative ($n = 6$) to produce ganglionic block. We wish to describe briefly the main characteristics of these compounds, in view of the great attention being paid to possible substitutes for *d*-tubocurarine chloride[2,3] and to the use of tetraethylammonium iodide for ganglionic block[4].

The accompanying table gives the doses of C 10 and *d*-tubocurarine chloride which are approximately equipotent in causing neuromuscular block when injected intravenously into unanæsthetized monkeys (*Macaca mulatta*), cats and rabbits.

	Monkey	Cat	Rabbit
d-Tubocurarine chloride (mgm./kgm.)	0·1	0·15	0·17
C 10 compound (mgm./kgm.)	0·3	0·03	0·10

These results show variation of potency of the C 10 derivative of the bistrimethylammonium salt with species (as we previously reported); preliminary trials indicate that man is close to the cat in sensitivity. The onset of the paralysis is smooth and uneventful in the monkey and the cat; in the rabbit, transient fine fasciculations (of the type reported in the cat under chloralose[1]) are just detectable. In general, the order in which the various muscles are paralysed and recover from paralysis is much the same as with *d*-tubocurarine chloride.

The main difference between the C 10 compound and *d*-tubocurarine chloride lies in the relative sparing of the respiration by the former in the monkey and the cat. In the monkey, even a small dose of *d*-tubocurarine chloride (0·075 mgm./kgm.), sufficient to produce weakness for about ten minutes, is accompanied by exaggerated movements of the nostrils and trunk indicative of respiratory difficulty. Similar respiratory signs can only be produced by the C 10 compound under test with a dose of 0·5 mgm./kgm., which causes complete paralysis of the animal for ten minutes, and weakness for an hour. Similar observations have been made in unanæsthetized and anæsthetized cats, and (to a less extent) in the rabbit. The ratio of the dose which just suspends respiration in half the animals to that which produces definite weakness for at least 10 min. has been estimated, as an index of the relative activity on respiratory and other muscles. In the monkey, the ratio is 2·6 for the C 10 compound, and 1·5 for *d*-tubocurarine; in the cat, the ratios are respectively 2·2 and 1·25. In the rabbit we have not been able to demonstrate any significant difference by this method, the ratio in both cases being close to unity. It is also noteworthy that the duration in the monkey of a paralysis due to the C 10 compound is usually two to three times longer than that of one of equal initial intensity due to *d*-tubocurarine chloride.

Eserine and prostigmine do not antagonize the C 10 compound; but a lower member of the series, C 5, has proved to be a useful antagonist. In all three species, an injection of 0·5–5 mgm./kgm. of C 5 cuts short a moderate or shallow paralysis, accelerates recovery from a deep curarization, and restores to normal a respiration that is becoming inadequate, where these conditions are due to the C 10 compound.

The C 10 compound must be compared with *d*-tubocurarine chloride in two other respects: (*a*) the latter is active in paralysing autonomic ganglia, and may thereby cause a small fall in blood pressure; the former exhibits some activity of this kind, but requires a dose five to ten times as great to produce the same effect; (*b*) the latter is known to liberate histamine[5], and such liberation might cause undesirable side-effects; the former can also be shown to produce an effect on the blood pressure characteristic of histamine liberation[6]; but it requires a dose at least four times larger. We have confirmed Barlow and Ing's[7] finding that this series of compounds possesses a weak anti-esterase activity; but this activity does not appear to produce any side actions, except possibly the fine fasciculations in the rabbit mentioned above. Chronic toxicity tests have shown that rabbits and cats can receive curarizing doses of the C 10 compound daily for six weeks without change in type or degree of the paralysis, or deterioration in the health of the animal.

As a possible substitute for *d*-tubocurarine chloride, therefore, this C 10 compound merits consideration, since it is both potent and can be antagonized; it also has the following advantages: (1) it spares the respiration; (2) it has less ganglionic action; (3) it has less power of liberating histamine; (4) it is a simple compound easily synthesized.

The C 6 derivative possesses great potency in paralysing autonomic ganglia, although it is inactive in other respects except in very large doses. Its effects, when injected in a dose of 0·1–1 mgm./kgm., are closely similar to those of tetraethylammonium iodide (paralysis of contraction of cat's nictitating membrane excited by preganglionic stimulation; fall of blood pressure, no longer obtainable after a paralysing dose of nicotine; paralysis of peristaltic reflex of rabbit intestine; paralysis of parasympathetic ganglia of the heart), and have been shown to be restricted to the autonomic ganglia. C 6 differs from tetraethylammonium iodide in its greater potency (ten to twenty times, according to test object), and in its slower onset and three to four times greater duration of action.

The C 6 derivative, therefore, offers possibilities of clinical usefulness in such fields as hypertension and vascular disease, whenever tetraethylammonium iodide has too brief or slight an action.

Details of the pharmacological investigations will be published in full elsewhere.

W. D. M. PATON
E. J. ZAIMIS
National Institute for Medical Research,
London, N.W.3.
Aug. 17.

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Tracer Phosphatase Determination in Tissue Sections

THE increasing use of radioactive tracers in biology demands methods for quantitative recording even in tissue sections. Autoradiography furnishes one method, either by simply placing the sections containing the radio-ions towards a photographic plate[1], or by covering the section itself with a film of photographic emulsion[2,3]. In this way α- and even β-rays can be recorded[4].

The Geiger – Müller counter, however, is still the best means for quantitative recording of β-rays. I have used a counter in the way described below to record the amounts of radioactive tracers in tissue sections as well as of tissue extracts according to established principles.

A Geiger – Müller counter, as described by Ambrosen, Madsen, Ottesen and Zerahn[5], is placed within a lead cylinder directly above an aluminium turntable with eight holes for small aluminium dishes which contain the radioactive material. The electrical details of the apparatus, which contains a regulated 2,000-volt power supply, a scale-of-16 and a scale-of-10, a registering device and an arrangement which makes it possible to make counts for each dish or slide automatically as long as desired within the limits of 2 minutes and 30 hours, has been described elsewhere[6].

When tissue sections are to be measured, they are mounted on polished slides and covered by a 'Cellophane' coverslip ; the sections are placed above the holes in the turntable, and by means of a microscope fixed to the apparatus their positions are controlled. Small brass plates, 1 mm. thick, with diaphragms of the desired diameters, ½–2 mm., are then lowered upon the slides and are kept in place by means of small pins fitting into holes in the turntable. Before the plates are pressed into position, it is checked by the microscope that the desired parts of the sections actually are centred beneath the diaphragms.

Now the Geiger – Müller tube with its lead cylinder is raised 2 mm. by means of a half-moon-shaped piece of lead which corresponds to the height of the slide plus brass plate, and the counting may begin.

As the brass plate directly covers the section, except for the 0·05 mm. thick 'Cellophane' coverslip, the amount of tissue in which the radio-ions are measured depends only upon the diameter of the diaphragm and the thickness of the section. Using a common diaphragm of 1 mm.[2] and sections of 5 μ, the amount of tissue under observation is only 0·005 mgm. Either frozen sections or paraffin or celloidin sections, stained or unstained, may be used. When possible, stained sections are preferred, as the histological examination and the radio-ion counting can then be undertaken in the same section.

As an example of the method, I have made a quantitative estimation of phosphatase in tissue sections by means of a modified Gomori[7] technique. The tissue, fixed in 80 per cent alcohol and imbedded in paraffin wax melting at 42°, is cut in 10 μ sections which are deparaffinized and incubated in a substrate of glycerophosphate containing radiophosphorus and calcium nitrate. The sections, which now contain radioactive calcium phosphate, can then be placed directly in the apparatus, and afterwards—or previously—be stained with cobalt according to Gomori. The Gomori technique thus affords a qualitative, and the method mentioned here a quantitative, means of estimating phosphatase in the same section.

A further report of the results will appear in due course.

JÖRGEN B. DALGAARD

Department of Anatomy,
University of Aarhus,
Denmark.
June 6.

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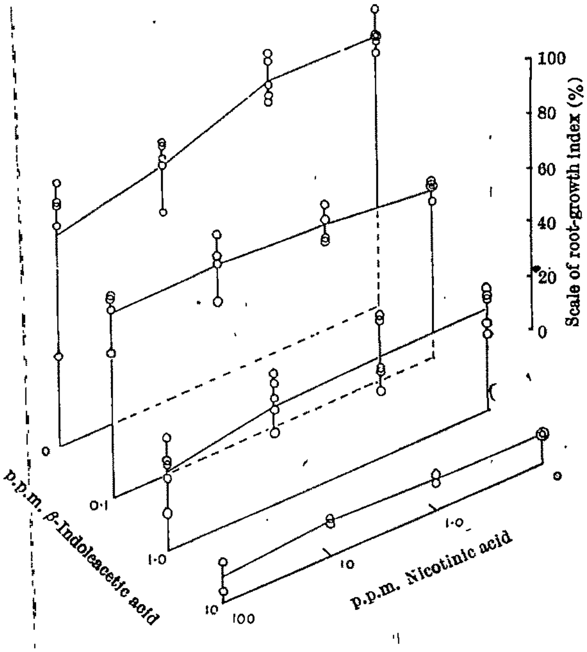
Nicotinic Acid and the Inhibition of Growth by Auxin

IN a recent paper, Galston[1] has shown that β-indoleacetic acid, at concentrations of 1–10 p.p.m., inhibits the growth in the dark of excised stem tips of *Asparagus*, in contrast to its normal stimulating effect in the light. Nicotinic acid, at a concentration of 0·5 p.p.m., was shown greatly to augment this dark inhibition, although without any effect by itself. These results were regarded as indicating that nicotinic acid is involved in the growth-regulating action of β-indoleacetic acid.

Recently, I have been studying the interactions with auxins of a wide range of plant metabolites in the growth inhibition of roots, and a considerable number of observations has been made with nicotinic acid. The technique employed has been fully described in a previous paper[2] and consists essentially of growing samples of cress seedlings in sterile water-culture in a number of different concentrations of the two substances both singly and in all possible combinations of those concentrations. Total root-



Three-dimensional diagram showing the interaction of nicotinic acid and β-indoleacetic acid in the growth-inhibition of cress roots growth per seedling was determined by weighing the fresh excised roots at the end of the experiment (7–10 days growth) and expressed as a percentage of the controls in the pure culture medium (root-growth index). The seedlings were grown in normal daylight. The results of a number of experiments are collected in the accompanying three-dimensional diagram. The two basal axes represent a grid of the various combinations of concentrations of β-indoleacetic acid and nicotinic acid, while the vertical axis gives the relevant values of the root-growth index.

It will be seen that nicotinic acid by itself brings about slight growth inhibition at high concentrations, but is without significant effect in any of the β-indoleacetic acid concentrations. It is possible that nicotinic acid may itself be, or may give rise to, an inhibitor of the auxin type in these high concentrations; but its effect is not detectable in the presence of the much more active β-indoleacetic acid. There is certainly no indication of any synergistic effects of the two substances, and this suggests that the phenomenon observed by Galston is not of general occurrence.

It is pointless with such meagre data to attempt an explanation of the discrepancy between two such isolated observations; but the above results suggest that the experiments of Galston should be repeated on an organ in which the inhibiting action of auxins has been much more intensively studied, such as the root. It is hoped eventually to extend the above investigations to excised roots growing, as in the case of Galston's stem tips, on a purely synthetic medium.

L. J. AUDUS

Botany Department,
University College of
South Wales and Monmouthshire,
Cardiff.

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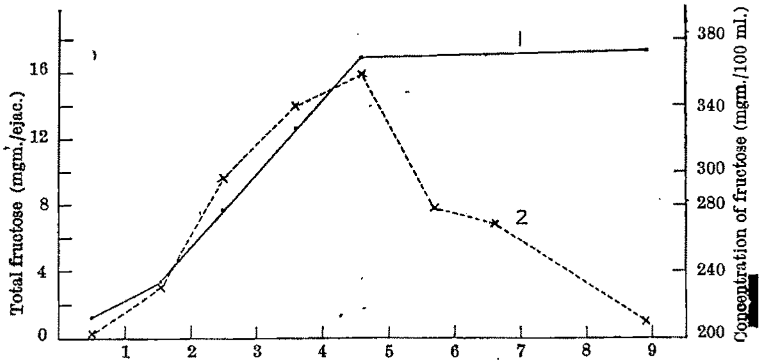
Relation between the Volume and Fructose Content of Human Semen

ESTIMATIONS of fructose content, by the method described by Mann[1], have been carried out on 150 specimens of human semen, obtained from 123 individuals. Of these, 41 ejaculates were obtained from 31 men of proved fertility, the remainder from men whose marriages had been involuntarily childless.

Considerable variation was found both in the concentration of fructose and in the total fructose content of the ejaculate. The concentration varied from less than 5 mgm. to 640 mgm. per 100 ml., with a mean value of 287 mgm. per 100 ml., while the total fructose ranged from less than 0·05 mgm. to 31·6 mgm., with a mean of 9·37 mgm. per ejaculate. The semen with minimum concentration, and also minimum total fructose, came from a fertile donor, as did the specimen with maximum concentration. That with maximum total fructose came from a childless man with a sperm density persistently less than 1 million per ml. Apart from a notable excess of good specimens and of fertile donors in the fructose range 200–500 mgm. per 100 ml. semen, no significant correlation was found between seminal fructose level and either sperm density or motility. This is not surprising in view of Mann's finding that azoospermic bull semen can be very rich in fructose, and that fructose is a chemical compound characteristic of the seminal plasma but not of spermatozoa as such.

On the other hand, a very interesting relationship was found between the fructose content of the semen and the volume of the ejaculate. As shown in the accompanying graph, the average concentration of fructose increases with volume, at first gradually, and then more steeply up to a maximum of 360 mgm. per 100 ml. in specimens with a volume between 4 ml. and 5 ml. With further increase in volume the concentration falls, specimens more than 7 ml. in volume having an average concentration of 209 mgm. per 100 ml. The total fructose content of the ejaculate also increases with volume, below 2 ml. at the rate of 2 mgm. per ml., and between 2 ml. and 5 ml. at the rate of 4·5 mgm. per ml. Above 5 ml. there is no appreciable increase of fructose with volume. It appears that the fructose-bearing secretion contributes the greater part of the extra volume between 2 ml. and 5 ml.; but further increments in volume are almost entirely due to the activity of other glands. Assuming that the majority of the fructose is produced by the seminal vesicle, the variation in volume and fructose content found in different individuals may well be the result of the marked variation in size of the seminal vesicle in man.

The ejaculate with highest fructose content in this series contained 31·6 mgm. of fructose in 8 ml. of semen. The highest concentration found was 640 mgm. per 100 ml., in a specimen of 4·4 ml. volume, and total fructose content of 28·2 mgm. It would seem that the maximum fructose output of the human seminal vesicle is about 30 mgm. of fructose contained in about 4 ml. of fluid of concentration 700 mgm. per 100 ml. On this basis the proportion of vesicular to other secretions could be worked out for any specimen of semen, an average specimen of 4–5 ml. volume being approximately 50 per cent vesicular secretion, whereas the seminal vesicles contribute only 30 per cent of the fluid in specimens less than 2 ml. in volume. However, Huggins and Johnson[2] found that in fluid obtained from the seminal vesicles by massage per rectum the copper-reducing substances varied from 275 mgm. to 625 mgm. per 100 ml., and it cannot be assumed, therefore, that the composition of the seminal vesicle secretion is approximately constant in sugar content.



Curve 1, variation of total seminal fructose with volume of ejaculate; curve 2, concentration of fructose

The volume of an ejaculate is to some extent affected by the time since the previous emission, and, in particular, specimens produced after intervals of less than 24 hours tend to be exceptionally small. In the present series 23 (47 per cent) of the 49 specimens with a volume less than 2 ml. were produced after an interval of less than 24 hours since the previous ejaculate. If the semen specimens are grouped according to time since previous ejaculate, at intervals of 24 hours, the average concentration of fructose remains constant after the second day up to the eighth day, the longest interval for which sufficient specimens were available to give a reliable value. The total fructose increases during this period in proportion to volume at the rate of 2 mgm. per ml. increase in volume. The mean fructose value for specimens produced with less than two days interval since the previous ejaculate is 250 mgm. per 100 ml., compared with 300 mgm. for specimens produced after longer intervals. The rate of increase of fructose with volume during the first two days is 5 mgm. per ml. increase in volume. These results suggest that the seminal vesicle in man is depleted to a much greater extent by a single ejaculation than appears to be the case in certain domestic animals such as the bull and the ram, and that a period of about 48 hours is required before the contribution of the seminal vesicle to the semen plasma, and therefore its fructose content, reaches the value characteristic of the individual donor.

It follows from these results that the volume of the ejaculate and the interval since previous emission must be taken into account in any attempt to correlate fructose content with other seminal characteristics, or to use fructose content as a measure of testosterone activity in man. Clearly no specimen produced within two days of a previous ejaculate can be relied upon to give a proper measure of fructose content. When the characteristic concentration has been reached, each specimen must be considered in relation to the mean fructose content of specimens of similar volume.

I am indebted to Dr. T. Mann for his instruction in technique, and his unfailing interest. The work was carried out with the help of a grant from the Medical Research Council.

CLARE HARVEY

Department of Zoology,
University College of the
South West of England,
Exeter.

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Preservation of the Fertilizing Capacity of Bull Semen in the Genital Tract of the Cow

HEIFERS and cows with regular œstrous cycle were nseminated several hours (6–12 up to 48 hours) before the expected œstrus. The sperm used in these xperiments was collected from the two bulls of the artificial insemination centre; it was diluted 1/50 in odium citrate – egg yolk diluent and inseminated y rectal fixation of the cervix. In most of the ows the operation was executed very easily, and he insemination was made partly in the corpus uteri and partly in the cervix; exceptionally the ervix is insufficiently dilated, but penetration with the catheter was possible though more difficult than in the heat-period.

The beginning and the end of heat were noted by the owner; we did not control by rectal examination the exact moment of ovulation for fear of damaging the follicle; but we believe that ovulation takes place 10 hours after the end of heat in heifers and 16 hours in cows (Hammond).

In three of thirteen inseminated animals, the expected œstrus did not appear during the first days after insemination. Of the remaining ten animals, four returned in heat and were not pregnant; two of them were inseminated about 48 hours before œstrus; six animals (four heifers and two cows) became pregnant, which corresponds to the conception-rate for artificial insemination during the heat-period. Of these six animals, two were inseminated nearly 51 hours before ovulation, three were inseminated 45 hours before ovulation, and one was inseminated about 40 hours before ovulation.

Further experiments are going on with a larger number of cows; but these results seem to indicate that the sperm of fertile bulls, diluted with sodium citrate – egg yolk diluent and inseminated deeply in the cervix and the corpus uteri, may keep its fertilizing capacity, completely undamaged in the genital tract of the female at least up to 50 hours, even when this sperm has been stored for three days in the refrigerator.

M. VANDEPLASSCHE
F. PAREDIS

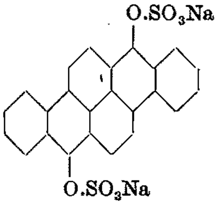
Centre for Artificial Insemination,
Veterinary College,
State University,
Ghent.
June 10.

Inhibition of some Respiratory Enzyme Systems by Derivatives of Sulphuric Acid

IN the course of work primarily concerned with the biological action of carcinogens, it was found that various sulphuric acid derivatives of large-molecule hydrocarbons strikingly inhibited certain enzyme systems when tested in Warburg respirometers. Substances I, II, III and IV (see over) inhibited the pyruvate-triose-phosphate system of rabbit skeletal muscle[1] by 87, 95, 94 and 50 per cent respectively, and the oxaloacetate-triosephosphate system of the same preparation by 68, 70, 53 and 10 per cent when added at $M/500$ in presence of 1/150 per cent extra cozymase. With extra cozymase the inhibition was decreased. It appeared to be competitive. Substance V was almost inactive at this concentration.

The first four compounds also inhibited the oxidation of lactate by ferricyanide[2] in presence of the Straub[3] lactic apodehydrogenase of bullock's heart muscle. The four inhibitors at $M/10{,}000$ in presence of 1/150 per cent added cozymase caused losses in activity of 52, 88, 20 and 21 per cent respectively. This effect was also diminished by extra cozymase. Substance V was again inactive.

The first four compounds at $M/7{,}500$ also inhibited the oxygen uptake of a rabbit-liver homogenate in presence of succinate by 71, 70, 21 and 34 per cent respectively. Sodium methyl sulphate, sodium methane sulphonate and sodium α-naphthalene sulphonate gave no inhibition even at $M/300$.



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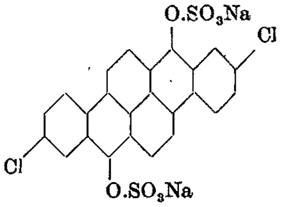

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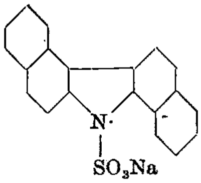

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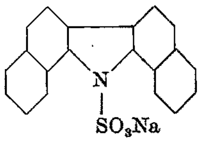

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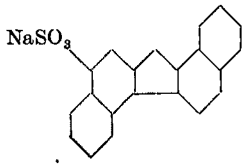

V

It appears that the inhibitory activity may be primarily attributable to the presence of an O—SO_3Na or N—SO_3Na grouping (in the cozymase systems the action of substance II being possibly potentiated by the presence of two chlorine atoms in the molecule). On the other hand, the grouping C—SO_3Na seems to be inactive. The mode of action of the active compounds may be either direct competition with cozymase or some reaction entailing fission of the active groupings in the manner postulated by Crabtree[4] for chlorcompounds.

My thanks are due to I.C.I. (Dyestuffs), Ltd., for gifts of chemicals.

DONALD HOCKENHULL

College of Technology,
Manchester 1.

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Enzymatic Degradation of Ribonucleoproteins of Chromosomes, Nucleoli and Cytoplasm

IN experiments utilizing purified crystalline ribonuclease in conjunction with various staining procedures, it has been possible to demonstrate that chromosomes of higher plants and animals contain appreciable quantities of nucleic acid of the ribose type. These experiments have also shown that ribonuclease may hydrolyse ribonucleoprotein, and that the residual material (non-histone protein) can be digested by pepsin. Conversely, ribonucleoprotein may be hydrolysed by pepsin, and the residual material (ribonucleic acid) degraded by ribonuclease. Such combination treatments have provided information concerning the localization of ribonucleoproteins, ribonucleic acid and non-histone proteins in nucleus and cytoplasm. The validity of these methods for diagnostic purposes rests upon the use of highly purified and carefully assayed enzymes, and the employment of an adequate series of controls to determine the influence of variables capable of modifying the histochemical reactions.

Results obtained by treating root-tip cells of onion and lily and salivary-gland cells of *Drosophila* serve to illustrate the potentialities of histochemical methods utilizing enzymatic hydrolysis. When sections or smears of these materials fixed in acetic alcohol are stained with Unna's methyl green – pyronin combination, the chromosomes are blue-lavender, the nucleoli and cytoplasm red. If hydrolysis by ribonuclease precedes staining, however, no component remains that colours with pyronin[1], so that cytoplasm and nucleoli are colourless and the chromosomes green. The possibility, inherent in earlier experiments of this type[2,3], that reduction in stainability might be referable to removal of proteins by protease-contaminated ribonuclease[4] has been obviated in these studies by the use of preparations of ribonuclease that are free from all measurable traces of proteolytic activity[5]. It can be concluded, therefore, that ribonucleic acid is present in chromosomes as well as in cytoplasm and nucleoli. Additional evidence leading to the same conclusion has been provided by the preparation of ribonucleoprotein from isolated chromosomes[6].

The use of fixatives particularly suitable for cytological studies, such as the fluids of Flemming and Navashin, makes possible staining procedures which cannot be used advantageously following fixation in acetic-alcohol. Thus the safranin – gentian violet – orange *G* triple stain, when used after the chrom – osmic – acetic acid fixatives, permits a pattern of differentiation in meristematic cells of root tips in which metaphase and anaphase chromosomes are bright red whereas the chromonematic threads of late telophases and early prophases are violet. Ribonuclease attacks this red-staining component, so that metaphase and anaphase chromosomes appear violet after hydrolysis. Prolonged treatment with ribonuclease also impairs stainability with the gentian violet component of the triple stain. These observations suggest that the ribonucleic acid of condensed chromosomes may be present in more than one form and that there occurs in the course of mitosis a cycle of accretion and dispersion of chromosomal ribonucleic acid which may be correlated with the appearance and disappearance of the nucleolus, and which is presumably related to the control of genic activity.

Flemming's triple stain has also provided a clue to the localization of the non-histone or tryptophane-containing protein[7,8]. It was found that cytoplasm chromosomes and nucleolus, after treatment with ribonuclease, show a density and brilliance of coloration with orange *G* that is not detectable in the controls. A similar colour intensification may also be obtained with other acidic dyes, such as acid fuchsin, light green and fast green. Thus, if sections are treated with ribonuclease and stained with fast green (using the Feulgen reaction for desoxyribonucleic acid to provide contrasting colour in the chromosomes), they will show an over-all intense and vivid green as compared with the pale green of undigested controls; but if the treatment with ribonuclease is followed by one with pepsin, the amount of green colour is then much less than that of the controls. Similar results are obtained when the nucleic acid is removed by Schneider's trichloracetic acid treatment[9]. These results indicate that ribonuclease can digest ribonucleoprotein, and that the protein thus freed stains intensely with acidic dyes and can be degraded by pepsin. Digestibility by pepsin suggests that this stainable material is non-histone protein[10]; its distribution within the cell, moreover, parallels that of tryptophane-containing material as determined by histochemical application of Bates' modification of the May – Rose test[1].

Ribonucleoprotein may be degraded by pepsin as well as by ribonuclease. If sections are treated with pepsin and stained in Unna's pyronin – methyl green combination, chromosomes, nucleoli and cytoplasm of the hydrolysed cells stain more intensely with pyronin than do those of unhydrolysed controls. If sections are treated successively with pepsin and ribonuclease, chromosomes, cytoplasm and nucleoli no longer stain red, indicating that the nuclease has removed the pyronin-avid material. These experiments indicate that ribonucleic acid may be present in fixed cells either free or combined as ribonucleoprotein, and that its stainability with pyronin is influenced by the state of association.

Such treatments, using combinations of enzymes, thus serve as a guide to an understanding of the affinity of certain dyes for specific cellular components. Other combinations of enzymes and dyes have been utilized in the study of a variety of normal and aberrant types of plant and animal cells. A detailed account of these studies will be presented in other publications.

Progress of this study has been facilitated by a grant from the United States Public Health Service, National Institute of Health, Bethesda, Maryland.

BERWIND P. KAUFMANN
MARGARET McDONALD
HELEN GAY

Department of Genetics,
Carnegie Institution of Washington,
Cold Spring Harbor, New York.
June 10.

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Giant Binary Stars and the Mass-Luminosity Law

It is well known that spectroscopic parallaxes are an index of stellar surface gravity, which in turn is functionally related to the mass and luminosity of a star. If, therefore, there exists a class of stars in which this functional relation differs from that found for the majority of stars, we should expect a lack of agreement of the mean trigonometric, dynamic and spectroscopic parallaxes of these stars.

In "The Masses of the Stars", Russell and Moore[1] directed attention to a serious discrepancy between the trigonometric and spectroscopic parallaxes of 52 visual binaries of the giant sequence. It is especially significant in view of the very excellent agreement of these parallaxes found for 641 *single* stars of the giant sequence. For the latter, the 'reduced' trigonometric and spectroscopic parallaxes are 0·0988″ and 0·0985″, respectively, whereas for the 52 double stars the corresponding values are 0·063″ and 0·095″.

The agreement of the spectroscopic parallaxes of the single and double stars is a strong indication that the surface conditions of these stars are, as a whole, identical. One is led to suspect a systematic error in the trigonometric parallaxes, yet none is obvious; none exists for double stars of the main sequence, and the discrepancy noted by Russell and Moore is not related to the separation or relative brightness of the components of the double star.

Acceptance of the trigonometric values places these stars about a magnitude above the regular giant sequence and, according to Russell, indicates a mass of about double that of single giant stars (mass-luminosity law). It is of particular interest that the increased mass would in this case be compensated almost exactly by the increased radius necessary to account for the greater luminosity, thus leaving the surface gravity unchanged. The giant binaries, then, would at once be over-luminous for their spectral class, sub-luminous for their mass, but of unchanged surface gravity. The observed agreement of the spectroscopic parallaxes of the single and double stars would thus be explained.

In view of the apparent failure of the mass-luminosity law in giant binaries, it is of interest to consider also the dynamic parallaxes of these stars, and secondly, to find whether the parallax discrepancy found for visual pairs exists also for spectroscopic binaries and for very wide common-proper-motion pairs.

The appeal to dynamic parallaxes is of special interest, for if giant binaries are sub-luminous for their masses, dynamical parallaxes derived for these stars should be somewhat greater than their trigonometric parallaxes, yet considerably smaller, numerically, than their spectroscopic values. This is observed to be the case: for 64 pairs for which trigonometric dynamic and spectroscopic parallaxes were available, the reduced values of these quantities are 0·065″, 0·075″ and 0·104″, respectively. Again, for 103 pairs for which dynamic and spectroscopic parallaxes were available, the respective values were 0·088″ and 0·114″. This latter discrepancy is, of course, totally independent of any possible error in the trigonometric parallaxes. No corresponding discordance occurs for main sequence pairs.

Spectroscopic binaries were also found to exhibit the discordance found for visual pairs: for 47 spectroscopic binaries, the mean reduced trigonometric and spectroscopic parallaxes were 0·079″ and 0·100″, respectively. However, for 34 very wide common-proper-motion pairs, excellent agreement in the mean for these parallaxes was found, thus perhaps relating these stars more closely to the single stars than to the closer doubles. That this agreement argues for a systematic error in the trigonometric parallaxes is not supported by the fact that in the closer pairs, for the most part, the components were far too faint, and of too long a period of revolution, to affect the measured parallaxes.

We can conclude, then, that the mean observed values of the trigonometric, dynamic and spectroscopic parallaxes of giant binaries are consistent with the hypothesis that these stars (the primary components) lie above the ordinary giant sequence but are subluminous for their masses.

J. A. HYNEK

Perkins Observatory,
Delaware, Ohio.
April 15.

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Mixed Types of Stellar Populations

ONE of the most interesting and most mysterious features of the stellar contents of our own and other known galaxies is the fact that there seem to exist two rather distinct types of stellar populations differing between themselves by mechanical as well as by physical properties of individual members. In fact, as was first indicated by Oort[1], the so-called 'high-velocity' stars which describe highly elongated elliptic trajectories around the galactic centre seem to possess rather different physical characteristics as compared with the 'ordinary' stars predominating in the neighbourhood of our sun and moving along regular, almost circular, orbits. This distinction was amplified by the recent work of Baade[2], who has shown that the ordinary type of stellar population (which he calls type I) is characteristic only for the region of spiral arms, whereas the other type (type II) forms the structure of the galactic nucleus along with the tenuous, almost spherical, 'atmosphere' surrounding the entire system. All elliptical and spherical galaxies seem to be formed entirely from stars of type II.

The physical differences between the two stellar populations, as evidenced by the study of the corresponding Hertzsprung – Russell diagrams, can be summarized as follows: (1) the giant branch of the main sequences is completely absent in stellar population II; (2) the red giants of population II are different from those in population I, and are distributed along a continuous band which starts from the middle of the main sequence (the upper part of which is absent in this case) and is about one to three magnitudes above the ordinary red giant branch of population I; the number of type II red giants (relative to the number of dwarfs of the same spectral clan) is smaller in type II as compared with type I; (3) the lower part of the main sequence seems to be identical in both populations.

It has been also noticed that the percentage of double stars is two to three times lower among the stars of type II.

The understanding of physical differences between the two types of stellar population, and their relation to the difference of their motion and distribution within the galactic system, will undoubtedly throw much light on the general problem of stellar and galactic evolution. It is, therefore, especially annoying that hitherto we have not had any reliable theory of the internal structure of red giant stars capable of representing one of the principal differences between two types of stellar populations. For the same reason it is extremely important to collect all possible information concerning these stars and their possible relation to one of the two accepted types.

The results published by Dr. Hynek in the preceding letter seem to permit some interesting, though highly hypothetical, conclusions in this direction. Whatever may be the model on which the ordinary red giant stars are built, it seems very improbable that it could lead to the mass-luminosity relation, in which the doubling of the mass will increase the luminosity only by a factor of two. In fact, thermonuclear reactions which are responsible for the entire energy balance of the star must be expected to be much more sensitive to the internal temperature changes which would result from the larger total mass of the star. It seems, therefore, more reasonable to assume that the observed difference between the single red giants and those which are the members of a pair must be connected with the difference of their chemical constitution, their internal structure (model), or both. Since the same assumption must also probably be made to understand the difference between red giants of the types I and II, we could ask ourselves whether it is at all impossible to explain the facts stated by Dr. Hynek by assuming that red giants in the binary systems are essentially the stars belonging to the stellar population II? Indeed, the mean luminosity difference of about one magnitude between the single and double giants is comparable with the mean difference between the red branches of the two populations. Also the discrepancies between the spectroscopic and trigonometric parallaxes of single and double red giants which led Dr. Hynek to his conclusions are similar to the discrepancies observed by Morgan and Keenan[3] in the case of 'high-velocity' stars, inasmuch as they state that "high-velocity stars appear to be the only stars likely to cause serious trouble in using the method of spectroscopic parallaxes".

It must be remembered, however, that the binaries studied by Russell and Moore and by Hynek are, as a rule, the ordinary slow-moving stars which would be classed normally as type I. Thus, in making the above statement, we would be forced to accept the possibility of a mixed type of stars (type II_{I}) which possess the physical characteristics of type II but the motion of the type I. There may be also stars (type I_{II}) which look like those of type I but move as type II. Remembering that the correlation between physical properties and the type of motion of any individual star must be due to some events in the early history of its existence (formation process), and that the motion (as well as the family status) o a star may be changed by a number of externa causes, such an assumption does not look at al unreasonable.

G. GAMOW

George Washington University.
May 4.

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New Localized Interference Fringes

IN this note a description is given of a simpl method for producing a new type of sharp localize interference fringes with interesting properties. Thes sharp fringes are best formed by multiple-bean interference, although a broadened variant can b obtained with two beams. They arise when a plan parallel sheet of flexible material silvered on bot sides is bent into a curve (suitable radii of curvatur are 1–5 cm.) and illuminated with strictly paralle monochromatic light from a point source, suc collimation of light being essential. The simples procedure is to flex a thin slip of doubly silvered mica into a cylindrical shape. In such a case straight-line fringes somewhat resembling those of a Lummer plate are the result. If the thin film is in the form of a spherical shell (for example, a blown thin film of glass) circular fringes form, resembling Fabry-Perot rings. Under suitable conditions, the fringes are critically localized and appear on a screen suitably placed. Both the mode of formation and the plane of localization are indicated by Fig. 1, where, for simplicity, refraction effects are disregarded. The detailed theory will be published elsewhere, and main conclusions only are given here.

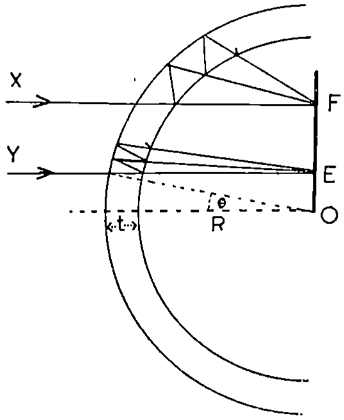


Fig. 1

Let parallel monochromatic light be incident from the left and let O be the centre of curvature. An incident ray Y is partly transmitted and partly reflected, and the successive beams all intersect at E. The multiply-reflected rays have a path difference $n\lambda = 2\mu t \cos\theta$, and at E, if the reflectivity is high, there is formed a sharp localized interference fringe with effectively an Airy intensity distribution, providing high values of θ, and small values of radius of curvature are employed.

In like manner, another incident ray X produces a fringe at F. Detailed analysis shows that a succession of fringes is localized nearly on the line OF, which is perpendicular to the direction of incidence. As in the Fabry-Perot interferometer analogue, the fringe 'radii' are here approximately proportional to the roots of the natural numbers, the diameter of the nth ring being approximately given by $2R\sqrt{\lambda(\varepsilon+p-1)/t}$, in which R is the radius of curvature, t the film thickness, ε the fractional order of interference at the centre and λ the wave-length.

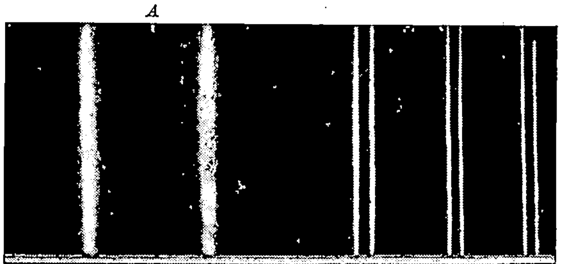
An example of the fringes so obtained is shown in Fig. 2, which are transmission fringes from cylindrically bent mica. They can be seen either on a ground-glass screen placed in the plane OF or with a lens focused on this plane.

Attention may be directed to the following features:

(1) Extreme sharpness, due partly to the high angle of incidence improving the effective reflecting coefficient.

(2) These particular fringes are double, the doubling depending on direction. This is due to birefringence of the mica, the doublet fringes which emerge being plane polarized, mutually perpendicularly, although non-polarized incident light is used. In Fig. 2 the centre of the system is at A.

Fig. 2



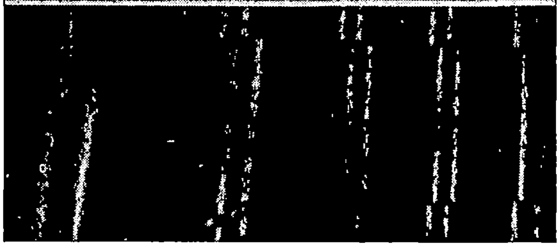


Fig. 3

(3) Under suitable conditions, that is, correct flexure of the specimen, two directions are found in which there is no birefringent doubling.

(4) Cleavage steps in the mica. These reveal their presence, and precision measurements on steps can be made, an example of such steps being shown in Fig. 3.

The fringes can be formed both by transmission and by reflexion. In the latter, tolerably sharp outer fringes are given by *unsilvered* films, because of the increase in reflecting coefficient at the higher angles of incidence. When silvered surfaces are used, the outer transmission fringes (higher angles of incidence) show additional complexity due to differential phase change effects, which lead to alteration in the birefringence doubling separation. Although a detailed analysis of the properties of the fringes in general, using both isotropic and crystalline media, is being communicated elsewhere, we suggest here a name to describe this new interference. It is proposed to describe the fringes as 'fringes of equal tangential inclination'. This is a fitting nomenclature since each fringe originates at the locus of points at which the incident rays all make the same angle with the tangents at the points of entry. The proposed name fits aptly into the accepted classical terminology for the other two types of fringes formed by a thin film with monochromatic light already long recognized, namely, the fringes of equal inclination and the fringes of equal thickness.

It may be noted that these precisely localized, sharp fringes, given here by a strictly parallel incident beam which suffers multiple reflexions, differ entirely both as to character and localization from the broad, confused, expanding, non-localized, elliptical fringes obtained by Raman and Rajagopalan with a widely diverging beam and a piece of unsilvered bent mica[1].

S. Tolansky
N. Barakat

Royal Holloway College,
Egham, Surrey.
June 16.

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[1] See *J. Opt. Soc. Amer.*, **29**, 413 (1939), and *Proc. Ind. Acad. Sci.*, **10**, 317 (1939).

Low-Level Atmospheric Ducts

During 1943–46, the Signals Research and Development Establishment operated a series of experimental centimetre-wave radio links along a 60-mile oversea path across Cardigan Bay. One major purpose of the investigation, which was carried out for an inter-Service committee under the chairmanship of Sir Edward Appleton, was to determine the degree to which meteorological factors affected microwave propagation and to find out to what extent the performance of such links could be predicted from synoptic data.

In addition to the taking of continuous records of radio field-strengths, frequent measurements were made of temperature, pressure, humidity and wind velocity at the two terminal stations at Strumble Head in South Wales and Aberdaron in North Wales. We have found a fairly definite correlation between the radio field-strength and the difference between air and sea temperatures, particularly when this difference was large, for the lowest link, in which the transmitting and receiving aerials were each about 100 ft. above sea-level. Figs. 1 and 2 show the results obtained on a wave-length of 9 cm. for those periods during the twelve months from July 1945 to June 1946 when the difference between the air and sea temperatures was greater than 5° F. It will be seen from Fig. 1 that when the air temperature was more than 5° F. lower than that of the sea, a condition which obtained mainly on cold days, the field-strength usually lay between 20 and 30 decibels below the free-space value. When, however, on warm days the air temperature was more than 5° F. higher than that of the sea, the field-strength was approximately equal to the free-space value. These two field-strengths, corresponding to cold and warm days respectively, although differing appreciably, are both well above the field-strength of 70 decibels below the free-space value which would be expected on the assumption of standard atmospheric conditions for this link, which was 2·3 times the optical range.

A study of the radio results according to modern radio-meteorological theory[1] suggests that the high field-strengths in Figs. 1 and 2 are due in both cases to the presence of so-called atmospheric ducts lying directly on the sea surface. For the conditions corresponding to those in Fig. 1, the heights of the ducts appear to vary between 20 ft. and 50 ft., while for the higher field-strengths in Fig. 2 the duct heights are greater and lie between 80 ft. and 120 ft. The ducts which give rise to these high field-strengths are due singly or to a combination of a temperature inversion and a rapid decrease with height in the water-vapour pressure in the atmosphere. The presence of the low ducts of 20–50 ft. when the air (at 100 ft. above sea level) is colder than the sea is not easy to explain. It was noted that the cold conditions giving rise to these particularly low ducts were associated frequently with high wind when, incidentally, the radio signal was found to be particularly steady. We would suggest that these ducts may be due to the presence of sea spray whipped up by the wind, either directly as constituting an increase in the water content in the lowest air strata, or indirectly as a means by which evaporation is assisted in these strata by the presence of the spray. The atmospheric moisture required to form the higher ducts necessary to satisfy the field-strength values in Fig. 2 during warm weather can be explained by evaporation from the relatively cold sea.

This relation between the radio field-strength and the difference between air and sea temperatures was studied first by Mr. H. Jarkowski, when he was in charge of the running of the Welsh stations. We regret that as he is now in Poland his name cannot be added to this note without causing undue delay. We are indebted to the Chief Scientist, Ministry of Supply, for granting permission to publish this note.

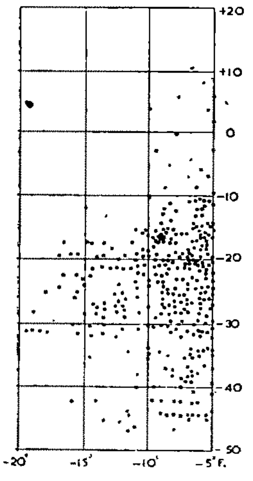

Fig. 1

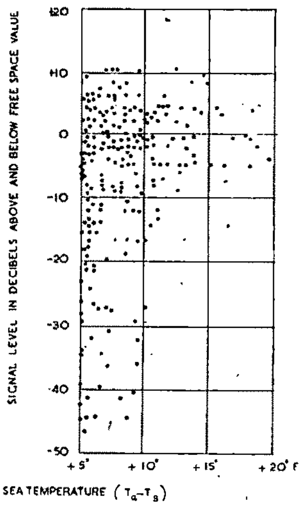

Fig. 2

J. S. McPetrie
B. Starnecki

Signals Research and Development
Establishment,
Ministry of Supply,
Christchurch,
Hants.

June 14.

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[1] Hartree, D. R., Michel, J. G. L., and Nicholson, Phyllis, "Meteorological Factors in Radio-Wave Propagation", 127–168 (London: Physical Society).

Elastic Constants of Alum Determined by a New Ultrasonic Method

Following our work on the diffraction of light by ultrasonic waves in glasses described in an earlier communication[1], we have now obtained similar patterns in crystalline media, thus enabling us to devise a new method for determining the elastic constants.

Transparent and flawless specimens are suitably cut and polished, and stationary sound waves are maintained along specific directions of propagation. In cubic crystals, the cube and the octahedral axes are the most suitable. An X-cut or a Y-cut quartz plate is cemented on the surface of the polished prism according as it is desired to send longitudinal or transverse sound waves respectively. The sound velocities are then determined in each case in the usual manner by photographing the diffraction patterns at known frequencies. The effective elastic constants for specific directions are then calculated and the principal values deduced. Results obtained for alum along with those reported earlier by Voigt[2] and by Sundara Rao[3] employing other methods are given below in units of 10^{11} dynes/cm.^{2}.

	C_{11}	C_{12}	C_{44}
Authors	2·54	1·07	0·84
Voigt	2·43	1·009	0·843
Rao	2·56	1·07	0·86

As the measurements involved are of simple lengths, a high degree of accuracy can be obtained in this method by employing frequencies greater than 50 Mc./sec. The method is capable of being extended to a study of the dependence of elastic constants on temperature. Each crystal has, however, to be cut and polished to a high degree of perfection for a successful application of the method.

S. BHAGAVANTAM
B. RAMACHANDRA RAO

Department of Physics,
Andhra University,
Waltair, India.
June 10.

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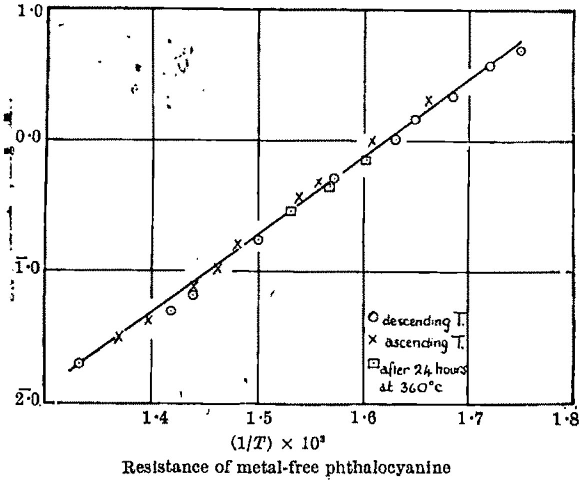
Phthalocyanines as Semiconductors

IN recent years Szent-Györgyi has directed attention to the possible importance of the electrical properties of organic molecules in biochemical catalysis[1] and has given evidence for photoconductivity in gelatin[2]. An approach to the theory in trans-conjugated polyenes has been indicated by N. S. Bayliss[3]. Hoping to obtain a system suitable for quantitative investigation, I have examined the electrical conductivity of two phthalocyanines. These substances, described by Linstead and co-workers[4], form a group of conjugated structures closely related to the biologically important porphyrins. They are particularly suitable for a research of this kind, because of their high degree of involatility and thermal stability. Their crystal structures are known from the work of J. M. Robertson[5].

Crystals of metal-free phthalocyanine and its derivative, copper phthalocyanine, have been examined in a 'Hysil' conductivity cell between platinum electrodes of area 2 sq. cm. separated by 2 mm. approximately. The crystals as packed in the cell had a bulk density of about 0·2. Hydrogen was circulated through the cell and its resistance measured as a function of temperature with a 'Megger'.

Both phthalocyanine and copper phthalocyanine have been found to be semiconductors. The accompanying graph shows the results for sample 1, I.C.I. metal-free phthalocyanine purified by sublimation *in vacuo*. It is clear that the results fit the well-known formula, $\rho = \rho_0 \exp E/RT$, where ρ is the resistance, R the gas constant, and E an 'activation energy'. The curve was quite reversible, and the sample was unaffected by 24 hours heating in hydrogen.



Resistance of metal-free phthalocyanine

Table 1. Metal-free phthalocyanine

Sample	$\log_{10} \rho_0$ (megohms)	E, k.cal.
(1) I.C.I., sublimed *in vacuo*	$\overline{10}$·24	27·6
(2) ,, ,,	$\overline{10}$·47	27·6
(3) I.C.I., sublimed in nitrogen	$\overline{10}$·08	29
(4) From Prof. R. P. Linstead	$\overline{10}$·35	27·6

Table 1 shows values of ρ_0 and E for four separate samples. The relatively small differences may be attributed to differences in the size of crystals and their packing in the conductance cell. It is very unlikely, in view of this reproducibility, that the semiconductivity of metal-free phthalocyanine arises from impurity centres. Metal-free phthalocyanine would appear to be an intrinsic semiconductor[6].

Two specimens of copper phthalocyanine were found to give qualitatively similar behaviour to metal-free phthalocyanine. However, both specimens showed some decrease in resistance and activation energy on heating in hydrogen at about 400° C. After twenty-four hours of such treatment a moderately steady state appeared to be reached, although a little hysteresis was still to be noted on the $\log_{10} \rho$ *vs.* $1/T$ curve, between values for ascending and descending temperature. The data in this state are summarized in Table 2.

Table 2. Copper phthalocyanine

Sample	$\log_{10} \rho_0$	E, k.cal.
I.C., sublimed *in vacuo*	$\overline{11}$·04	29·4
From Prof. R. P. Linstead	$\bar{7}$·1	20·7

While copper phthalocyanine does *not* require heat treatment to show semiconductivity, such treatment does have a modifying effect, and the two samples show quantitatively different behaviour. It is possible that impurity centres play a part here.

Considering the simple case of metal-free phthalocyanine, we may suppose that the electrons lie in energy-bands common to the whole crystal, arising perhaps by intermolecular overlap of the π-orbitals of the porphyrin rings. The observed activation energy of 28 k.cal. is then one half the energy gap between the full ground-band and the empty first excited band[7].

My thanks are due to I.C.I. (Dyestuffs Division), Ltd., and Prof. R. P. Linstead for the gift of specimens.

D. D. ELEY

Chemistry Department,
University, Bristol.

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Utilization of Wheat Bran for Streptomycin Production by *S. griseus*

THE study of the nutritive requirements of *Streptomyces griseus* has assumed great importance on account of the remarkable activity of streptomycin against a number of bacterial infections. A number of media in which successful antibiotic production takes place have been recorded in the literature[1-5]. During the course of investigations on streptomycin production, aqueous extracts of wheat bran were found to give encouraging results; the methods of preparation and composition of the extract are described elsewhere[6]. By the procedure employed, about 4,000 ml. of the extract with about 3 per cent total solid content can be prepared from 1,000 gm. of bran.

The experimental procedure adopted was the one described previously[6]. The total solids of the media were adjusted to 0·5, 1·0, 2·0 and 3·0 gm. per 100 ml., and the *p*H to 6·5–7. A Waksman's strain of the organism was used. Daily observations of the antibiotic contents and the change in the reaction of the culture fluids were made (see Table 1).

Table 1

Total solids in medium	Reaction of medium						Streptomycin in μgm. per ml. days					
	3	4	5	6	7	8	3	4	5	6	7	8
0·5 gm./100 ml.	6·9	7·3	7·4	7·6	7·9	7·9	29	36	98	89	85	78
1·0 ,,	7·1	7·4	7·6	7·7	7·9	7·9	29	35	108	110	108	99
2·0 ,,	7·1	7·2	7·6	7·7	7·9	7·9	32	69	111	114	109	92
3·0 ,,	6·9	7·2	7·4	7·6	7·8	7·9	25	32	69	93	117	103

These data show that good production of antibiotic takes place even when the total solids in the medium are reduced to about 1·0 gm. per 100 ml. Further, 1,500–2,000 μgm. of streptomycin is formed for each gram of the bran used.

Different additions in the form of minerals, nitrogenous and carbonaceous material were then made to the basal wheat bran extract medium and their effect on antibiotic production was studied. Addition of small amounts of sodium chloride to the media increased the antibiotic production, as may be seen from Table 2.

Table 2

Composition of medium		Streptomycin in μgm. per ml. (days after seeding)						
Wheat bran extract	Sodium chloride	2	3	4	5	6	7	8
100 c.c. containing 1 gm. of total solids	0·5 gm.	75	126	160	95	73	68	63
	1·0 ,,	66	148	178	93	88	82	77
	2·0 ,,	46	161	163	98	98	83	82
	4·0 ,,	15	73	78	58	53	43	32
	5·0 ,,	15	40	78	70	65	45	33
100 c.c. containing 2 gm. of total solids	0·5 gm.	40	189	159	137	108	95	86
	1·0 ,,	52	179	203	138	123	86	76
	2·0 ,,	45	169	98	89	75	68	58
	4·0 ,,	23	85	93	93	60	54	33
	5·0 ,,	15	18	45	52	53	33	35

Concentrations of about 1 per cent appear to be the optimum. Higher ones are definitely harmful. In a medium containing sodium chloride, the antibiotic production is not only increased but also quickened. Observations of a similar nature regarding the role of sodium chloride have been recorded by Cook *et al.*[7] for penicillin production in pea extracts, and by Reke *et al.*[4] for streptomycin formation in soya-bean meal medium.

Wheat bran thus appears to serve as a cheap raw material for streptomycin production. Results of detailed investigations on these studies will be recorded elsewhere.

My thanks are due to Dr. K. M. Pandalai for helpful suggestions, to Prof. V. Subrahmanyan for his interest, and to Merck and Co., Rahway, N.J., for the standard streptomycin kindly supplied by them. I also acknowledge the financial support of the Council for Scientific and Industrial Research, India.

R. RAGHUNANDANA RAO

Department of Biochemistry,
Indian Institute of Science,
Bangalore.
May 17.

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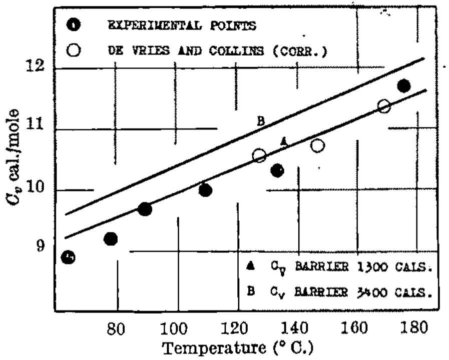
Heat Capacity of Methanol Vapour

CRAWFORD[1] has directed attention to a discrepancy between values assigned to the height of the energy barrier restricting the internal rotation in methanol. Such rotation is infra-red active, and spectroscopists have inferred that the barrier is 1,300 cal./mole. This would require the entropy at 25° C. and one atmosphere to be 57·62 E.U., while the observed value is 56·63 ± 0·25 E.U. Crawford pointed out that the discrepancy would disappear if the barrier were 3,400 cal./mole.

Independent information about the height of the barrier may be obtained from the heat capacity of the vapour. There is only one modern calorimetric measurement[2]. No attempt was made to correct for deviations from the gas-laws, and the results show an anomalous rise below 120° C. which was attributed to a dimerization of the vapour. New measurements of the heat capacity have been made between 64° and 176° C. by measuring the velocity of supersonic waves of frequencies 570 and 1,200 kc./s. The apparatus was that of Alexander and Lambert[3]. No dispersion of the sound was observed, the absorption was negligible and the observed value of the heat capacity was the same at each frequency. Under these conditions, the method is reliable (cf. Telfair[4]). At each temperature measurements were made over a range of pressure, and the 'ideal velocity' found by extrapolation to zero pressure. The results are, therefore, independent of any assumptions about the equation of state of the vapour.

The accompanying diagram shows both the experimental points and the values of the heat capacity



Heat capacity of methanol vapour

corresponding to barrier heights of 1,300 and 3,400 cal./mole. The latter were calculated by using the vibrational assignment recommended by Herzberg[5], the bond-lengths and angles given by Crawford[1], and the tables of Pitzer and Gwinn[6]. They are unlikely to be in error by more than 0·15 cal. The results obtained above 120° C. by de Vries and Collins[2] have been corrected by the Berthelot equation and are also included in the diagram.

The experimental results favour the lower (spectroscopic) value for the barrier height. This would indicate that the entropy discrepancy of 1·0 ± 0·25 E.U. is real. Pauling[7] showed that a similar discrepancy of 0·8 E.U. for ice could be accounted for by assuming a 'residual entropy' at low temperatures due to a completely random orientation of hydrogen bonds. Methanol may be similar. Unfortunately, the crystal structure is not known; but an infinite lattice with every oxygen atom tetrahedrally coordinated to one methyl group (covalency) and three other oxygen atoms (H-bonded) would allow each molecule to arrange its OH bond in three equivalent directions. The chance that its neighbours would permit any given orientation is 2/3. In *complete* disorder, such a lattice would have a residual entropy of $k.\ln 2^N = 1{\cdot}37$ E.U., which is adequate to account for the observed discrepancy. The lattice assumed is in agreement with the X-ray diffraction data for the liquid at − 75° C.[8].

It is interesting that there is a disagreement about the barrier height for methylamine[9], which might have a similarly disordered solid structure, but not for trimethylamine[10], where hydrogen bonding is impossible.

J. S. Rowlinson

Physical Chemistry Laboratory,
Oxford. June 14.

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Factorial Analysis of Rheological Measurements on Cheese

In psychology, the meaning of tests of intelligence and mental abilities has been clarified by factorial analyses of the correlation coefficients between the different tests[1]. In industrial physics there are occasions when empirical tests are employed the exact meaning of which is not fully understood, and where the interrelationships between the tests could profitably be studied by similar means. Subjective judgments of quality as assessed by experts and others may be included. In view of the elusive nature of such subjective judgments in cheese-grading, it has been thought desirable to develop a number of related mechanical measurements.

We have carried out an analysis of six separate mechanical tests directed towards measuring essentially different 'properties' on some 250 Cheddar cheese. The tests were as follows: (1) total penetration of a sphere under standard load into the surface after 30 sec.; (2) percentage of this penetration remaining unrecovered 30 sec. after removing the load; (3) penetration of a cylindrical borer under standard load after 10 sec.; (4) ratio of the 10-sec. reading to the 60-sec. reading of the borer (taken negatively); (5) total penetration of a sphere following a series of increments of load (Meyer analysis); (6) slope of the log deformation/log load curve derived from test 5.

The 58 measurements which were correlated were the means from four samples taken from the same batch of cheese. The correlation matrices from these tests were analysed by Thurstone's Simplified Centroid Method[2] without adjustments to the entries in the diagonal cells in the second stage of approximation. The 'factor axes' may, if desired, be rotated according to specified rules; but in the present analysis of data from experiments not specifically designed for a factorial study, little appeared to be gained by rotation. The correlation and factor matrices are given in the accompanying table.

Correlation matrix: ripe cheese

Test	1	2	3	4	5	6
1	....					
2	0·559	....				
3	0·853	0·674	....			
4	0·636	0·255	0·538	....		
5	0·850	0·544	0·765	0·556	....	
6	0·583	0·094	0·434	0·525	0·390	....

Factor matrix

	Factor		
Test	I	II	III
1	+ 0·957	+ 0·026	− 0·026
2	+ 0·602	− 0·499	+ 0·116
3	+ 0·907	− 0·210	+ 0·164
4	+ 0·677	+ 0·301	− 0·083
5	+ 0·861	− 0·123	− 0·297
6	+ 0·574	+ 0·525	+ 0·101

An analysis of the pattern of factor loadings in relation to the qualitative nature of the tests suggests that factors I, II and III may be termed 'hardness', 'springiness' and 'hardening' respectively. It cannot at present be stated how complex these individual 'factors' are or whether, when additional tests are included, further categories will be necessary. The present analysis agrees with Burt's description of factors as "principles of classification"[3].

It is of interest to note that both the borer test and the ball compressor test, each of which has a high saturation with the first 'factor', have been designed to simulate the actions of the skilled grader, the first when plunging a steel skewer into the cheese and the second when 'thumbing' it[4]. By means of these operations, the grader is able to make useful judgments of the rheological properties of unripe cheese, from which he foretells the development of quality.

We conclude from this preliminary survey that the technique of factorial analysis shows promise of giving valuable information where mechanical properties of complex materials are to be compared and studied.

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R. Harper
M. Baron

National Institute for Research in Dairying,
University of Reading. June 10.

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LEAD ISOTOPES AND THE AGE OF THE EARTH

By PROF. HAROLD JEFFREYS, F.R.S.

RATIOS of the abundances of isotopes of lead from a considerable number of ores have been given by A. O. Nier[1] and discussed by A. Holmes[2]. They are expressed as numbers of atoms of Pb^{206}, Pb^{207}, Pb^{208} per atom of Pb^{204}. The last is not of radioactive origin; the others are presumably partly original and partly derived from the decay of the radioactive elements U^{238}, U^{235} and Th^{232}. Their abundance would therefore be expected to increase with time, and this is found to be the case; they are more abundant, always relative to Pb^{204}, in ores more recently formed than in old ones. Holmes has used the variation to derive an estimate of the age of the earth, which he gives as about 3,350 million years. This is substantially more than had previously appeared probable, though no evidence definitely contradicts it. On the other hand, several geophysicists have found Holmes's argument difficult to follow; the following account is partly based on a suggestion made privately by Bullard.

We assume that in a region sampled by the extraction of a lead ore from the rocks within it the atomic abundances of U^{238}, U^{235} and Th are u_m, v_m, w_m; then if the age of the crust is t_0 and the decay constants k_1, k_2, k_3, the original abundances were $u_me^{k_1t_0}$, $v_me^{k_2t_0}$, $w_me^{k_3t_0}$. If the actual sample is of age t_m, the amounts surviving when the ore was formed were $u_me^{k_1t_m}$ and so on. The losses would be associated with the production of equal numbers of atoms of the corresponding lead isotopes. If the original abundances of the lead isotopes were a, b, c, the abundances in the ores will be x_m, y_m, z_m, where

$$x_m = a + u_m\,(e^{k_1t_0} - e^{k_1t_m}) \qquad (1)$$

with similar relations.

If u_m was constant, equations of this type could lead to no estimate of t_0. By a statistical study we could find the variation of x_m with t_m and hence estimate u_m; but any change in t_0 would produce a change of the right-hand side that could be exactly compensated by a change of a, which is one of the unknowns of the problem. The method would fail if the radioactive elements were uniformly distributed through the crust. But if u_m is variable, there will be variations of x_m even for materials of the same age, and this variation will decrease with increasing age, vanishing for $t_m = t_0$. Hence by study of the scatter of x_m for collections of rocks of different ages, it should be possible to find t_0. Holmes proceeds by taking the ore analyses in sets of four, each of which gives one estimate of t_0, and plots the results on a frequency diagram; but this procedure has two disadvantages. It obscures the essential principle that what matters is the variation with time of the scatter of the data; and it suggests also that the evidence is more abundant than it really is. Holmes determines 1,419 solutions by taking sets of four; but the original data refer to only twenty-five rock samples, so that the same material has been used many times.

The constancy of a, b, c is assumed. Correspondingly we may assume constancy, for a given date, of the ratio u_m/v_m. At present this is 139; but as U^{235} decays more rapidly than U^{238}, the ratio was smaller in the past. I shall give two solutions, one without this assumption and one with it.

Study of the radioactive content of rocks has shown that within a given region the abundance of the radioactive elements follows a Pearson Type III law with terminus at zero; but the formation of the maximum likelihood equations with this law proved to be very complicated in the present problem, and as the data refer to many parts of the world the values of the index for specimens from special regions would not be applicable. The normal law of error will therefore be used.

Of the data quoted by Holmes, two (Nos. 20 and 24) are for ores of unknown age. Three (Nos. 9, 10, 11) are for ores from Joplin, Missouri. In other cases where different specimens from the same place have been analysed, mean values are given, and there seems to be no reason against doing the same for the Joplin leads. The data to be used here are then as follows. Holmes's numbering is retained.

No.	Pb^{206}	Pb^{207}	Pb^{208}	Age (m.y.)	Residuals		
1	18·85	15·66	38·63	25	+0·06	+0·03	+0·16
2	18·67	15·45	38·15	25	−0·12	−0·18	−0·32
3	18·40	15·53	38·1	25	−0·39	−0·10	−0·37
4	19·22	16·17	39·15	25	+0·43	+0·54	+0·68
5	18·07	15·40	38·0	25	−0·72	−0·23	−0·47
6	18·71	15·70	38·5	25	−0·08	+0·07	+0·03
7	19·30	15·73	39·5	60	+0·51	+0·10	+1·03
8	16·04	15·11	35·26	60	−2·75	−0·52	−3·21
9, 10, 11	21·89	15·92	40·93	100	+3·10	+0·29	+2·40
12	17·75	16·21	38·05	175	−0·29	+0·56	+0·1
13	18·10	15·57	37·85	220	+0·06	−0·08	−0·1
14	18·20	15·46	37·7	220	+0·16	−0·19	−0·2
15	17·36	15·46	37·38	220	−0·68	−0·19	−0·5
16	18·46	15·66	38·6	220	+0·42	+0·01	+0·6
17	17·95	15·57	37·9	220	−0·09	−0·08	−0·0
18	18·43	15·61	38·2	220	+0·39	−0·04	+0·2
19	14·65	14·65	34·48	600	−0·81	−0·25	−0·5
21	16·27	15·16	35·60	800	+0·81	+0·26	+0·5
22	16·07	15·40	35·5	1200	+0·09	+0·07	+0·1
23	15·93	15·29	35·25	1200	−0·05	−0·04	−0·1
25	15·93	15·30	35·3	1330	−0·05	−0·03	−0·0

The ages fall into four groups, for which the summaries are as follows:

Mean age	Pb^{206}		Pb^{207}		Pb^{208}		Numbe
	Mean	s_1	Mean	s_2	Mean	s_3	
41	18·79	1·52	15·63	0·30	38·47	1·52	9
214	18·04	0·39	15·65	0·26	37·95	0·38	7
700	15·46	1·15	14·90	0·36	35·04	0·79	2
1243	15·98	0·081	15·33	0·061	35·35	0·132	3

The residuals are given in detail, as it will b necessary to refer to them again. s is the standar deviation of one observation, found from the usua formula.

There is a clear trend in the means, a less clea one in the standard deviations s. The estimate o t_0, as we have seen, will depend wholly on the latte Now if the standard error of u_m is σ_1, that of x_m i $\sigma_1(e^{k_1t_0} - e^{k_1t_m})$, and s_1 is an estimate of this. A the standard error of s_1 itself can be taken a $s_1/\sqrt{\{2(n-1)\}}$, it is convenient to write the equation of condition in the form

$$\log \sigma_1 + \log(e^{k_1t_0} - e^{k_1t_m}) = \log s_1 \pm \frac{1}{\sqrt{\{2(n-1)\}}}. \qquad (2$$

For each t_m we have such an equation, and σ_1 i independent of t_m. The equations can be solved b the method of least squares. The solutions are a follows. The last expression in each case has a uncertainty independent of that of t_0: $\beta = (t_0 -$ 1,600 m.y.)/100 m.y.

$$\left.\begin{array}{lll} Pb^{206}.\ \log \sigma_1 = +1{\cdot}54 \pm 0{\cdot}26; & t_0 = 1{,}250 \pm 170 \text{ m.y.}; & \log \sigma_1 + 0{\cdot}113\,\beta = 1{\cdot}14 \pm 0{\cdot}17 \\ Pb^{207}.\ \log \sigma_2 = -2{\cdot}25 \pm 0{\cdot}33; & t_0 = 1{,}390 \pm 170 \text{ m.y.}; & \log \sigma_2 + 0{\cdot}162\,\beta = -2{\cdot}59 \pm 0{\cdot}17 \\ Pb^{208}.\ \log \sigma_3 = +2{\cdot}54 \pm 0{\cdot}26; & t_0 = 1{,}430 \pm 180 \text{ m.y.}; & \log \sigma_3 + 0{\cdot}108\,\beta = 2{\cdot}36 \pm 0{\cdot}17 \end{array}\right\}. \qquad ($$

We compare these solutions with the separate values of s that they were derived from; using the standard errors suggested by (2) we get respectively $\chi^2 = 11\cdot9$, $0\cdot9$ and $11\cdot3$, in each case on two degrees of freedom. Plainly there is some source of variation besides those contemplated in the hypotheses. Also as the estimates of t_0 are not much more than the age of the oldest ore, the probability distributions of t_0 must be very unsymmetrical.

In addition, we have from direct measurement of the isotopic abundances of U^{238} and U^{235}

$$\log\sigma_1 - \log\sigma_2 = 4\cdot93. \qquad (4)$$

We take the last two equations for each of Pb^{206} and Pb^{207}, use (4) to eliminate σ_2, and get a least squares solution

$$s = -1\cdot1 \pm 1\cdot2\,;\ t_0 = 1{,}480 \pm 120\text{ m.y.}\,;\ \log\sigma_1 = 1\cdot89 \pm 0\cdot21. \qquad (5)$$

Comparing this with the four equations used, we get $\chi^2 = 28\cdot7$ on two degrees of freedom. Thus we have a still more serious discordance.

None of the solutions is anywhere near that given by Holmes; and in any case it will be necessary to truncate the probability distribution found for t_0, because the most probable values on these data alone are less than the ages of some known rocks. The following procedure, however, is of some interest. If we take $\sigma_1/\sigma_2 = 139$ as before, the ratio of the present amounts of Pb^{206} and Pb^{207} of radioactive origin should be

$$139\,(e^{k_1 t_0} - 1)/(e^{k_2 t_0} - 1). \qquad (6)$$

For $t_m = 41$ m.y., the ratio should not differ appreciably from this; and the ratio of the values of s_1, s_2 gives

$$\log s_1 - \log s_2 = \log 5 \pm \frac{1}{2\sqrt{2}}. \qquad (7)$$

This expression, equated to (6), gives an equation for t_0, and the solution is

$$t_0 = 4{,}000 \pm 370\text{ m.y.} \qquad (8)$$

This is comparable with Holmes's estimate.

This result, though based on only a portion of the data, indicates the source of the principal discrepancy. When three separate solutions give values in the neighbourhood of 1,400 m.y., a piece of evidence that gives a value differing from this by 2,600 ± 370 m.y. will make a very large contribution to χ^2 however the data are combined. If we accept the smaller values of t_0, or indeed any value less than 3,000 m.y., the variation of Pb^{207} as between ores of the same age is greater than we should expect from the variation of Pb^{206}. On the other hand, if we adopt a value near 4,000 m.y., we have no explanation of the small scatter of the values for the three oldest ores.

The validity of the comparison made in deriving (5) or (8) can be checked from the original residuals. If it is correct that the original ratios of isotopic abundances for the same element were absolutely constant, then for rocks of the same age there should be a strictly linear relation between those of Pb^{206} and Pb^{207}. There are too few determinations in the two oldest groups, but for the two more recent groups we find the following correlation coefficients:

$t_m = 41$ m.y. Pb^{206} and Pb^{207}, $+\,0\cdot77$; Pb^{206} and Pb^{208}, $+\,0\cdot94$.
$t_m = 214$ m.y. Pb^{206} and Pb^{207}, $-\,0\cdot11$; Pb^{206} and Pb^{208}, $+\,0\cdot77$.

On the hypothesis considered, the correlations between the two lighter isotopes should be $+\,1\cdot0$. Actually it appears that the variation of Pb^{206} accounts in the first set for little more than half the variance of Pb^{207}, in the second for none of it. The correlations of Pb^{206} with Pb^{208} in both cases are higher than with Pb^{207}. The two largest residuals, numerically, for Pb^{206} are for ores No. 8 and Nos. 9, 10, 11, and are associated with Pb^{207} residuals of the same sign; but the larger Pb^{207} residual for No. 4 is associated with a much smaller Pb^{206} one. Evidently there is a disturbance affecting the values for Pb^{207} by $\pm\,0\cdot2$ or so and not associated with the variation of Pb^{206}. This could be due to a variation of the order of 1 per cent in the isotopic constitution of the primitive lead, or to experimental errors of the same order in the estimates of Pb^{204}. But in any case the existence of such a disturbance, whatever its explanation may be, shows that no reliance can be placed on the estimates of t_0 that depend on the abundance of Pb^{207}.

On the other hand, each of the values found from Pb^{206} and Pb^{208} gives a χ^2 about six times its expectation, and the adopted uncertainty taken from the normal law of error is much too low. If we simply redetermine it from the residuals, we must multiply it by about $2\cdot4$. The determinations are not independent, since we have seen that the variations within the groups are closely correlated; the best we can do is simply to average the solutions as they stand and increase the estimated uncertainty. The solution is then

$$t_0 = 1{,}340 \pm 420\text{ m.y.}$$

Ahrens[3] gives 2,100 m.y. for the ages of the oldest known rocks. This would suggest that the small scatter in the oldest group of ores in the present study is an accidental agreement. As there are only three in this group, this is quite probable. But so far as the present study goes, it suggests that Ahrens's value is not much less than the true age of the crust. To improve the estimate appreciably would require isotopic analyses of at least four times as many old lead ores. The point is that with any statistical treatment of the data there is a great asymmetry of the posterior probability of t_0; corresponding to the possibility that the scatter of the data for the oldest rocks is an over-estimate, there will be a strong concentration of the probability for values between the greatest of these ages and the 'best estimate', but this must be balanced by a long tail on the other side to give the expectation found for the squared error. Additional information such as the discovery of actual rocks of greater ages will then be taken into account by cutting out the part of the probability distribution of t_0 for values less than the ages of these rocks[4].

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[1] *J. Amer. Chem. Soc.*, **60**, 1571 (1938); *Phys. Rev.*, **60**, 112 (1938) with R. W. Thompson and B. F. Murphey).

[2] *Nature*, **157**, 680 (1946); **159**, 127 (1947).

[3] *Nature*, **160**, 874 (1947).

[4] For analogous but simpler cases, see Jeffreys, "Theory of Probability", 132 (1939); 142 (1948).

EFFECTS UPON TUMOURS OF VARIOUS HALOALKYLARYLAMINES

By PROF. ALEXANDER HADDOW,
PROF. G. A. R. KON, F.R.S.
AND
DR. W. C. J. ROSS
Chester Beatty Research Institute, Royal Cancer Hospital, London

IN an extension of work upon the growth-inhibitory and carcinogenic effects of 4-aminostilbene[1], special attention has been devoted to the influence on these properties of varying the basic side-chain. In one series, the compound 4-NN-di(2-chloroethyl) aminostilbene was of interest as containing the chloroethyl groupings characteristic of the nitrogen mustards. Administration of this substance in relatively high dosage (c. 500 mgm./kgm.) to rats bearing the Walker carcinoma, in an orienting type of experiment already described[1], produced an inhibition of tumour-growth considerable in degree but of very brief duration; and pharmacologically the compound appeared, not surprisingly, to be markedly different from the aliphatic chloroethylamines on one hand and the aminostilbenes on the other.

Partly because of the relatively low toxicity of this compound, and partly because published results in this field deal mainly with chloroalkyl derivatives of aliphatic amines, it became of interest to decide in what types of aromatic amine (if any) the NN-di-2-chloroethyl side-chain could still contribute its specific cytotoxic properties: a long series of haloalkylarylamines, a description of some of which is now in press[2], has therefore been examined to this end. From the biological results it is apparent that marked cytotoxic and inhibitory activity, as judged against the growth of various animal tumours, is a feature of the NN-di-2-chloroethyl derivatives of aniline, *o*-, *m*- and *p*-toluidine, *o*- and *p*-anisidine, β-naphthylamine, and *p*-aminobenzoic acid. Less activity was observed for the corresponding derivatives of α-naphthylamine and *p*-aminobenzaldehyde, while no activity was detected (under the conditions employed) for those of 2:4-dinitroaniline and *p*-xenylamine, or for the NNN′N′-tetra-2-chloroethyl derivatives of benzidine, *o*-tolidine or *o*-dianisidine. Certain compounds, for example, NN-di(2-chloroethyl)-*m*-toluidine and NN-di(2-chloroethyl)-β-naphthylamine, showed perceptible advantages in reduced toxicity, and by administration of these in a single intraperitoneal injection of 70–100 mgm./kgm. in solution in arachis oil on the day following implantation with the Walker tumour, it is possible to extend the survival-period considerably, and even to inhibit development of the graft completely in about half the animals. Similar results may also be obtained through administration of such compounds orally.

In such experiments it has been noted that treated tumours may increase in size for a few days before undergoing regression. Regression is, however, less frequent in larger tumours, although prolongation of survival-time can still be demonstrated in animals bearing fully established tumours. While rather less marked results have been obtained in the case of various mouse neoplasms, for example, spontaneous mammary cancer, the Crocker sarcoma 180, the sarcoma *S*37, the Gorer histiocytoma and a transplantable lymphosarcoma, outstanding sensitivity to inhibition is seen in spontaneous and transmitted leukæmia originating in the Furth *AK*1 pure line, and is expressed in much longer survival times (in certain cases of the order of many weeks) than can be achieved by the treatment of the same tumour with urethane.

Work now in progress is aimed at establishing the optimal structural requirements for biological activity and correlating such with chemical reactivity. Inhibitory activity is clearly associated with the haloethyl chain and not with the basic nature of a given substance, since diethylaniline, for example, is wholly inactive. As in the aliphatic series, a prominen feature is dependence for activity upon two haloalky groups; thus the following types are inactive N-2-chloroethyl-N-ethylaniline, NN-di(2-cyanoethyl) aniline, 2-chloroethylphenylsulphide, chloroacetophenone. Substituents in the aromatic ring which reduc the reactivity of the chlorine atoms, as measured by the rate of hydrolysis in aqueous acetone (fo example, *p*-NO_2, *p*-Cl, *p*-CHO and *p*-CO_2Et), als reduce the biological activity. The active NN-di(2 chloroethyl)-*p*-aminobenzoic acid is an interestin case since the reactivity of the chlorine atom, whil low in the free acid, is appreciably higher in th anion which would be formed at physiological *p*H A considerable number of 2-bromo- and 2-iodo homologues has been prepared: replacement of C by Br or I leads in general to active compound which hydrolyse more rapidly than the correspondin chloro derivatives and usually exhibit increase toxicity. Halo-ethylamine derivatives of larger molecules, for example, diphenyl, are less soluble, an substances of this kind may be inactive notwithstanding substantial reactivity of the halogen atom

This feature suggests that a certain concentratio of reactive halogen compound, expressed as 'reactivit of halogen × solubility', must be reached in order t permit biological activity. Such a relation is show in the series NN-di(2-chloroethyl)-*p*-xenylamine (inactive), NN-di(2-bromoethyl)-*p*-xenylamine (active NN-di(2-iodoethyl)-*p*-xenylamine (highly active and NN-di(2-chloroethyl)-*p*-chloroaniline (inactive NN-di(2-bromoethyl)-*p*-chloroaniline (active), whe in both cases increasing reactivity of the halogen ato compensates for decreased solubility. While 3-chloropropyl derivatives are inactive, as might be anticipated from the low reactivity of the halogen atom NN-di(3-iodopropyl)aniline is also inactive, althoug in this case the reactivity of the iodine atoms is a high as that of the chlorine atoms in NN-di(2-chloroethyl)aniline. 2-Chloropropyl derivatives are i general biologically active and tend to show increase toxicity, as would be expected from the high r activity of the halogen: an interesting comparison provided by NN-di(2-chloroethyl)-*p*-chloroanilin (inactive) and NN-di(2-chloro-*n*-propyl)-*p*-chlor aniline (active). The 2-chloropropyl derivativ studied are hydrolysed without change of structu (cf. Ross[3]), and in particular no evidence has be obtained to suggest, nor would the form of t hydrolysis curves lead one to postulate, the formati of an ethyleneimonium ion. The low basicity of t chloroalkylarylamines (for example, for NN-di(chloroethyl)aniline $pK_a = 2 \cdot 2$ in a series measur by Mr. G. C. L. Goss) would possibly account for t non-existence of this intermediate, in contrast wi the higher basicity of the chloroalkylamines (f xample, for methyl di(2-chloroethyl)amine pK_a = 6·1 [4]).

A fuller account, including a description of the cytological effects produced by these compounds in umour tissue and normal organs, the influence of diet upon response, the further correlation of biological activity with chemical and physical characters, and the clinical effects of selected compounds, will be published later jointly with others. The investigation has been supported by generous grants made o the Royal Cancer Hospital by the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the Division of Research Grants of the U.S. Public Health Service, and was conducted during the enure by one of the authors (W. C. J. R.) of a Sir Halley Stewart Fellowship. It is a pleasure to acknowledge the assistance provided by Mr. J. L. Everett in the preparation of some of the compounds described.

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OPHTHALMIC OPTICS

ON November 3, the master of the Worshipful Company of Spectacle Makers, Alderman Sir Frank Newson-Smith, opened a two-day optical convention which was held in the Apothecaries' Company's Hall, London, to mark the fiftieth anniversary of the inauguration of the Company's examinations. During this time, 116 examinations have been held and 4,200 diplomas issued, so that at the present time the services of a useful nucleus of trained opticians s available for the administration of the Health Service Act.

The Spectacle Makers' Company is an old City guild with a charter dating from 1629, which with upplementary ordinances gave control over persons practising the craft throughout Great Britain. These powers were at first rigorously applied; but by the end of the nineteenth century had fallen into disuse. A class of ophthalmic optician had been growing which petitioned the Company about 1898 to ssociate itself with the training and examination of opticians. The convention just held affords ample vidence that the Company is very much alive, particularly at the present time, to the encouragement of the sciences of spectacle and visual optics.

Papers presented and discussed were: (1) The Need of Research and the Means of Meeting it (A. J. Philpot); (2) Optical Theory and Ophthalmic Lenses (W. Swaine); (3) Nomography Applied to Optical Calculations (A. G. Bennett); (4) Some Applications of the Slit Lamp (H. C. Binstead); 5) Binocular Vision (Lord Charnwood); (6) Binocular Vision (Dr. W. D. Wright); (7) Routines and Techniques (C. S. Flick); (8) The Causes of Faulty Refraction (Prof. H. Hartridge); (9) The Physical Interpretation of the Spectral Sensitivity Curve of the Eye (Dr. W. S. Stiles). It is expected that these apers will be bound together in a commemorative olume.

It may be that the successful convention just held, coinciding as it does with the emergence of a profession attending to the visual requirements of the ation, marks the start of an era in which opticians will take a greater part in scientific advancement. Mr. Philpot pointed out that ophthalmic optics is concerned with a nicely balanced mixture of fundamental and applied study, visual problems and spectacle production. While small firms may not be able to finance a special research worker, it should be possible to engage the services of a scientific worker who through education, background and experience could serve as an interpreter and liaison officer between his own organisation and the external research field. The possibility of co-operative research was emphasized. On the visual side, it may be advisable for the optical community to provide bursaries for postgraduate research workers and to provide machinery to effect the absorption of such within the community.

Prof. L. C. Martin presided over the session devoted to the discussion of optical theory and lens calculations. Mr. Swaine, from his experience as examiner to the Company, urged the more direct application of basic fundamental theory not only by candidates for the examinations but also by those who had qualified. He pointed out that it is possible to write down immediately formulæ, involving successive addition or multiplication only, which describe most of the more complicated actions of accommodation, convergence and retinal image size when the eyes are aided by lenses or instruments. Mr. A. G. Bennett gave a valuable summary of nomographic methods generally and their application to ophthalmic and other lenses. A nomogram to solve the problem of contact lens design was described. Of particular interest was a composite circular and elliptic nomogram—four nomograms on one framework—designed to solve the laborious calculation of prismatic effect at decentred points of astigmatic thin lens systems.

Mr. H. H. Emsley, an examiner to the Company, presided over a session to discuss binocular vision. Lord Charnwood commenced with a review of fusion and suppression theories of stereoscopic vision. With his paper he presented a set of eight stereograms with which self-experimentation could be made in order to test descriptions and deductions which a theory of stereopsis must explain. Some of these are: single binocular vision can obtain provided retinal disparity is not too great, when it will be seen that the images glide into fusion; fusion of disparate images is more difficult if disparity is such as to contradict other clues. Suppression of stereopsis can occur without suppression of images, and occurs when the stereopsis runs counter to preconceived convictions—such suppression causes discomfort. The role of the mind in choosing an interpretation which fits best the other evidence, changing from one interpretation to another at will, was emphasized. An explanation was suggested whereby stereopsis is attained by a process of integration of successive disparities too small to cause physiological diplopia.

Dr. W. D. Wright took up an intentionally provocative thesis criticizing the theory that stereopsis arises from retinal disparity. The rapid drop of visual acuity with distance from the fovea suggests that the peripheral parts of the retina contribute little to stereoscopy from disparate points. It does impart to the eyes a pointer-like action ('visual fingers') by the foveæ which, combined with an elementary foveal fusion and with the assistance of the muscle movements, through mental integration, serves to complete the solidity impression.

Mr. H. C. Binstead showed the development of the slit lamp from Gullstrand through Fincham's design to its applications for the examination of the iridic angle, depth of the anterior chamber, depth of lesions in the eye media and the ingenious Ronne colloidometer for measuring the albumen content of the aqueous. Mr. C. S. Flick set the question: Do routines and techniques for the measurement of refractive error matter? A set of four typical routines included one which was typically American —a twenty-one point technique with standardized analysis—which led to extensive discussion.

Prof. H. Hartridge provided a fascinating introductory study of the development of X-ray techniques for determining the actual length of the living eye (Rushton, Sorsby and O'Connor) and the Goldmann–Hagen modification for measuring refraction. This led to the development of the main topic of his lecture, the cause of refractive error. Five or six theories were passed under review to explain the normal tendency of eyes so commonly hypermetropic at birth to settle down to an approximate emmetropic condition. The X-ray technique should serve to separate the roles of axial length and of optical refraction, which hitherto was not possible.

Dr. W. S. Stiles reviewed the physics of light absorption (including finer adjustments introduced by quantum considerations) and the bleaching of visual purple. Three curves of corrected means effected a simultaneous comparison of absorption coefficients and photosensitivity of visual purple solutions and the subjective spectral sensitivity of the dark-adapted parafoveal retina. The maxima at 500 mμ all agreed; but further study is needed in order to explain the differences towards the violet side, where there appears an absorption band at about 360 mμ. The curves agree very well on the red side of the maximum, especially as regards linearity and gradient, for which a rough theory giving a good fit of gradient was elaborated. A comparison of spectral sensitivity curves of the parafoveal rod vision and of the foveal cone vision shows, besides the Purkinje shift, a significant gradient difference on the red side of the maximum. This will require explanation in any future photochemical theory of vision.

WILLIAM SWAINE

ELASTICITY OF WOOD AND PLYWOOD

SPECIAL REPORT No. 7, issued by the Forest Products Research Laboratory (London: H.M. Stationery Office, 1948. 2*s.* net), summarizes the available information on a piece of important research undertaken on the "Elasticity of Wood and Plywood". The work and results embodied in the report are said to be mainly for the designer and the research worker. The forest officer might also have been included, since on the work of the sylviculturist all 'wood' of the future, whatsoever its type, may be said to depend, with the exhaustion of Nature's resources.

The theory of wood elasticity rests on the assumption that the gross material possesses three perpendicular planes of elastic symmetry, and that it is perfectly elastic and homogeneous. A point which needs emphasis at the outset is that wood is actually only an approximation to this ideal material. The longitudinal tangential surface (the surface generated by a line parallel to the axis of the tree and moving along the growth rings) is not plane, but roughly cylindrical. The other two principal surfaces, the longitudinal-radial (defined by the axis of the tree and the medullary rays) and the tangential-radial, are more truly plane; but even in these cases there will be some deviation owing to local irregularities in the growth of the tree. This is where the sylviculturist comes in. "The extent to which any actual specimen departs from the ideal material will depend not only on the regularity of the growth but also on the position of the specimen in the tree."

The report is intended chiefly as a summary of knowledge known, but it contains a number of new results, some obtained in America and Australia during the Second World War, here published for the first time. The first part of the report is entitled the "Elastic Constants of Wood"; it deals with the measurement of the nine independent elastic constants of wood and the effect on them of factors such as temperature, moisture content and grain angle. The second part deals with the elastic constants of plywood. The manner in which they are related to the form of construction of the plywood and to the elastic constants of the wood from which the plywood is made is explained.

Under the heading of "The Properties of Plywood Plates and Cylinders", the third part deals with the frequency of vibration, the buckling and deflexion of plywood plates and the buckling of plywood cylinders

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION

SECOND ANNUAL CONGRESS

THE most important outcome of the annual congress of the International Scientific Film Association held in London during October 4–11 1948, has been the formation of a number of international commissions to pursue in detail the programme of work agreed in general by the member countries for the coming year. Before discussing this programme, a few words on the Association's history may not be out of place.

The International Scientific Film Association was inaugurated last year in Paris, largely as a direct result of the initiative of the British and French Scientific Film Associations. The preliminary work of these two organisations, the first contact of which at the end of the War revealed many common interests, resulted in the assembly last year of representatives from twenty-two countries to discuss and agree to the formation of this international organisation to further the interests of the scientific film. Unesco, recognizing the scientific film as an important aid in the dissemination of knowledge, showed a benevolent interest in the new Association, the maintenance of which was demonstrated by the attendance again of a Unesco observer at this year's Congress.

Some twenty-five countries had accepted the invitation to the second Congress, and the number of those who finally managed to send delegates fell little short of this figure, some unfortunately failing to overcome the many obstacles with which post-war travelling is beset.

The honour of organising this year's congress was given to Great Britain, and its Scientific Film Association, assisted by financial aid from the British Film Institute, rose worthily to the occasion. A ver full programme of eight days of meetings, receptions, demonstrations and film showings was arranged and carried through smoothly.

The general assemblies of the delegates formed the most important part of the proceedings. The events of the first year of the Association's history were reviewed, and delegates gave brief reports of the work being done in their countries. It was striking testimony to the value of the activities of the Scientific Film Association of Great Britain to note how several countries, notably Holland and Belgium, are modelling their own young organisations along closely similar lines.

The need for continuous exchange of general information, and details regarding films in particular, soon established itself as paramount in the discussions. A vital step in its fulfilment was taken by the approval of an index card to record essential data of scientific films and thus to form the material for the first catalogue of such films available throughout the world. One of the international commissions set up was charged with supervising this work and preparing recommendations for the international appraisal and grading, according to merit and purpose, of scientific films.

Other matters of prime interest in the further work of the Association were also entrusted to commissions. It is believed that these will be able to work out practical details for some kind of international co-operation in the joint production of certain specialized films, and that eventually the problem of film distribution on the widest international scale will be solved. Discussion indicated to what extent customs barriers and finance regulations are likely to hinder the early achievement of this aim, but hope for a solution, even if only on a limited scale at present, was not abandoned.

The Belgian delegate offered a very practical contribution by trying to form an international scientific film reference library in his country. The representative of the Dominican Republic suggested that they might help by providing translations of information for the Spanish-speaking countries. Such offers of practical assistance showed the keen interest in the proposed activities and pervaded the meetings with a strong feeling that the aims of this international organisation are likely to be successfully implemented.

Much of the proceedings of the assemblies was in connexion with the constitution and internal organisation of the Association itself. While these may not be of such immediate public appeal as other matters already mentioned, they are none the less essential for the smooth and efficient working of the Association. In accordance with its democratic constitution, delegates from member countries elected a governing Council for the coming year, the officers of which are: *President:* M. Jean Korngold (Poland); *Vice-Presidents:* Mr. John Maddison (Great Britain) and Mr. C. A. Burmester (Australia); *Honorary Secretary:* M. Jean Painlevé (France); *Honorary Treasurer:* M. Luc Haesaerts (Belgium).

In conclusion, mention should be made of some of the many events occupying the full programme of the week. Receptions for the delegates were given by the Council and Congress Committee of the Scientific Film Association of Great Britain, the Royal Microscopical Society and the British Council. At the former, the inaugural reception, delegates were received by the Parliamentary Under-Secretary of State for Commonwealth Relations on behalf of the Lord President of the Council. These various functions, while dignified, were given a pleasantly informal character by the renewing of many old friendships among the delegates.

The Scientific Film Association of Great Britain had also organised some specialists' meetings dealing with the film in medicine, schools, universities, industry and scientific research. They provided welcome opportunities for discussion between experts in Britain and abroad as to how best the film can help in these various fields. Much valuable material was contributed from both sides and the detailed discussions served to co-ordinate thought on these problems. These links between groups of similar specialized interests, thus established, will serve to strengthen considerably the work of the International Association.

Fifteen of the participating countries sent more than sixty scientific films, some of which were shown during the course of these specialized meetings, but about forty of which formed the programme for a public International Scientific Film Festival held in London on October 8, 9 and 10. Such was the interest in this Festival that the hall of the Royal Empire Society was filled to capacity by some four hundred spectators on six separate occasions. An even wider audience, estimated at 100,000, was reached, however, by means of television. On October 4, a special programme was transmitted giving previews of some of the films to be shown later and ending with the first demonstration in Britain by the French delegate, M. Jean Painlevé, of the combination of television camera and microscope to achieve 'live' broadcast pictures of microscopic organisms.

The second congress of the International Scientific Film Association in London will undoubtedly be remembered as a significant milestone in the history of the Association. One may hope, however, that it served an even wider purpose, for it demonstrated once again the common aim of all men of science to further human progress and happiness. To achieve this on a truly world-wide scale, the film will play a major part by using visual images to transcend barriers of language in the spreading of knowledge.

MICHAEL MICHAELIS

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, November 20

ROYAL AERONAUTICAL SOCIETY (joint meeting with the HELICOPTER ASSOCIATION, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Helicopters".

Monday, November 22

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Single-Phase to Three-Phase Conversion Systems" (to be opened by Mr. A. N. D. Kerr).

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. H. E. Bowman: "Education for International Understanding—The Moslem World".*

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. W. McG. Morgan: "Accelerators for Stocks containing Reinforcing Furnace Blacks".

TEXTILE INSTITUTE, YORKSHIRE SECTION (in the Large Hall, Technical College, Huddersfield), at 7.15 p.m.—Mr. B. H. Wilsdon: "Principles of Textile Research".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. L. H. Bedford: "Some Technical Aspects of Television" (Cantor Lecture).

Tuesday, November 23

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. F. W. Jane: "Some Problems in being a Tree".*

Chadwick Public Lecture (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. Alister MacDonald: "The Influence of Hygiene on the Shape of Buildings" (Bossom Gift Lecture).*

Royal Anthropological Institute (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Robert H. Lowie: "Some Aspects of Political Organisation among the American Aborigines" (Huxley Memorial Lecture).

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. E. Rhys-Jones: "Printed Circuits, including Miniature Components and Sub-Miniature Valves".

Sir Halley Stewart Trust Lecture (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Lord Russell, F.R.S.: "The Atomic Age—Our Scale of Values in the Atomic Age".*

Society of Dyers and Colourists, Scottish Section (at the St. Enoch Hotel, Glasgow), at 7 p.m.—Dr. D. Traill: "The Problem of the Synthetic Fibre".

Wednesday, November 24

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. J. E. O'Breen: "Automatic Control of Steam Raising Plant".

University of London (at Bedford College for Women, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. L. J. Audus: "Jungle Economy" (Inaugural Lecture).*

Linnean Society of London (in conjunction with the Systematics Association, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. T. A. Sprague: "Botanical Taxonomy up to and including Linnæus".

Manchester Literary and Philosophical Society, Chemical Section (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Dr. Metcalfe Brown: "Chemistry and Public Health".*

Society of Chemical Industry, Microbiological Panel of the Food Group (in No. 3 Room, Gas Industries House, Grosvenor Place, London, S.W.1), at 6.15 p.m.—Dr. J. B. Firth: "Spontaneous Combustion in Hay, Cotton and other Vegetable Materials".

Thursday, November 25

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Discussion on "The Theory and Practice of New Techniques in Separation and Purification".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Physical Society, Acoustics Group (in the Small Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. R. S. Dadson and Mr. E. G. Butcher: "Apparatus for Acoustical Measurements at Low Frequencies".

Physical Society, Low-Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. C. J. Gorter (Leyden): "Irreversible Processes in Liquid Helium II".

Institute of Welding (joint meeting with the Institution of Structural Engineers, at 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. H. Gottfeldt: "Curved Bridges and Why they should be Welded".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. W. H. Lindsey: "Development of the Armstrong Siddeley Mamba Engine".

Institute of Metals, Birmingham Section (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 6.30 p.m.—Mr. T. Land: "High Temperature Measurements".

Royal Institute of Chemistry (at the Medway Technical College, Gardiner Street, Gillingham), at 7.15 p.m.—Dr. F. Wormell: "The Corrosion of Metals".

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. E. A. Krahenbuhl: "New Principles in the Continuous Dyeing of Wool".

Wednesday, November 24—Thursday, November 25

Institution of Gas Engineers (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 10 a.m. each day. —Fourteenth Autumn Research Meeting.

Friday, November 26

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

Royal Statistical Society, Birmingham Group of the Industrial Applications Section (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. Philip Lyle: "Factorial Regression Analysis".

Manchester Statistical Society, Industrial Group (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. W. T. Hale: "The Statistical Solution of an Industrial Problem".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. A. B. D. Cassie: "Physics in the Wool Industry".

Institution of Electronics, North-Western Branch (at the Gas Showrooms, Town Hall, Manchester), at 7 p.m.—Mr. P. A. Cummins: "Electronic Equipment for Radio Control".

Royal Photographic Society, Scientific and Technical Group (joint meeting with the Industrial Radiology Group of the Institute of Physics, at 16 Princes Gate, London, S.W.7), at 7 p.m.—Mr. H. S. Tasker and Mr. K. H. Gaseltine: "The Reproduction of Radiographs".

Society of Chemical Industry, Fine Chemicals Group (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Dr. F. Bergel: "Some Aspects of the Relationship between Chemical Constitution and Physiological Activity".

Saturday, November 27

British Psychological Society, Social Psychology Section (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 8 p.m.—Prof. T. H. Pear: "Social Stratification as a Necessary Consideration in English Social Research".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Graduates in Chemistry (2) as Research Assistants in the Department of Chemical Engineering and Applied Physical Chemistry—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (November 27).

Lecturer (Grade IIb) and a Lecturer (Grade IIc) in the Department of Electrical Engineering—The Secretary, The University, Edmund Street, Birmingham 1 (November 27).

Scientific Editor in London (Central Office of Information) for news and feature periodicals published in Eastern Europe—The Ministry of Labour and National Service, Technical and Scientific Register K, York House, Kingsway, London, W.C.2, quoting A.374/48A (November 30).

Mining Consultant to advise the Government of Tanganyika on all matters pertaining to mining development in that territory—The Ministry of Labour and National Service, Technical and Scientific Register K, York House, Kingsway, London, W.C.2, quoting C.731/48A (November 30).

Technician in the Pathology and Bacteriology Laboratory at Galway Central Hospital—The Secretary, Galway County Council, County Buildings, Galway (December 7).

Chair of Physical Geography at Fouad I University—The Dean of the Faculty of Arts, Giza, Egypt (December 15).

Lecturer in Physiology in the United College—The Secretary, The University, St. Andrews (December 15).

City and Water Engineer to the City of Port Elizabeth, South Africa—Davis and Soper, Ltd., 52–54 St. Mary Axe, London, E.C.3 (December 31).

Marine Zoologists (2)—The Secretary, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth (January 31).

Biochemist or Organic Chemist in the Department of Lactational Physiology, to assist in the investigations of the intermediary metabolism of the mammary gland—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

Telecommunication Engineers in the Postmaster-General's Department, Commonwealth of Australia—The Representative of the Australian Post Office, Australia House, Strand, London, W.C.2, endorsed 'Application for position of Telecommunication Engineer'.

Graduates in Physics or Chemistry for investigation of various problems connected with the manufacture of pottery—The Director, British Ceramic Research Association, Queen's Road, Penkhull, Stoke-on-Trent.

Entomologist in the Medical Department (Health Branch) of the Gold Coast—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in Agricultural Zoology, and an Assistant Lecturer in Agricultural Botany—The Secretary and Bursar, Seale-Hayne Agricultural College, Newton Abbot, Devon.

Departmental Demonstrator in Physical Anthropology—The Professor, Department of Human Anatomy, The University, Oxford.

Physicist for fundamental work on the structure and properties of fibrous materials, etc., and a Physicist for laboratory and service test of shoes and shoe materials, etc.—The Director, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering.

Metallographer with wide experience of non-ferrous metals and alloys, to take charge of metallographic laboratory—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

Laboratory Steward (Grade I) to take charge in Department of Geography—The Registrar, University College, Leicester.

Biochemist (man or woman, preferably with post-graduate experience in the field of Enzymes or Tissue-Metabolism) for research appointment—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.

Technical Officers and Senior Technical Officers for work in connexion with the pottery industry—The Director, British Ceramic Research Association, Queen's Road, Penkhull, Stoke-on-Trent.

Curator—The Honorary Secretary, Hancock Museum, Newcastle-upon-Tyne 2.

Lecturer in Zoology—The Registrar, University College, Exeter.

Agricultural Research Officer, Cyprus—The Director of Recruitment (Colonial Service), Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Survey and Policy of Field Research in the Archaeology of Great Britain. 1: The Prehistoric and Early Historic Ages to the Seventh Century A.D. Pp. 120. (London: Council for British Archaeology, Institute of Archaeology in the University of London, 1948.) 5s. [48

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DISTRIBUTION OF INDUSTRY IN BRITAIN

CRITICISM of the Distribution of Industry Bill of the Coalition Government of 1945 centred mainly on the two points: whether the Government had a central policy in regard to the location of industry, with all that such a policy implies in regard to the control of the use of land, town and country planning, agriculture, building and amenities; and whether the Board of Trade was, or would be, staffed with the type of Civil servant qualified by training, outlook and experience to deal with these positive functions of government with imagination, decision and courage. No central independent tribunal had then been established to consider the national position as a whole, as recommended in the report of the Barlow Commission, nor has the present Government taken such action.

The paper on "Distribution in Industry" just issued by the Board of Trade* once again indicates the seriousness of the omission. The immediate occasion for the paper is the duty placed by the Act on the Board of Trade jointly with the Secretary of State for Scotland of reviewing the boundaries of the Development Areas from the passing of the Act. The paper examines in some detail the results which have followed, partly from war-time developments, and partly from the operation of the policy adopted, not only in the Development Areas, as the old Special Areas have been designated, where they are most apparent, but also in the rest of Great Britain. On the negative side, the Government has restricted new industrial development in parts which were already congested with industry; and on the positive side, it has, with the co-operation of many industrialists, assisted the Development Areas and other parts which needed more industrial employment.

The situation in the Development Areas has changed for the better, both absolutely, and relatively to other parts of Britain. Employment in these areas is much greater than before the War, while unemployment is now much smaller; and when the programme of industrial growth at present only half completed is fulfilled, there should no longer be a special danger of heavy localized unemployment in most parts of the Areas. There will be more of the industries which have been less liable to depression than some of the basic industries in which the greatest proportion of workers in those Areas was previously engaged. The existence of a wider range of industries will also mean that a recession in any one of them will have less effect on the economy as a whole. Nevertheless, the White Paper argues that it is too soon to remove the whole or part of any of the present Development Areas from the first schedule of the Act. On the contrary, it recommends the addition of two new Areas: Merseyside, and a district to serve as an industrial nucleus for the Highlands of Scotland.

The policy on the distribution of industry pursued by the Board of Trade has as its purpose the provision of regular work for the greatest possible number of those seeking it in all parts of Great Britain, especially in those parts which are known as the Development Areas, and so helping to raise the number in work and the nation's total output to the highest possible level. Now, although the White Paper admits that sometimes there have been sound economic reasons why movement of particular enterprises to the Development Areas was impracticable, such a purpose, the natural development of the policy evolved in the late thirties, fails to take adequate account of the new situation. What were the 'depressed' industries are now those that most need labour. Furthermore, Britain's economic recovery depends on capital reconstruction and equipment being concentrated in those industries where it will increase exports or save imports.

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* Distribution in Industry. (Cmd. 7540.) Pp. ii+52. (London: H.M. Stationery Office, 1948.) 1*s*. net.

These are the principles against which we must judge the fact that about half the new factory-building since the War has been in the Development Areas, which have only 2,500,000 of the country's workers. The weakness of the White Paper is that it fails to take account of, and clearly distinguish, the social and the economic aspects of the policy it describes. The White Paper, in fact, is exclusively concerned with the first—the prevention of widespread unemployment—and so much ignores the second that it does not stop to consider whether, measured by the numbers placed in employment, the experiment in directing new industries to the Areas has been very costly. Nor is there shown any awareness that the attraction of a particular enterprise to the Areas may increase the cost of its products. For example, it is probable that location of the British Nylon Spinners, Ltd., mill at Pontypool, instead of at Banbury, may, owing to the double haulage of the polymer and the spun yarn necessitated, involve in effect a small continuing levy on nylon sales.

Under pre-war conditions, it might still have been worth while, from the national point of view, to locate this industry in Monmouthshire. Under post-war conditions and with the present insistence on exports, where costs are becoming increasingly important, particular instances must be judged by the same criteria as the general policy: are resources being directed into the Development Areas which could from the national point of view be better employed elsewhere, and is the movement of labour from those Areas to other districts urgently needing men being prevented? We cannot continue to build factories for unimportant industries while industries where development is essential are unable to get new buildings and equipment. On these issues the White Paper is silent. Nor does it consider the social implications of the present policy of encouraging in those Areas the lighter industries providing consumers' goods. Quite apart from the question of which type of industry should be encouraged from the point of view of economic recovery, the demand for export goods is much more likely to be sustained than that for the consumer goods coming from the light industries.

The dominant impression left by this White Paper is, in fact, the lack of clear thinking. There is no evidence that policy is governed by explicit principles about the distribution of industry. The slightness c the reference to the report of the Barlow Commissio indicates the absence of such a coherent policy, an it would not be unfair to conclude that the influenc of pressure groups has deflected the Board fro paying attention to the essential price that has to b paid for social security—mobility of labour. This i not a matter of directing men and women to th factories rather than, so far as possible, bringing th factories to the workers. Security and enterprise a uneasy bedfellows, but both are essential in an economic system; and enterprise is a quality not t be restricted to the management or employer. It i true that the State must now ensure that there a certain minimum social and economic standard below which no one can fall, in order to forestall th threats of insecurity to the efficiency of its industri and economic life. It is equally true that, unde modern conditions, the workers cannot enjoy th higher standards of living which mechanical advan has put within their reach unless they themselv show enterprise, initiative and adaptability to t changing conditions.

The most hopeful section of this White Pape is that which deals with research for the futur For all its shortcomings, it recognizes that wi conduct of the distribution of industry deman constant study and examination of the needs an resources of every part of Britain, and that the futu of the Development Areas is bound up with that world trade and our share in it, and with that certain basic industries such as coal, steel and shi building. Among the functions which the Barlo Commission recommended that a central authorit should discharge was the organisation of researc and it was recognized that to provide a sure basis f action under the Development of Industry Act it w essential that the Government should establish research organisation capable of studying the ma problems of industrial location in greater detail tha had hitherto been possible.

Regional research units have been set up joint by the Board of Trade, the Ministry of Labour a the Ministry of Town and Country Planning, and, Scotland, the Department of Health. This policy decentralization has already borne much fruit; th the plan for the West Midlands region recently pr duced by Sir Patrick Abercrombie and Mr. Herbe Jackson at the behest of Mr. Silkin is one exampl Small research staffs, however, are maintained headquarters to direct and co-ordinate the work the regions, to provide basic data of a natio character and to study particular problems whi can be most effectively studied at the centre. extensive programme of research has been undertak to assist the regional offices of government depa ments concerned in the execution of the distributi of industry. General surveys of all the regions a sub-regions throughout the country have furnish knowledge about such matters as variations in industrial structure of regions and sub-regions a their causes, difference in industrial specialization a diversification, divergences in the degree of vuln ability to structural and localized unemployment between areas, industrial facilities and basic services, the constitution and geographical distribution of industrial population, labour supplies, industrial sites, the availability of factory premises, housing and general amenities.

The administration of the Distribution of Industry Act has revealed some problems requiring special investigations of particular areas or towns, and the possible uses in peace-time of war-time government factories. It is also stated that the development of physical planning, the drive to increase production in the textile and other industries, and the necessity for concentration upon the manufacture of goods to meet the export target, have all led to further research; though, as already indicated, the White Paper does not elsewhere indicate much awareness on the part of the Board of Trade of this point where the Development Areas are concerned. In addition to the maintenance of comprehensive records of what has been done or is planned, the fullest measure of co-operation exists with the research officers of the Ministry of Town and Country Planning, as well as with the staffs of local planning authorities, to ensure that research on distribution of industry problems is properly related to all developments in town and country planning.

Most of the activities described in this section of the White Paper admittedly relate to current issues and short-term problems; and in this account more reference might well have been made to the contributions from other bodies such as the West Midland Group and the Northern Industrial Group. The study of long-term problems, however, has also been undertaken, and here it is recognized that there are certain fundamental problems which are best investigated by the universities. To ensure that these problems will receive attention, the Board of Trade set up early in 1947 an informal committee, with Sir Henry Clay as chairman, consisting of members of the economic and statistical departments of several universities, to consider how the assistance of the universities might be secured.

This account of the research activities of the Board of Trade in the field of the location of industry, set against the general trend of the whole report, conveys the main impression that failure to implement the proposals of the Barlow Commission has been due to ineffective co-ordination, duplication of effort and the absence of any authority competent to choose the right subjects of research and ensure that the results of research are used. Unified research into the problem of distribution on a national scale is embryonic; there is no unified plan of development based on such research, and no effective control meanwhile of such changes as must continue to take place in the interests of trade. We are no nearer than when the Distribution of Industry Act was passed to the effective relation of schemes for industrial development to those for hydro-electric development, water supply, the building of new towns and the like.

The absence of that high standard of ministerial statesmanship which Gertrude Williams, in her book, "The Price of Social Security", showed to be the essential foundation of successful government control of any communal activity effectively prevents the formulation of a national policy. Piecemeal developments and yielding to sectional interests make the objectives professed in this White Paper as farcical as the continued encroachment on national park areas or Nature reserves by unco-ordinated demands from the Services and other interests make the nominal profession of the Government of supporting the idea of Nature reserves or national parks. This White Paper shows little sign of the imagination, vigour and statesmanship which could reverse these trends, and give Great Britain a genuine national policy for land use in which the claims of defence, amenities, industry and culture are fairly balanced, apportioned and reconciled.

THE LIFE AND WORK OF CHARLES DARWIN

Charles Darwin

Par Jean Rostand. (Collection 'Leurs figures'.) Pp. 244+4 plates. (Paris: Libr. Gallimard, 1947.) 220 francs.

THIS book is easily readable. It deals in a pleasant manner with Darwin not only as a man of science but also as an individual. It mentions, but does not stress, the shocking state of health in which Darwin carried out all his work after he returned from the voyage with the *Beagle*. The fact that, during the years 1837–59, while Darwin was collecting together his material for the "Origin", he carried out and published all the geological results of the *Beagle* expedition and, at the same time, produced a monograph on the barnacles which is still the standard work on this group can only be appreciated when it is remembered that he could only work at his desk for relatively short periods and was continually bound to lie down and rest after these short periods of exertion.

The book, however, cannot be said to throw any new light on Darwin. It is written in the modern Neo-Mendelian idiom. One sentence (p. 144) gives away the author's attitude. He maintains that one of the greatest originalities of Darwin was to have seen in the variation of domestic animals the image of the phenomenon of evolution. To a Neo-Mendelian this may make sense, but, of course, it begs the question. Then, again, the author states definitely that we now know that acquired characters are not inherited. Whatever view one may take as to Lamarck's theory—a theory which, the author rightly points out, was always misunderstood by Darwin—it has certainly never been established scientifically and probably never will be that acquired characters *cannot* be inherited. Surely it is a fact that recently one of our leading Neo-Mendelians published an account of a mechanism based on the conception of the gene complex whereby acquired characters *could* be inherited. They cannot have it both ways!

It is a pity that the author does not stress the fact that in the title of the book "On the Origin of Species" there are two inaccuracies: the word 'origin' should really have been 'establishment' after the species had originated, and then the word 'species' is not defined; and Darwin pointed out in a letter to Hooker "to define a species is to wish to define the indefinable".

H. GRAHAM CANNON

COTTON SEED: A PIONEER CROP AND AN EXAMPLE

Cottonseed and Cottonseed Products

Their Chemistry and Chemical Technology. Edited by Alton E. Bailey. (Fats and Oils, a Series of Monographs on the Chemistry and Technology of Fats, Oils and related Substances.) Pp. xxiii+936. (New York and London: Interscience Publishers, Ltd., 1948.) £5 5*s*.

THE cultivation of cotton in quantity in the United States did not commence until towards the end of the eighteenth century; but the cotton fibres only were utilized for many years, the rest of the cotton seed not being recognized to have any, except perhaps manurial, value. Although so early as about 1830 crushing of the seed was commenced in a small way, it was not until after the American Civil War that the value of the cotton seed was more fully appreciated, and that its conversion into cotton-seed oil and cotton-seed cake was undertaken on an increasingly large scale. From 1910 onwards, however, cotton-seed crushing became one of the major industries in the United States. Frequently, the quantity of cotton seed crushed annually exceeded 5,000,000 tons, the corresponding value of the products (oil and residual cake) usually being more than 200,000,000 dollars. The annual production of cotton-seed oil was 700,000–900,000 tons, and of cotton-seed cake and meal 2,000,000–2,500,000 tons. The cake is valued as an animal feeding-stuff and is also used as a fertilizer, while the oil is used both as salad oil, in margarine and in cooking fats (lard substitute) either in its original state or after 'hardening' by partial hydrogenation, and as one of the raw materials for soap-making.

Thus a by-product of the production of the cotton plant for textile purposes came at length to be the source of a number of other materials of vital importance, notably the contribution of three-quarters of a million tons or more annually of valuable edible fatty oil. The cotton-seed crushing industry was thus a pointer to what is now seen to be an urgent need in overcoming the increasing world shortage of fats, namely, the cultivation of suitable species of oil-seeds primarily for the sake of their oil content and of their residual cake or meal for feeding animal stock. Moreover, the careful selection and cultivation of both seed and crop, which have been practised for many years in order to secure constancy of quality in the cotton fibre, are evidently an example to be followed in the cultivation of other oil-seeds in order that oil and cake of the highest quality may be produced. Oil-seed cultivation is a branch of agriculture with its own special problems demanding specific control in regard to the quality of the products ultimately to be harvested.

The present volume of more than 900 pages, edited by Dr. A. E. Bailey, is thus informative to the British reader not only for its wealth of information on cotton-seed products, but also for the utilization of the knowledge acquired in this industry when dealing with other oil-seeds. The book is remarkable for its scope and for the exhaustive manner in which the details of all phases of the industry have been covered. It consists of twenty-four monographs, each of which has been written by an author with special knowledge of the part of the subject which has been entrusted to him. It opens with two monographs which deal with the history of the cotton-seed industry and its economic development, and here, as elsewhere in the book, the discussion is not restricted to the United States, but also includes full accounts of the smaller but still important cotton industries of India, Egypt and some other countries. The next seven monographs (amounting to 400 pages) deal very fully with the constituents of cotton seed—fatty oil, proteins, pigments, etc.—and also with the influences exerted upon these by differences in variety, maturity and environment of the growing cotton plant, while a separate section is devoted to the biological processes of the cotton seed. Later sections cover equally exhaustively the processing of the seed and of its various products, naturally with special emphasis on the refining, hydrogenation, etc., of cotton-seed oil for use as an edible fat. There is also a useful discussion on the nutritional aspects of cotton-seed oil utilization in the human dietary (which, in fact, covers and includes the corresponding aspects of most other vegetable fatty oils); and the concluding monographs deal with cotton-seed oil for soap, cotton-seed cake as a source of animal food-stuffs, and the utilization of cotton-seed hulls and linters.

The book is outstandingly comprehensive in its exhaustive treatment of all the factors—scientific, technical and economical—connected with the cotton-seed industry. The enormous quantity of factual data of all kinds appears to have been collected with accuracy and is certainly presented lucidly and clearly. Full references to scientific and technical literature are given, with adequate author and subject indexes. The editor and publishers are to be congratulated on the production of so complete a guide to the products of the cotton seed, and to the technical aspects of the important industries which have been built up in connexion with its processing.

As indicated earlier, the volume is of importance and interest to a wider circle than those concerned with cotton seed itself. The principles involved in the cultivation and processing of cotton seed are in many instances equally applicable to other oil-seeds. Notably this applies to consideration of the variety and environment of the plant in relation to the seed fat produced, and to the influence of moisture and enzymes on retrogressive changes within the harvested seed, leading to oxidation and to production of free fatty acid in the seed fat. As we have seen, cotton-seed oil is by way of being a by-product; the same may be said of soya bean oil, now produced to about the same extent as cotton-seed oil in the United States owing to the demand of the American farmer for soya bean cake. In the British Empire and elsewhere, except for coconut plantations, deliberate cultivation of oil-bearing species only commenced with that of the oil palm about 1910. Systematic cultivation of seed crops primarily for their oil content is thus still a comparatively young development in agriculture. Groundnuts will soon be grown in large quantities, and sunflower and some few other oil-seed crops are being developed; intensive cultivation of other selected species capable of yielding fatty oils suitable for edible, soap or paint purposes must be set in hand in tropical or sub-tropical localities with as little delay as possible—perhaps sesame, soya bean and some additional oils for edible fats and soaps, safflower, candlenut or other oils of a more unsaturated type to correct and relieve the over-dependence on linseed oil of the paint and allied industries. The information already vailable in the case of cotton seed will be of profound dvantage to those responsible for developing these ew fat resources.

Nevertheless, it is clear that for a long time to ome an important proportion of our vegetable fat pplies must continue to be derived, as of yore, om seeds or nuts grown by the native peoples in frica or elsewhere, or collected by them from the uits of wild trees and shrubs. Thus, the oil palm lantations still yield only about one quarter at most f the total supplies of palm kernels, while ground- uts have hitherto been cultivated only in primitive shion in India and in West Africa. Here it is of rgent importance to teach the native peoples and thers concerned two simple but essential principles : il-seeds must be gathered exactly at maturity ; they ust be thoroughly dried and kept dry until they ach the seed-crushing plants.

Dr. G. Scott Robertson, in his presidential address the Agricultural Section of the British Association st September, commented upon the enormous loss f good grain by insect and mould infestation. Loss nd deterioration of good edible fats in oil-seeds is ndoubtedly at present proportionately far greater, wing to the retrogressive changes, especially in the t, caused by damp conditions in storage and much ccelerated by enzymes already present in the seed, s well as those introduced by mould infection. Oil om native West African groundnuts may contain 0 per cent or more of free fatty acid, in which case ore than 30 per cent of the crude oil must be lost producing a refined edible oil. Indian groundnuts sually give oil with not less than 3 per cent of free tty acid. There is no reason why, if the principles eveloped in the cotton-seed industry and fully dis- ssed in the volume reviewed in this notice are pplied to groundnuts, the free acidity of crude roundnut oil should exceed 1 per cent, with cor- sponding improvement in its colour and general ppearance. The world production of edible fats ould be notably increased (by perhaps 10–15 per nt at least), without any increase in the tonnage f oil-seed crops, by insistence on these simple rinciples of hygiene in harvesting, storage and ansport.

T. P. Hilditch

CLASSIFICATION OF BACTERIA

ergey's Manual of Determinative Bacteriology
y Robert S. Breed, E. G. D. Murray and A. Parker itchens. Sixth edition. Pp. xvi+1529. (London : aillière, Tindall and Cox, 1948.) 82*s*. 6*d*.

TAXONOMY, "that branch of biology which treats of classification in accordance with a con- ntion or law", is the neglected foster child of cteriologists, most of whom call their pet *Bacillus* *is* or that-coccus, and for taxonomy care nothing at l. But however much classification may be neglected, y, even be despised, it is not only the bookworm d the historian who pursue it as an armchair udy ; it is also a field where research is active, and ere is increasing need that the newest ideas and chniques should be brought to bear on old problems bacterial relationships. The modern approach llects strains into groups with stable characters and nores minor differences that were once thought to important ; when the groups have proved their lue in classification they are given generic and specific names. Groups worked out according to this principle include the genus *Salmonella* and species like *Streptococcus pyogenes* and *Str. agalactiæ*, all of which have a serological basis. Much of the older work has now lost its value and should be reconsidered in the light of modern findings. The need for this is seen in the section on micrococci in "Bergey's Manual"; only twenty-two species are recognized (scarcely one is well characterized), but there is an appendix of more than four hundred names of so-called micrococci. As Abd-El-Malek and Gibson said recently, "The genus *Micrococcus* provides what is probably the worst example in bacteriology of uncritical systematic work".

Most systems of classification try to show natural relationships; but what criteria—morphology, metabolic activities, pathogenicity, or antigenic structure —are required to show these is unknown. Different relationships are brought out according to the criterion of kinship used; similarity of metabolic products makes cousins of streptococci and lactobacilli, morphology makes streptococci brothers of staphylococci, a relationship supported by the sharing of common antigens. "Bergey's Manual" adopts a classification based mainly on two characters, morphology and metabolic activities (where these do not clash), uses pathogenicity (as in *Erwinia*) to a small extent, and antigenic relationships scarcely at all. Few will quarrel with the outline classification into families, but fewer in Great Britain will accept the further subdivision into genera and species. In spite of an increase in the number of genera, there are welcome signs of retraction; *Eberthella, Proactinomyces* and *Staphylococcus* have disappeared, and *Klebsiella* has probably appeared for the last time.

By its title "Bergey's Manual" sets itself an impossible task : to construct, from data at present available, a key by which any bacterium can be identified. If we admit that, though perfection cannot be aimed at, such a key is desirable, there are two approaches to the problem : to limit the scheme to well-characterized species, using only proved criteria in the construction of the key ; or, the other choice, to include as many species as possible at the expense of having to use less stable criteria for species differentiation. In the "Manual" most writers adopt the second course ; notable exceptions are the sections on *Bacillus* and *Mycobacterium*, the authors of which have shown a welcome ability to cast historic but ill-defined species into oblivion, or to show their true status as synonyms.

If all sections resembled Nathan R. Smith's treatment of the genus *Bacillus*, with descriptions based on studies by modern methods of authentic cultures, there would have been no need to repeat vague details of ill-defined species, many of which are no longer available for study. It may not be ethically correct, but it would be a sound practical move to abolish priority and afford recognition only to species the types of which are preserved in dried or other permanent form, the naming and placing of such species being supported by adequate descriptions of the organisms and comparative studies with related species and genera. The editors of the "Manual" have made a move in this direction ; many species recognized in earlier editions and now mainly of historic interest are listed in appendixes.

Much effort would have been saved—and a better book produced—if writers of the different sections had recorded only species with which they were familiar from their own bench work.

S. T. Cowan

Electrolytic Polishing and Bright Plating of Metals

By Dr. S. Wernick. Pp. xv+243. (London: Alvin Redman, Ltd., 1948.) 30*s.* net.

IN the author's preface and in the foreword by Dr. U. R. Evans, great stress is laid on the commercial value of a brightly finished metal article, be it a piece of a machine or merely a luxury knick-knack. In the foreword it is further pointed out that there is a great practical utility in smoothness, and the examples of reflectors and bearings are quoted; but it is surprising that he does not mention the fact that electrolytic polishing seems to secure a measure of greater resistance to the normal tarnishing of metal surfaces. Except for a fairly full account of the anodic oxidation of aluminium, which is a rather exceptional case, the author's mention of corrosion is more or less limited to a couple of pages (146 and 147) in the chapter on carbon steel. Thus, when one considers the enormous sums of money that are annually expended in combating corrosion, it is surprising that (according to the author) for most metals the extent of the increased protection afforded by electrolytic polishing is rather uncertain.

It seems that to obtain a bright surface there are two rival processes, electrolytic polishing and the deposition of an inherently bright plate; and Dr. Wernick has written a very detailed account of the two techniques even to the extent of suggesting how the former may be used to reinforce the latter. The special attention devoted to nickel surfaces and the appendix on its bright plating are particularly interesting. Little or no theory is presented, as the exact mechanism of these processes does not appear to be understood; but this book is a wealth of empirical information. As such it will be of great value to the qualified chemical engineer and, being written simply and in a straightforward style, it can be recommended to manufacturers, works managers, etc., who may not have had any formal chemical training.

Dimple-Based Pottery from Central Kavirondo, Kenya Colony

By M. D. Leakey, the late W. E. Owen and L. S. B. Leakey. (Coryndon Memorial Museum Occasional Papers, No. 2.) Pp. 43. (Cambridge: Deighton, Bell and Co., 1948.) 5*s.* net.

STUDENTS of the later stages of African prehistory will welcome the publication of the detailed analytical study by Mrs. Mary Leakey of the iron-age pottery industry discovered by Archdeacon W. E. Owen in the Central Kavirondo of north-western Kenya. Isolated discoveries of pottery with little, if any, apparent affinity to known cultural groups are too frequently merely stored and their publication held over for further evidence. Since modern and recent domestic pottery in tropical Africa often appears to differ so slightly in the details of shape, ingredients and decoration, it is precisely the exceptional elements, like the occurrence of the impressed dimple in this Kavirondo material and its unusual decorative motifs, that are likely to be of significance to workers in other parts of Africa. The excellent drawings by Mrs. Leakey, supported by eight pages of photographs, and the descriptive analysis will give the reader a very accurate idea of the quality of this important pottery assemblage.

No definite age can be postulated for the dimple-based pottery until the geological significance of Owen's "Bed 5" horizon has been determined. The long-range correlation throughout the equatorial be of the pluvial phenomena deposited during the la important climatic phase (the Nakuran wet phase East Africa) presents difficult problems which ma well eventually be solved by the type of evidenc described in this paper. Recent discoveries in norther Nigeria of a pottery culture, associated with la neolithic and early iron-age material, in seale deposits of a widespread and persistent type invi a very tentative equation with similar deposi (Nakuran) in East Africa, and emphasize the impor ance of the early publication of *in situ* cultur material throughout the continent.

BERNARD FAGG

Gall Midges of Economic Importance

By Dr. H. F. Barnes. Vol. 3: Gall Midges of Frui (Agricultural and Horticultural Series.) Pp. 184 9 plates. (London: Crosby Lockwood and So Ltd., 1948.) 15*s.* net.

DR. BARNES is a tireless investigator with extensive output of original papers to h credit. He is, furthermore, a world authority on t Cecidomyidæ or gall midges and, therefore, the prop person to write a book of this kind. It forms t third of a projected series of volumes which he is write on gall midges of economic importance. planned, the series will run into eight volumes; t last volume is also to contain a general index to t whole series.

The present volume, like its two predecesso provides entomologists with well-documented a counts of all that is known about certain kinds gall midges—in this case those affecting fruit. Mu of Dr. Barnes' own work is incorporated in its page and he surveys the subject in a thoroughly compr hensive manner, since all known gall midges affecti fruit in different parts of the world are included. book of this kind, written in a terse but clear sty is invaluable to the horticulturist, the adviso officer and, in fact, to entomologists of all persuasio whether economic, biological or taxonomic in ou look. The long and complete literature list at t end of the book adds greatly to its value as authoritative work and will mark it out as a standa source for future reference. The author is to congratulated on his effort, and we wish him eve success in completing the task before him.

A. D. I.

Practical Zoological Illustrations

Invertebrates. By W. S. Bullough. 32 cards, 14½ × 9¾ in. (London: Macmillan and Co., Ltd., 194 15*s.* net.

THESE cards, illustrating the structure of vertebrates, are on the same lines as the vertebra series by Lockyer and Crofts. Selected types fr the protozoa, cœlenterates, flatworms, roundwor annelids, crustacea, insects and molluscs have be chosen, and a few figures of *Amphioxus* append The drawings are clear and bold, the directio concise, and the notes on the culture of some of t organisms should prove useful. But the set is m suited to the school than to the university, bei neither accurate enough nor full enough for first-y university students, who would discover errors many of the figures, for example, in the leg of t cockroach, the head of *Nereis* and the gills *Amphioxus*, and who would need sections as well dissections of their types.

The printing and production are excellent.

BLOOD CAPILLARY CIRCULATION UNDER NORMAL CONDITIONS AND IN TRAUMATIC SHOCK

By Prof. ROBERT CHAMBERS
Department of Biology, New York University, New York

AN important feature of the peripheral circulation is the close correspondence between the local needs of a given tissue and the amount of blood supplying it. Controlling mechanisms, to accomplish this, must involve more than the vasoconstrictor and dilator reactions of the terminal arterioles. Krogh attempted to ascribe the relative autonomy of the capillary circulation to the widespread occurrence of contractile, pericapillary elements, the Rouget cells. This has been considerably debated, and has never been adequately demonstrated. Moreover, there is till the question concerning the manner in which an adequate venous return can be maintained in spite of the supposed interposition, between arterioles and venules, of a network of extremely pervious capillaries[1]. The techniques hitherto used for observing he capillary vessels have been either too fragmentary or have lacked the required delicacy of experimental approach for ascertaining their highly reactive and inely balanced behaviour.

An adequate survey of the capillary bed for a study of variations in its functional activity requires a tissue in which the vessels can be traced from the arteriolar to their venular ends and, at the same time, can be exposed for observation with a minimum of trauma as not to upset the normal reactivity of the functioning components of the bed.

Three important regions, in which physiological fluctuations in blood supply occur normally from time to time, are the skin, the skeletal muscles and the viscera. In the skin, the circulation is somewhat specialized because of its temperature-regulating mechanism, and is a fertile, though difficult, field for investigation. The skeletal muscular system offers good possibilities. Unfortunately, in mammals it has the disadvantage that the trauma required for exposing it for microscopic study is excessive. Thus far, the most satisfactory has been the visceral region, particularly the mesoappendix of the rat and the omentum of the dog. The incision in the body-wall to expose these tissues is sufficiently far removed to obviate any direct effect of the trauma involved. Through the development of a technique for maintaining appropriate temperature, colloidal and moisture conditions, it has been possible to make prolonged microscopic observations over extended areas of the capillary bed of these visceral structures and to observe the effect of varied experimental procedures[2]. The studies have revealed that the capillary bed is composed of specialized vessels grouped into a series functional units. The integrated reactions of these units present a picture of the capillary bed as a differentiated organ possessing a highly specific function of controlling locally the supply of blood and the drainage of the tissue. This is accomplished by the peculiar structure and arrangement of the vascular components of the bed and by the highly sensitive reactivity of certain of the components to varying local conditions[3].

The concept developed concerning the visceral capillary circulation may be illustrated by analogy with the irrigation of a field under cultivation. Water is brought into the field by means of one or more main conduits carrying a continuous stream from one end of the field to the other. From these conduits the flow of the water can be regulated, by valves or sluice-gates, into side-canals which lead to all parts of the field. The return of the water is through other side-canals which empty into the lower ends of the main conduits and then to the outlet.

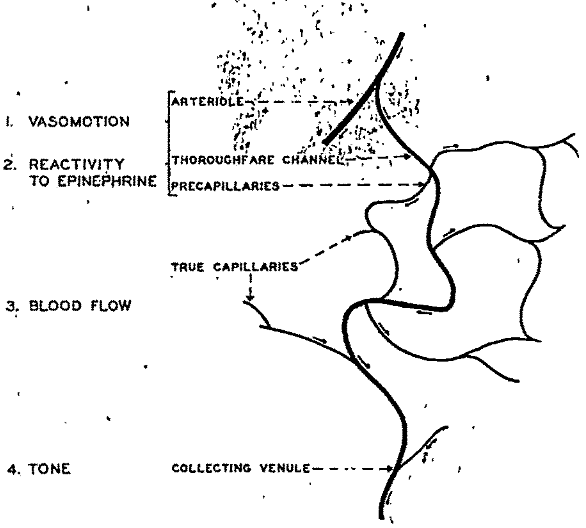

Diagram of a functional unit of a capillary bed

This simile, converted into terms of the capillary bed, is as follows. Well-differentiated, thoroughfare channels as conduits pass from the arterioles to their corresponding venules (see diagram). These channels possess outflowing branches along their proximal portions and inflowing branches along their distal portions. The branches connect with the network of capillaries lying on either side of the channels. The sluices of the capillary irrigation system are the intermittently functioning precapillary sphincters, located where the outflowing side-branches lead off from the upper or arterial segments of the thoroughfare channels. The alternating periods of closing and opening of the sphincters vary from about 20 sec. to 3 min. When the sphincters are relaxed, the precapillaries open up and permit the blood to flow from the channels into the network of the capillaries. When the sphincters are closed, the blood becomes restricted to the thoroughfare channels, which normally are always open and serve to transmit the blood pressure from the terminal arterioles to the collecting venules. Moreover, the continuous flow in the thoroughfare channels aids drainage from the capillary network through the inflowing branches which lead into the lower or venous segments of the channels.

The intermittent closing of the precapillary sphincters does not *per se* normally cause the capillaries of the network to collapse. Drainage, at the venous end, still continues, and, during this period, the capillaries, after being emptied of the corpuscular blood in them, exhibit a flow of a clear fluid which is filtering into them from the surrounding tissue spaces.

In summary, the capillary bed possesses three notable features: (1) a system of continuously flowing thoroughfare channels from arteriole to venule ; (2) intermittently closing sphincteric precapillaries, as abrupt side-branches emerging from the upper reaches of the thoroughfare channels and supplying the network of true capillaries with blood ; (3) relatively large postcapillaries entering at acute angles into the lower reaches of the thoroughfare channels. In accordance with the intermittent opening and closing of the precapillaries, the postcapillaries receive at one time blood and, at another, fluid filtering into the true capillaries from the tissue.

In resting ischæmic tissues, the closed periods of the precapillary sphincters are prolonged, during which time the blood courses only through the thoroughfare channels. The capillaries being devoid of blood, the intracapillary pressure falls and fluid filters into them from the surrounding tissue. Thereupon, the postcapillaries, which, similar to the true capillaries, are always open, now transmit a continuous flow of clear fluid into the venous end of the channel, and the tissue tends to be dehydrated.

On the other hand, when the tissue is activated, as in the case of muscle undergoing contraction, the open periods of the sphincters are prolonged. The result of this is a flooding with blood of all the true capillaries and an increase in intracapillary pressure with outward filtration which is accompanied by increased hydration of the tissue[4].

The sphincters are composed of smooth muscle cells, innervated by vasoconstrictor nerves. There is no good evidence for vasodilator innervation, but we do know that many tissue extracts and metabolites cause vasodilatation. On the basis of this we may draw the following conclusion. In resting tissue the metabolites are scanty and are not sufficiently concentrated to prevent the sphincters from responding to vasoconstrictor nerve impulses. Conversely, in activated tissue, the accumulated metabolites cause the sphincters to become refractory to nerve stimulation ; whereupon they relax and let blood through. These intermittent, constrictor and dilator phases of the sphincters and of the proximal muscular portion of the thoroughfare channel (metarteriole) constitute a precise mechanism delicately adjusted to the circulatory requirements of the tissues[5].

Having described the capillary circulation under normal conditions, let us consider the effects of acute hæmorrhage and of hæmorrhagic shock. In both, there is loss of fluid, for which the system tends to compensate by a widespread constriction of the larger blood vessels. What happens in the capillary bed ? Initially, the reaction is also compensatory. The sphincters contract, preventing egress of blood into the capillary network and restricting the blood to the thoroughfare channels. Meanwhile, the capillary network still continues to drain into the lower reaches of the channels. This serves as an additional compensatory reaction of drawing on the tissue fluid, thus increasing the volume of the circulating blood and causing hæmodilution.

In acute hæmorrhage[6], the compensatory reactions continue until the loss of blood reaches excessive proportions. There is then neither sufficient pressure nor volume of blood to supply the capillaries. The resulting collapse is mechanical in nature and usually not of sufficient duration to affect the vasoconstrictor reactions. There actually occurs an increase in the reactivity of the muscular vessels of the capillary bed which persists almost to the death of the animal. Adequate blood replacement is sufficient to bring about complete recovery.

In hæmorrhagic shock[7], the loss of blood extends over a much longer time. Throughout the somatic structures, in particular, the cutaneous and muscular regions of the body, there is a widespread and pronounced constriction of the blood vessels which continues during the entire shock syndrome.

In the visceral tissues there are initially the compensatory reactions characteristic of acute hæmorrhage. During the early period of the loss of blood, these reactions succeed temporarily in maintaining a good capillary flow. However, the flow gradually deteriorates. Proof has been presented of the existence of a vaso-excitor substance in the blood during the compensatory phase of the shock syndrome, and the predominating presence of a vaso-depressor substance during the later decompensatory phase[8]. This renders the precapillary sphincters refractory to constrictor impulses, whereupon they relax, a condition under normal conditions intended to spread the flow and carry away the accumulating metabolites. However, in traumatic[9] or hæmorrhagic shock the situation is vitiated by the inadequate propelling force and the poor inflow from the greatly constricted arteries. The little blood which now arrives slowly spreads throughout the bed and remains there, aggravating the general oligæmia and intensifying the deleterious effects of the accumulated metabolites.

When this state is reached, the reactivity of the muscular components of the capillary bed becomes depressed to such a degree that it cannot be recovered by the infusion of blood plasma. The impairment o the reactivity upsets the physiological integrity o the capillary circulation. Blood replacement at thi stage is not only ineffective but is actually harmful The infusion now merely dilates the minute vessel which no longer spontaneously possess the power o regaining their contractility. The infused blood then becomes pooled in the peripheral vascular system and the blood pressure which rose during the infusion falls again as soon as the infusion is stopped. Thi is the crucial phase in traumatic shock during which a more positive therapy than fluid infusion is required Preliminary experiments indicate that certain vaso tonic agents, which will not intensify the already constricted state of the larger vessels, are effective in extending the recoverability of dogs beyond the state in which the dogs are irreversible to bloo infusion[10].

In traumatic shock, involving fluid-loss, Nature' first provision is to drive blood away from the somato-muscular system so that the reduced circulating blood volume may effectively circulate where the blood flow is most needed, namely, the viscera organs. Hence the danger of bringing blood to the skin by warming the patient. When the bleeding patient can be promptly reached, fluid replacemen therapy is usually adequate. For the later stages o shock, it is significant that the infusion of blood o of blood plasma has been the preferred treatment.

The study of the capillary circulation in shock has emphasized the need of restoring the reactivity of it muscular components. It has also emphasized th need of a more thorough understanding of the peculia mechanism which enables the capillary bed t maintain a degree of autonomy from the rest of th blood circulation.

The account presented here is a brief summary o results obtained in association chiefly with D Benjamin W. Zweifach, now of Cornell Universit Medical College, under grants of the Committee o

Medical Research, Lilly Research Laboratories and the Josiah Macy, Jr., Foundation.

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SCIENTIFIC INSTRUMENTS AT THE COPENHAGEN EXHIBITION

IT was appropriate that the conclusion of an Anglo-Danish trade agreement should have been followed by the exhibition of the products of British industry, which took place in Copenhagen during September 18–October 2. The Danes were thus able to assess for themselves the variety and quality of the manufactures which would be entering their country, in accordance with the terms of the trade agreement, while British exhibitors and visitors were enabled to sample far more freely than has been possible in Great Britain during recent years the Danish produce which was the subject of the converse part of the agreement. One abiding impression of the exhibition is the happy and almost festive atmosphere in which t was staged. Welcome was in the air at Copenhagen —being British was a passport to goodwill. We, on our side, contributed an exhibition of the products of our industry and added for good measure a visit by a contingent of our naval forces, the picturesqueness of the Gordon Highlanders, the spectacle of jet-planes in full flight, and the two-decked utility of British buses. The Danes responded with unlimited enthusiasm, courtesy and hospitality.

The exhibition was spread over a number of buildings in the city, and in one of them, the Gutenberghus, two floors were occupied by a display of cientific instruments. This exhibit took place under he ægis of the Scientific Instrument Manufacturers' Association of Great Britain and included the products of forty British scientific instrument firms. The first comment on this exhibit must not be in respect of the instruments themselves but of the unique and most attractive catalogue-brochure which was produced for the occasion. This brochure took the form f a series of biographies of the exhibiting firms, the ypes of instruments being produced by any one firm being indicated in the margin, and the illustraions covered one outstanding product of each firm. One gathers from reading this brochure that any British scientific instrument firm celebrating its jubilee is in the 'young person' class of the industry; firm which can point to a century of activity may lay claim to some measure of maturity. The really firmly established have their origins in the eighteenth r even the seventeenth centuries! The remarkable contribution to the advancement of knowledge made by men of science in Great Britain during the era of modern science has created a continuous demand for the manufacture of scientific instruments as aids to experimentation, and the fulfilment of this demand has meant that scientific instrument manufacture has been a lively activity in Great Britain certainly for three centuries. This fact is worth mentioning for two reasons. On one hand, it has been suggested, and in fact in some quarters assumed, that the traditional home of scientific instrument-making was elsewhere than in Britain. On the other hand, somewhat illogically, instrument manufacture in Great Britain has been criticized on the grounds that it is saturated with tradition and that it has been slow in keeping abreast of modern requirements. The evidence contained in the brochure refutes the one suggestion, and the actual exhibition of instruments at Copenhagen provided a visual demonstration that, whatever truth there may have been at one time in the criticisms of the design and utility of British scientific instruments, such criticisms are no longer valid.

Conversations with those responsible for science and technology in Denmark made it abundantly clear that in the past the term 'scientific instrument' has been synonymous, so far as they were concerned, with 'German scientific instrument'. Very justly they held German scientific instruments in the highest regard, and both their interest in and knowledge of instruments emanating from other countries were practically negligible. It was, therefore, most heartening to hear these same people express considerable astonishment at the range of British instruments exhibited at Copenhagen and to receive their unqualified admiration of the design and quality of the instruments. It would be foolish to decry the excellence of instruments made elsewhere than in Britain. An exhibition such as that held in Copenhagen does, however, make it evident that we shall be carrying our national diffidence of self-advertisement too far if we do not pay tribute to the equal excellence of our own.

The first impression gained by a general survey of the instruments which were shown was that we have travelled a long way since the scientific instrument was, in the main, a tool of the scientific laboratory. One of the exhibits which excited very great interest was a radar equipment, by means of which a display was presented on a cathode-ray tube of the contours —church spires, main streets, harbour installations —of the city of Copenhagen. The home of such an instrument is the bridge of a ship, and the conditions under which it would be of most use are the very antithesis of those to be found in a laboratory. The main use of many of the instruments of greatest precision is in the street or the open country on one hand, or as an attachment to a machine tool on the other. This ubiquity of use, while in no way diminishing the importance of the achievement of the highest accuracy of measurement, has required that the modern scientific instrument shall be characterized by simplicity of operation and robustness in use. A comparison of the instruments shown at an exhibition twenty-five years ago and those recently displayed at Copenhagen would clearly indicate both the revolution and design which has been necessitated by the large extension of the use of instruments, and the remarkable evolution of entirely new types of instruments which has occurred during the last generation. The new principle incorporated in phase-contrast microscopy makes possible the observation of a wealth of detail within the confines of what were formerly merely nebulous outlines. Incidentally, it has set the microscopist a pretty problem in interpretation. Electronic timing devices have made the pendulum appear a slow and cumbrous thing. The modern spectrograph, a most important industrial tool, has the lines of a gun turret rather than of a delicate scientific instrument. Any exhibition of modern scientific instruments provides both a survey of the growth of scientific knowledge and an indication of the extent to which science has intruded into every sphere of human activity.

The final word on the exhibition of scientific instruments at Copenhagen should be one of congratulation to British scientific instrument manufacturers, who in the short period of three years, after a long period of complete preoccupation with the production of instruments for military purposes, have most successfully reverted to their normal and natural activities. They have done this so completely, and in spite of the abnormal difficulties of the post-war years, that they are now able to meet the scientific, civil and industrial demands for instruments more abundantly than ever before in their history.

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

THE first meeting of the International Union of Crystallography, which was held at Harvard University during July 28–August 3, provided an opportunity for the presentation of papers on many research projects that are being carried out in different parts of the world. More than seventy such papers were read, and there were many detailed discussions.

Some of the sessions—for example, those on "Alloy Phase Structures" and "Proteins and Related Structures"—were held at the same time, and it was therefore not possible for a single observer to attend all of them and so to present an account of the whole conference. Since, in addition, the collection of abstracts alone would occupy more space than could be allowed for this article, it has been decided to describe the work relating to a few topics only. This, unfortunately, means that many papers will not be mentioned at all; but it should be understood that the papers chosen for mention are not necessarily the most important, but are those that the present writer feels competent to knit into a coherent scheme.

It is inevitable that comparison should be made between the states of progress in the various countries represented at the Congress. In the thirty-six years since X-ray diffraction was discovered, many subdivisions of the subject have arisen, and it is interesting to see how these have differently attracted different nationalities. It is, of course, undesirable that some branches of the subject should be ignored in any one country, and, by and large, this has not happened in the countries of major scientific importance; only at such international conferences does any unevenness become apparent. Conversely, contacts made at these conferences should encourage people, perhaps subconsciously, to fill up any gaps that may exist.

These observations were well illustrated by the papers presented at the conference; but unfortunately the comparison can be made only between the United States and Great Britain; the latter had by far the largest foreign delegation and provided about one third of the papers read at the conference, while other countries—India, Canada, Sweden, Holland and Germany—provided only one tenth between them.

Instruments and Instrumentation

The session on instruments was almost entirely American, and this preponderance was evident also in the apparatus that was exhibited. It may be argued that this was naturally so since the conference was held in the United States, but to the writer it did not seem that American superiority was too strongly emphasized; there was some British apparatus on view, and the only important omission was that of demountable X-ray tubes—otherwise all the recent developments were American.

For example, probably the most important recent advance in X-ray analysis is the introduction of Geiger counters for measuring intensities; this may ultimately release X-ray workers from the tyranny of the photographic film. Geiger-counter spectrometers are being made both by Philips Laboratories and the General Electric X-ray Corporation in America, whereas in Great Britain the author is aware of their existence only in more primitive forms in certain laboratories. On the other hand, the American apparatus is directed toward the measurement of powder patterns, and, important as this measurement may be for industrial use, it has less theoretical importance than the study of single crystals. It is probable that this latter aspect is as far advanced in Great Britain as in America, but, in general, Geiger-counter apparatus is far more widely used in the United States.

As another example, Great Britain has produced nothing to compare with Buerger's precession goniometer. This instrument gives an undistorted reproduction of a section of the reciprocal lattice and is proving invaluable in the study of crystals with large unit cells. It is true that the indexing of photographs is not a limiting factor in the determination of crystal structures, but any aid to the shortening of this rather laborious operation must be welcomed and may even make practicable certain researches that are at present just outside the bound of possibility.

In methods of Fourier synthesis, practice in the two countries is at present more or less the same punched-card machines are greatly used by laboratories that have access to them, and printed strips with calculating machines, are used by the less fortunate. But this balance is likely to be altered when the electronic machine at the Alabama Polytechnic Institute is completed; this machine should enable a complete two-dimensional Fourier synthesis to be presented instantaneously as an image on fluorescent screen. With this instrument the major part of the operation will be the setting up of the coefficients; but, once these are set, changes in sig of certain coefficients can easily be introduced. It is possible that this instrument will make practicable the trial-and-error Fourier methods that have so often been suggested but never used.

Two other lines of progress must also be mentioned although they are not concerned with X-rays namely, electron microscopy and neutron diffraction. Dr. R. W. G. Wyckoff showed electron micrographs of crystals in which individual molecules appeared stacked together in orderly array. No intra-molecular detail appeared, of course, and it is likely that even the general appearance of the molecule is deceptive; but the fact that single molecules can now be observed is a striking testimony to recent progress with the instrument.

Dr. C. G. Shull gave an account of work on neutron diffraction. In this subject we pass from the orderly world of X-ray diffraction, where the intensity of scattering by an atom depends upon its atomic number, to one in which the intensity of scattering seems to be purely accidental; scattering factors have to be found by experiment and, as an extra complication, certain atoms scatter 180° out of phase with the others. Hydrogen is by far the best scatterer of neutrons, and thus neutron diffraction may settle certain arguments about the positions of hydrogen atoms in some organic crystals.

Crystal Structure Determination

As a contrast to American preponderance in the session on instrumentation, the session on crystal structure determination was largely British; W. L. Bragg and his Manchester school seem to have set a fashion that still persists. This fashion is to treat the problem as a puzzle in which the clues have to be searched for before the analysis can begin. Clues can be of quite different types, but ultimately the evidence they provide must all fit together to give the final answer—the crystal structure.

The work of Mrs. D. Hodgkin and C. W. Bunn on penicillin provides the best example so far of the co-ordination of a number of separate methods. At the conference Mrs. Hodgkin described similar work by J. D. Dunitz on the structure of calciferol (see also *Nature*, Oct. 16, p. 608). The compound used was $C_{35}H_{46}O_4NI$, and 123 parameters were involved. Since the general form of the molecule was known, the problem was not so difficult as the penicillin one, despite the larger number of parameters; nevertheless, the work must be regarded as an outstanding example of the use of heavy atoms in crystal structure determination.

This 'sporting' approach may be contrasted with the more severely logical American approach, which manifests itself in several different ways. For example, there is Buerger's systematization of the methods of interpretation of Patterson sections—the so-called 'implication' method; most workers in Great Britain have been content to derive the information in a rather casual way, which is adequate for simpler structures but may not give all the information that is contained in the sections.

A completely new approach to the general problem has recently been suggested in the form of the 'Harker–Kasper inequalities'. To most people in Britain the method seemed to be of limited utility, but it has been completely justified by its use in the determination of the structure of $B_{10}H_{14}$. Since the method is of greatest use for compounds in which all the atoms are approximately the same weight, it appears to fill a gap left by the development of the 'heavy-atom' methods.

The main recent British contribution to the 'logical' approach is A. D. Booth's use of 'steepest descents', which gives the variation in parameters necessary to improve the agreement between calculated and observed intensities. The method promises to be very useful for refining parameters in known structures, but it has yet to prove its worth in determining an unknown structure.

The 'fly's eye', described by de Vos, Clews and Cochran, provides a more typical example of the British approach. No new principle is involved—merely an appreciation of the relationship between the scattering of light and X-rays—but the apparatus enables the tedious process of calculating structure factors to be eliminated and so enables more structures to be tested than if the calculations had to be done separately for each.

To summarize, it will be seen that rapid progress is still being made in the field of crystal structure determination; still more complicated structures are being brought within the scope of existing methods, and completely new methods are being discovered and brought into use. Structures are being solved that would have been considered quite impossible of solution ten years ago.

Imperfect Structures

Important as the structures of perfect crystals may be, it must be realized that the most important materials, such as biological tissue, are highly imperfect and so their structures do not yield to standard methods of analysis. To these problems there are two methods of approach—the direct, typified by the Astbury school at Leeds, and the indirect, consisting of the study of slight imperfections first, and building on this foundation until the diffraction effects of the more complicated imperfections can be understood. Since the metals provide the simplest structures, it may ultimately appear that the biological problems are settled from an original study of metallic structures.

In this field progress seems to be about the same in both Great Britain and America. Dr. A. J. C. Wilson outlined the theory of diffraction by a one-dimensional imperfection, that for which the layers are perfect but are incorrectly stacked on each other. Examples of such imperfections were cited by Prof. W. Zachariasen, who dealt with the structure of uranyl fluoride, and by Dr. W. F. Bradley, who dealt with clays consisting of two different species of minerals. Imperfections in metals were dealt with by Dr. H. Lipson, who outlined some recent work on single crystals of $AuCu_3$; this crystal gives sharp main reflexions and diffuse superlattice reflexions. In addition, Dr. J. W. Fitzwilliam dealt with the effects of local order in some binary alloys such as $AuCu_3$, AuCu and AgAu.

As a contrast to these investigations, which are capable of theoretical treatment, Dr. H. M. Powell showed a remarkable set of Weissenberg photographs of the various layer lines from an organic crystal; the even layer lines showed sharp spots; but the odd layer lines showed continuous streaks along reciprocal-lattice lines. These effects can be accounted for qualitatively, but quantitatively their treatment is complicated by the complexity of the molecular structure; such photographs provide a striking challenge to the theoretician, and a complete solution of the problem should point the way to treatment of still more complicated imperfections.

The author would like to put on record his thanks to the Council of the Royal Society for enabling him to attend the conference, and to the organisers of the conference for enabling him to extend his stay in order to visit a number of laboratories where the work described in this article is being carried on.

H. LIPSON

OBITUARIES

Dr. C. M. Wenyon, F.R.S.

By the death of Dr. C. M. Wenyon, in London on October 24, at the age of seventy, the scientific world in general and tropical medicine in particular lost one of the foremost exponents of medical protozoology.

Charles Morley Wenyon, son of Dr. Chas. Wenyon, was born at Liverpool on March 24, 1878. He passed his childhood in China, where his father was a pioneer medical missionary, but returned to England for his education. He studied science at University College and medicine at Guy's Hospital, London, graduating B.Sc. (1901) and M.B., B.S. (1904). The dual training in zoology and medicine provided the right background to Wenyon's subsequent activities, and is a clue to the quality of his contributions to medical protozoology, a subject to which he devoted himself from the very beginning of his scientific career. During the first ten years (1904–14), he held with distinction the post of lecturer in protozoology at the London School of Tropical Medicine, where he worked under Patrick Manson. During this period he also continued his studies in Paris, under F. Mesnil, and in Munich, under Richard Hertwig (1906–7), and undertook an expedition for the study of protozoal diseases in the Sudan, where he spent a year (1907–8) working in a floating laboratory on the Nile. He was later (1910–13) sent by the School on missions to Mesopotamia, Syria and Malta, returning with abundant material which formed the subject-matter of important publications on oriental sore and kala-azar in these regions.

In 1914 Wenyon joined the staff of the Wellcome Bureau of Scientific Research as director of research in the tropics. Shortly after the outbreak of the First World War he was seconded—with the rank of lieutenant-colonel, R.A.M.C.—for work under the War Office and proceeded abroad. He carried out important researches on the intestinal protozoal infections, published in Wenyon and O'Connor's "Human Intestinal Protozoa in the Near East" (1917), and on malaria in Greece, the results of which appeared in a series of papers (*J. R.A.M.C.*, 1921–22). In 1924 Wenyon succeeded Sir Andrew Balfour as director-in-chief of the Wellcome Bureau of Scientific Research (now Wellcome Laboratories of Tropical Medicine) and director of research to the Wellcome Foundation, retiring in 1944, but continuing to act in a consulting capacity. Under Wenyon's direction the Bureau developed into a first-class scientific institute enjoying an international reputation among workers in tropical medicine and parasitology.

The variety and volume of Wenyon's contributions to protozoology render their assessment a difficult task. Though by no means restricted to purely medical questions, his work was chiefly concerned with protozoological problems having a direct bearing on tropical diseases. Much of our knowledge regarding the relative medical importance of the intestinal Protozoa and of the epidemiology of amœbiasis is due to Wenyon's pioneer work. He was particularly interested in the transmission of the leishmaniases. Though the credit of solving this problem belongs to others, his own researches and critical reviews of the existing data did much to clear the path for his successors in this field. The most outstanding work published by Wenyon, his *magnum opus*, is the well-known "Protozoology" (1926). This treatise, now generally recognized as a classic, gave a synthesis of our knowledge of the parasitic Protozoa and, though now in place out of date, it remains an indispensable referenc book for all serious students of protozoology.

Apart from research work, for many years Wenyo contributed authoritative reviews of the world literature on protozoal diseases to the *Tropical Disease Bulletin*. The present position of the Royal Society of Tropical Medicine and Hygiene in the medica world and the high quality of its *Transactions* ar due largely to Wenyon's untiring efforts during quarter of a century, first as its honorary secretar and ultimately as its president.

In 1927 Wenyon was elected a fellow of the Roya Society; he received many other honours and award both at home and abroad.

As a man, Wenyon was universally liked an respected for his friendliness and cheerful disposition His knowledge and experience were at everybody' disposal, and workers from all over the world, whe visiting London, never failed to call on him for advic and help. In his relations with immediate associate there prevailed a happy comradeship, in which 'C. M. W.' was *primus inter pares*. His colleagues wil remember with gratitude and affection his constan interest and encouragement in their work and welfare

C. A. Hoare

C. A. Hill

Charles Alexander Hill, founder of the Britis Drug Houses, Ltd., was born in London on Augus 18, 1874. He was educated at Winchester, King' College, London, and the Pharmaceutical Society' School of Pharmacy. His death occurred on Octobe 23.

C. A. Hill will be long remembered among men o science for the work he did in developing the manufacture of chemicals of high purity for use in researc and analysis which began in the 1914 crisis, when i became clear that Great Britain must no longe remain dependent upon importing supplies of thes chemicals from Germany or elsewhere.

Hill's natural abilities were well suited to this task he took a keen interest in science, passionatel insisted on accuracy in all matters, particularly i the written or spoken word, and was at all time disposed to devote meticulous attention to matte of detail.

Five years before the First World War broke ou the amalgamation of six companies concerned wit pharmaceutical manufacture had taken place unde Hill's leadership. Of the resultant company, th British Drug Houses, he had become chairman an managing director. At the outbreak of war, scientifi workers throughout Great Britain were made acutel conscious of their dependence upon imported laboratory chemicals, including organic chemicals for us in synthesis, and microscopical stains for use i bacteriology. This challenge made a profound appe to Hill and he applied his marked organising abilit to making good this defect. In the course of the ne ten years he achieved a great measure of success i so doing.

Important studies were made in determining t highest obtainable standards of purity for chemica in this category. New standards were in due cour formulated and submitted for acceptance to a independent committee set up for the purpose. Th analytical and research laboratories under h direction undertook much work in devising delica methods of analytical control; this led ultimately to numerous scientific publications by various members of his scientific staff.

It was a natural corollary to his achievement in setting up the manufacture of laboratory chemicals that Hill worked assiduously in the advocacy of the Safeguarding of Industries Bill, and later for having laboratory chemicals included in the list of goods scheduled under the Act.

Hill's family had long been connected with the Salters' Company; it was during his grandfather's mastership that the Salters' Company set an early example in founding research scholarships. Hill, who became master of the Salters' Company at an early age, was largely instrumental in the formation of the Salters' Institute of Industrial Chemistry, which has as one of its main objects the provision of funds for the training of men entering industrial chemistry.

Hill filled many public offices in connexion with pharmacy and pure and applied chemistry. His published addresses bear witness to his clear thinking and the high standards at which he always aimed. He became chairman of the Association of British Chemical Manufacturers and of the Wholesale Drug Trade Association, president of the British Pharmaceutical Conference, vice-president of the Institute of Chemistry and of the Society of Public Analysts.

The fine-chemical industry of Great Britain, which has undergone great growth during his life, has benefited by his notable contribution to its development.

FRANCIS H. CARR

We regret to announce the following deaths:

Dr. L. Doljanski, head of the Department of Experimental Pathology, The Hebrew University, Jerusalem, on April 13.

Mr. R. Murdin Drake, O.B.E., joint manager of the Association of British Chemical Manufacturers, on November 21, aged forty-five.

Sir John Fryer, K.B.E., F.R.S., secretary of the Agricultural Research Council, on November 22, aged sixty-two.

Mr. J. E. Kingsbury, a founder of Standard Telephones and Cables, Ltd., and an active member of the Society of Telegraph Engineers and later of the Institution of Electrical Engineers, on November 4, aged ninety-three.

NEWS and VIEWS

Nobel Prize for Physics:
Prof. P. M. S. Blackett, F.R.S.

THE Nobel Prize for Physics, for the year 1948, has been awarded to Prof. P. M. S. Blackett, of the University of Manchester. The most important of Blackett's contributions to experimental physics have been made with the Wilson expansion chamber. After the discovery of the artificial transmutation of some of the light elements by Rutherford in 1919, it became important to make a detailed study of individual disintegrations, and this could only be done with the Wilson chamber. In order to observe the transmutation of a nitrogen nucleus, it was necessary, however, to consider making many thousands of photographs. For this purpose, Blackett developed the automatic expansion chamber. The successful design and operation of this elaborate instrument, in which the many operations involved in taking a single photograpb were made mechanically, in an ordered sequence many times repeated, represented a technical achievement of the highest order. With this instrument, Blackett secured the classical photographs, now familiar to many generations of physics students, showing the disintegration of nitrogen by fast α-particles; and many other examples of nuclear processes.

The experience in design and operation gained with the automatic expansion chamber formed the basis for the next technical advance, the development of the counter-controlled Wilson chamber. If an ordinary chamber is expanded at random, the chance of observing the tracks of particles of the cosmic radiation is very small—in the case of apparatus of conventional design operated at sea-level. In collaboration with G. P. S. Occhialini, Blackett therefore arranged that the expansion should take place only when one or more particles had passed through the chamber. This was secured by a 'trigger' device which operated only if a particle passed through both of two Geiger counters, placed one above and one below the chamber. In this way the beautiful photographs of showers of positive and negative electrons—the 'soft' component of the cosmic rays—were obtained. The principle thus introduced, of combining the particular features of the Wilson chamber with those of the Geiger counter in a single apparatus, continues to be one of the most fruitful methods in the physics of the cosmic radiation. Blackett was also a pioneer in the development of apparatus for studying the deflexion of cosmic ray particles in Wilson chambers operated in strong magnetic fields—a method of great importance for the development of our knowledge of the momenta of cosmic ray particles. This present recognition of his distinctive and original contributions to physics will be welcomed everywhere.

Centenary of H. A. Rowland

NOVEMBER 27 marks the centenary of the birth of Henry Augustus Rowland, one of the most distinguished men of science that the United States has produced. Born at Honesdale, Pennsylvania, on November 27, 1848, Rowland was the son of a clergyman, and at the age of sixteen, after being allowed to abandon his classical studies, he devoted himself to science. He studied to be a civil engineer at the Rensselaer Polytechnic Institute at Troy and graduated in 1870. During the next few years he successively served as a railway engineer, taught in the Wooster College and lectured as assistant professor at the Rensselaer Institute. On April 3, 1876, he became the first professor of physics at the newly created Johns Hopkins University at Baltimore, having the previous year visited Europe and worked for a time under the great Helmholtz. Rowland retained the professorship until his death, adding lustre to the University by his own brilliant researches and by the band of devoted workers he gathered around him.

Rowland's greatest researches were those on the determination of the mechanical equivalent of heat, the determination of the ohm and the study of the solar spectrum. In 1882 he described to the Physical Society his celebrated diffraction grating which placed in the hands of the spectroscopist a new and powerful instrument of research—one which made it possible to photograph spectra directly without the use of prisms or lenses and with a greatly increased dispersion and resolving power. In 1888 he published a photographic map of the normal solar spectrum, in 1893 a table of standard wave-lengths, and in 1895–97 a table of solar wave-lengths. For his discoveries and investigations Rowland received the Rumford, the Draper and the Matteucci Medals and was honoured in many ways by societies and universities. Besides being a great investigator, he was a great teacher, kindling in his students an enthusiasm approaching his own. His work was always distinguished for refinement and accuracy; and withal he possessed the true scientific temperament. "For myself," he said once, "I value in a scientific mind most of all that love of truth, that care in its pursuit and that humility of mind which makes the possibility of error always present, more than any other quality. This is the mind which has built up modern science to its present perfection, which has laid one stone upon the other with such care that it to-day offers to the world the most complete monument of human reason." Rowland died at his house in Baltimore on April 16, 1901. His body was cremated and his ashes buried beneath his famous ruling engine. His library was in 1903 given by his widow to the Johns Hopkins University.

Mathematics at Ibadan

THE chair of mathematics at University College, Ibadan, Nigeria, has now been filled by the election of Dr. F. V. Atkinson. Educated at St. Paul's School and at the Queen's College, Oxford (of which he was an open scholar during 1934–37), Dr. Atkinson was later a Senior Demy of Magdalen. During the War he served with the Army in India, reaching the rank of major, and he returned to Oxford in 1946 as lecturer in mathematics at Christchurch. Dr. Atkinson's work has been chiefly concerned with the analytical theory of numbers, and the properties of the Riemann ζ-function.

Reading Institute of Education

AN Institute of Education has been established in Reading as the area training organisation for Berkshire, Buckinghamshire, Hampshire, Oxfordshire, West Sussex and Reading. The scheme for the Institute provides for a Board of Governors drawn in equal proportions from the local education authorities in the area and from the University of Reading. The Minister of Education has appointed Sir Frank Stenton, vice-chancellor of the University, as chairman. The principal objects of the Institute are to further the training of teachers and other persons intending to engage in educational work in the area; to foster close relations between the corporate members of the Institute (at present, the University of Reading, the county councils and county borough councils in the area and the training colleges in the area, namely, Culham, Bishop Otter, Easthampstead Park and Newlands Park); and to establish an educational centre for the promotion of the educational interests of students and teachers and other persons professionally concerned with or interested in education in the Institute area. The Institute will be established in or near Reading, and a search for suitable accommodation has already begun; ultimately it is hoped that the Institute will have a new building designed for the purpose. Mr. C. R. E. Gillett has been appointed director of the Institute.

Sources of Technical Assistance

A SURVEY of the technical assistance available for economic development in the United Nations and the Specialized Agencies has been prepared by the secretariat for the second session of the Sub-Commission on Economic Development of the Economic and Employment Commission (London: H.M. Stationery Office. United Nations, E/CN.1/Sub. 3/22. June 2, 1948). Its immediate purpose is to facilitate examination of provisions currently being made for such assistance to members of the United Nations in their programmes of economic development, and particularly to assist the Sub-Commission in considering measures for increasing the availability and effectiveness of such technical assistance. Its scope is limited to those activities, excluding the provision of funds and relief supplies, which are designed to assist economic development; provisions for technical assistance in the sphere of social welfare are not described in detail. The Survey gives a very clear but concise account of the types of assistance available, including that in the form of research and information, as well as international training, panels and conferences; and also of the sources of assistance. It then reviews in succession the various fields such as agriculture, forestry and forest products, fisheries, education and technical training, labour and employment, health, nutrition and safety, finance and currency, or statistics in which such assistance might be required. The Survey contains nothing that is new; but gives a convenient and impressive picture of the elaborate and interlocking organisation for world co-operation which has already been built up, and which could be used if the will to do so were genuine and widespread.

German Hydrographic Journal

REFERENCE was made in *Nature* of September 4, p. 364, to the first issue of the *Deutsche Hydrographische Zeitschrift*. The next two numbers have now appeared: Vol. 1, No. 2/3, June 1948; and Vol. 1, No. 4, August 1948. The former contains articles on problems of marine geology, coastal geodesy, terrestrial magnetism and oceanography, whereas No. 4 is completely devoted to oceanographical and tidal problems. An essay by O. Pratje on the bottom sediments of the southern and middle Baltic and their importance for the interpretation of fossil sediments is based on about a thousand bottom samples which had been collected in the years just before the War. It is accompanied by detailed charts and profiles. F. Rudolf Jung examines the limits of applicability of transit-bearing and of the trigonometrical determination of distances in the technique of marine surveying, and gives numerical and geographical aids for the practical work in question. F. Errulat deals with the mean intensity of great geomagnetic disturbances as dependent on geomagnetic latitude, and finds interesting relations with the results of J. Bartels. G. Neumann writes on resonance-oscillations of bights and on the mouth correction for seiches; his treatment of the Frische Haff agrees well with results which H. Lettau had derived from the registrations of tide gauges. F. Model discusses the thickness of the ice on the Alster in Hamburg towards the end of the severe winter of 1946–47. On the open basin a thickness of 51–56 cm. was found; below a rather broad and low bridge it fell to only 12 cm. G. Wust, studying once again the temperature-inversion in the deep waters of the South Atlantic, finds a remarkably close association between the inversion and the bottom relief, and points out that the depth of the inversion rises and sinks in accordance with the semi-diurnal tide. There are probably also seasonal and aperiodic pulsations. An important paper by W. Horn gives a concise and partly new representation of the tides as a function of time. G. Tomczak describes a wave gauge, an instrument for measuring short-period oscillations of pressure in the sea, and F. Nusser presents a notable report on ice-conditions on and off the German coasts during the severe winter of 1946–47.

Chemical Prevention of Potato Dry Rot Disease

As a result of research during the past five years, Bayer Products, Ltd., Crawley Research Station, Brighton Road, Crawley, Sussex, claim to have developed a highly efficient preparation for the prevention of dry rot of potato tubers caused by the fungus *Fusarium cœruleum*. This preparation, marketed under the trade name of 'Fusarex', is based on 2,3,5,6 tetrachlornitrobenzene, a chemical first described in 1868 by Jungfleish, who prepared it by treating tetrachlorbenzene with fuming nitric acid for some hours at near boiling point. 'Fusarex' is most effective for the control of dry rot when applied to the tubers immediately on lifting, followed by a period of four to six weeks storage in a clamp. It has been found in trials that the preparation does not need to cover each potato completely so long as an even distribution through the mass of tubers is obtained. Thus a simple manual application can be employed, involving no expense in labour or machinery, and no interference with the normal lifting operations. It has also been found that suitable 'Fusarex' treatment and storage conditions can delay the development of sprouts by the tubers. The treatment of main-crop varieties to prevent sprouting is now a practical proposition; but special techniques are still being worked out for early varieties. Intensive pharmacological tests have shown that tetrachlornitrobenzene is of such a low order of toxicity that it can be regarded as non-poisonous under the conditions of use suggested, and it is therefore safe to use on potatoes destined for human consumption and stock feeding.

Jewels for Instruments

A REVISED edition of "British Standard 904", first issued in 1940, has recently been published (British Standard 904 : 1948. Dimensions of Instrument Jewels. Pp. 12. (London : British Standards Institution, 1948.) 2*s*. net). The forms and dimensions of V-jewels, ring stones and end stones for instrument purposes, and compass jewels, are specified; and in an appendix the method and apparatus required for the inspection of jewels is described. The Standard does not relate to jewels for watches and clocks, for which a separate British Standard is being prepared, nor to cup jewels for integrating meters, the form of which is still the subject of research.

Sun-Bathing by Birds

RECENT communications to *British Birds* have directed attention to the widespread occurrence of the habit of sun-bathing among birds. The question has been raised "whether irradiation of the skin, with its consequent effect of vitamin D production, could take place through sun-bathing". Prof. W. C. Wynne-Edwards has stated that direct irradiation of the skin is usually impossible in both birds and mammals because of their thick coats. From observations lasting over sixteen years, however, Noble Rollin has collected photographs and information which lead him to the belief that irradiation of the skin takes place among jackdaws, chaffinches, blackbirds, hedge-sparrows and house-martins, although no evidence of sun-bathing has been observed among gulls and wading birds (*British Birds*, **41**, No. 10; October 1948).

Science Progress

AMONG the articles in the current issue of *Science Progress* (**36**, No. 144; October 1948) is one which has not only the appeal of a biography of a well-known man of science but also the charm of writing which reminds one of Maurois. This is "Augustin Fresnel: His Time, Life and Work, 1788–1827", by G. A. Boutry, director of the Laboratoire d'Essais, Paris. In the same volume Prof. H. P. Himsworth contributes a masterly survey of recent developments in the researches into liver disease, while E. E. Schneider's review of contemporary knowledge of the electronic structure of solids and H. H. Macey's consideration of the theoretical aspects of clay consolidation are supported by an article on the relationship between "Indeterminism and the Wish" by J. C. Gregory. The volume also contains the usual summary of recent advances in various aspects of science and a considerable number of reviews.

Proceedings of the Physical Society

IN order to accommodate the increased number of papers submitted for publication, the *Proceedings of the Physical Society* is to appear in two parts, *A* and *B*. *Proceedings A* will include a contents list of the corresponding *Proceedings B* and vice versa. Section *A* will include subjects such as quantum theory, statistical mechanics, nuclear physics and cosmic rays, atomic physics, molecules, spectra, theories of solids, liquids and gases, surface phenomena, growth and properties of crystals, crystal structure, luminescence, electrodynamics, heat and thermodynamics, standards. Section *B* will include subjects such as acoustics, including ultrasonics, optical design, electron optics, colour, elasticity and other mechanical properties of solids and liquids, crystal structure analysis, magnetic materials, refrigeration and liquefaction, electric discharges, radio, geophysics, including ionosphere, astrophysics, solar physics.

International Congress of Mathematicians

AN International Congress of Mathematicians will be held in Cambridge, Massachusetts, during August 30–September 6, 1950, under the auspices of the American Mathematical Society. It will be open to mathematicians of all national and geographical groups. Harvard University will be the principal host institution. A number of other institutions in Boston will join in the entertainment of Congress visitors. In recent years, mathematicians have been much impressed by the success of the conference method for presenting recent research in fields in which vigorous advances have just been made or are in progress. The 1950 Congress will include conferences in several fields. Following established custom, there will also be a number of invited addresses by outstanding mathematicians. In addition, sectional meetings for the presentation of contributed papers not included in conference programmes will be held in the following fields: I, Algebra and Theory of Numbers; II, Analysis; III, Geometry and Topology; IV, Probability and

Statistics, Actuarial Science, Economics; V, Mathematical Physics and Applied Mathematics; VI, Logic and Philosophy; VII, History and Education. The official languages of the Congress will be English, French, German, Italian and Russian. Harvard University has offered the use of its dormitories and dining-rooms for mathematicians and their guests for the period of the Congress, and the Organising Committee hopes that it will be possible to furnish board and room without charge to all mathematicians from outside the North American continent who are members of the Congress. Congress membership fees will be announced well in advance of the opening of the Congress. Every effort will be made to facilitate the travel at reasonable cost of foreign participants while in the United States. Communications about the Congress should be addressed to the American Mathematical Society, 531 West 116th Street, New York City 27, U.S.A.

Congress of Comparative Pathology

The International Congress of Comparative Pathology will hold its fifth meeting in Istanbul during May 17–20, 1949. The Congress covers all aspects of human, plant and veterinary pathology, and considerable latitude is permitted in the choice of subjects for discussion. The British National Committee (chairman, Prof. T. Dalling, Ministry of Agriculture) will be glad to receive, as soon as possible, the titles of communications which members in Great Britain, who hope to attend the Congress, wish to submit for transmission to the Secretaire Générale of the Permanent Committee. Further information can be obtained from Mr. R. E. Glover (honorary secretary, British National Committee), Royal Veterinary College, London, N.W.1, or from Pr. N. R. Belger, Taksim, Siraserviler 75/3, Istanbul.

Commonwealth Fund Fellowships

The Commonwealth Fund of New York is offering in 1949 a number of fellowships for British subjects to study in the United States for one year. Twenty such fellowships will be available to British subjects between twenty-three and thirty-five years of age, who are graduates of a university of the United Kingdom or who have studied in one, having previously graduated from a university of Australia, New Zealand or South Africa. In addition there are three fellowships for candidates holding permanent positions in the higher ranks of the Civil Service of Great Britain, and five more fellowships for those in Government service in the Commonwealth. The emolument consists of a total grant of approximately 950 dollars with an allowance of 200 dollars a month plus free travel to and from the United States. Applications must be submitted by February 1, 1949, and full details may be obtained from the Secretary of the Committee of Award, 35 Portman Square, London, W.1.

Royal Meteorological Society: Popular Lectures

The Royal Meteorological Society has arranged a series of monthly meetings, to be held at the Science Museum Lecture Theatre, Exhibition Road, South Kensington, and visitors will be welcome. The first meeting, on December 3 at 5.30 p.m., will consist of a film show, and thereafter popular lectures will be delivered at 6 p.m. by the following speakers on the dates shown: Sir George Simpson, January 12; Sir Nelson Johnson, February 10; Prof. Gordon Manley, March 3; Dr. G. M. B. Dobson, April 6; Mr. E. Gold, May 5.

University of London: Appointments

The following appointments in the University of London have been announced. Dr. Dennis Gabor has been appointed to the Mullard readership in electronics tenable at the Imperial College of Science and Technology, London, as from January 1, 1949. The title of reader in the University has been conferred on the following: Dr. Vera Fretter, lecturer in zoology at Birkbeck College; Dr. P. A. I. Gorer, of the Department of Experimental Pathology, Guy's Hospital Medical School; Dr. G. E. Newell, lecturer in zoology at Queen Mary College.

The degree of D.Sc. has been conferred on Mr. E. J. Popham, an external student.

The Night Sky in December

Full moon occurs on Dec. 16d. 09h. 11m. U.T., and new moon on Dec. 30d. 09h. 44m. The following conjunctions with the moon take place: Dec. 2d. 16h., Jupiter 4° N.; Dec. 2d. 17h., Mars 3° N.; Dec. 21d. 09h., Saturn 3° S.; Dec. 28d. 06h., Venus 4° N.; Dec. 31d. 19h., Mars 4° N. In addition to these conjunctions with the moon, Mars is in conjunction with Jupiter on Dec. 1d. 08h., Mars 1·1° S. Mercury rises at 7h. 15m. on Dec. 1, or nearly half an hour before sunrise, but is too close to the sun for observation, and is not favourably placed for observation during the month. Venus is a morning star, rising at 4h. 40m., 5h. 23m. and 6h. 09m. at the beginning, middle and end of the month, respectively. The magnitude of the planet is − 3·4 during December, and the visible portion of the illuminated disk varies from 0·84 to 0·90. Mars is still too close to the sun for favourable observation, setting less than an hour and a half after the sun throughout the month. Jupiter is also too close to the sun to be well observed, and is in conjunction with the sun on Jan. 1. Saturn, in the constellation of Leo, rises about 23h. on Dec. 1 and 21h. on Dec. 31; it is visible throughout the morning hours in the early part of the month and also during the later hours of the night in the last part of the month. The planet is stationary on Dec. 17. No occultations of stars brighter than magnitude 6 take place during December. Winter solstice occurs on Dec. 21d. 23h.

Announcements

Dr. W. Campbell Smith, keeper of the Department of Mineralogy in the British Museum (Natural History), has been appointed to the new post of deputy chief scientific officer in the Museum; he will retain his post in the Department of Mineralogy. Dr. Maurice Burton has been appointed a senior principal scientific officer (deputy keeper) in the Department of Zoology.

The following appointments have been made in the University of Leeds: Mr. W. J. Thomas, as lecturer in agricultural economics; Dr. A. D. Walsh, as lecturer in inorganic and physical chemistry.

The following have been appointed officers of the Society for Visiting Scientists, 5 Burlington Street, London, W.1: *President and Chairman*, Sir Harold Spencer Jones; *Secretary*, Prof. F. J. M. Stratton; *Treasurer*, Mr. H. R. Walters.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Œstrogens in Grass and their Possible Effects on Milk Secretion

STUDIES of variations in the composition of cows' milk[1,2] have revealed a progressive decline in the non-fatty solids content during the winter months, followed by a substantial and immediate rise when the cows are turned out to grass in the spring. Also it is widely recognized that on 'going out to grass' cows often show an increase in milk yield, greater than the amount ascribable to the extra nutrients ingested.

Attempts to simulate these (galactopoietic) effects of spring grass on milk yield and composition by liberal supplements of carbohydrate, protein or carotene to the ordinary winter rations of cows gave no response, though the characteristic effects were shown when these cows were later given access to spring pasture[2]. It therefore seems reasonable to conclude that these effects are due to the presence in young, rapidly growing grass of a galactopoietic factor such as a hormone or vitamin.

In speculating upon the nature of this postulated galactopoietic factor, we were impressed by the findings of Bennetts and his collaborators[3,4], who observed, in sheep grazing on subterranean clover in Western Australia, histological changes in the reproductive organs of both sexes which pointed to the presence of an œstrogen in the pasture, a conclusion which was later strengthened by the extraction of œstrogen by chemical methods[5]. These findings, taken in conjunction with those of Folley and his co-workers[6,7], who showed that administration of œstrogens will increase the solids content of cows' milk (enrichment effect), indicated the possibility that part at least of the galactopoietic effects of spring grass at the time of maximum growth might be due to the presence of œstrogens. Such a theory would also account for milk yield increases, since the 'enrichment effect' is only one aspect of a general galactopoietic action exerted by œstrogens under suitable conditions[8]. We were thus led to examine the growing herbage of English dairy pastures for the presence of œstrogen.

Samples of herbage cut from a number of pastures during the period of active growth were extracted by a method developed by Mr. T. J. Robinson, details of which were kindly made available by him in advance of publication. The method involves extraction with ethanol, followed by saponification and separation of the phenolic fraction. The extracts were tested for œstrogenic activity by the effect on the weight of the uteri of immature mice, six mice being used in each group. The extracts were dissolved for njection in arachis oil, and the dose given in six subcutaneous injections over three days, with autopsy eighteen hours after the last injection.

The results are noted in the accompanying table; he first series (Nos. 1–7) refers to tests of grasses cut at the early flowering stage in May 1948 at a ime when, though plant growth was restricted by adverse weather conditions, cows grazing the pastures showed moderate increases in milk yield and non-fatty solids. The second series (Nos. 8–14) refers to herbage from a number of pastures at the second seasonal cutting on June 23, 1948, and to a hay which was a year old and was included for comparison. This herbage was in the pre-flowering stage. Extracts of the two grass samples in the first series (Nos. 2, 3, 4 and 5) gave significant uterine weight increases over the controls ($P < 0{\cdot}05$), and the herbage undoubtedly contained œstrogen. The second series demonstrated œstrogen with certainty in the clover (No. 12) and probably in the grasses (Nos. 10 and 11), while the hay (No. 13) was negative.

Serial No.	Treatment	Mean uterine weight (mgm.)
	First series	
1	None	7·8±0·8
2	Grass No. 1: Extract equiv. to 0·75 gm. dry matter	14·2±1·1
3	,, ,, ,, 1·50 ,, ,, ,,	24·5±2·4
4	Grass No. 2: Extract equiv. to 0·75 gm. dry matter	19·6±1·7
5	,, ,, ,, 1·50 ,, ,, ,,	20·0±1·2
6	0·03 μgm. α-œstradiol	23·0±1·8
7	0·06 μgm. α-œstradiol	29·3±3·0
	Second series	
8	None	5·3±0·4
9	Arachis oil	6·4±0·5
10	Grass No. 3: Extract equiv. to 0·75 gm. dry matter	8·8±0·9
11	Grass No. 4: Extract equiv. to 0·75 gm. dry matter	9·9±0·8
12	Clover ,, ,, ,, 0·75 ,, ,, ,,	15·1±1·0
13	Hay ,, ,, ,, 0·75 ,, ,, ,,	6·3±0·8
14	0·03 μgm. α-œstradiol	17·4±1·5

These preliminary results are in harmony with the theory that the galactopoietic effects of spring grass in lactating cows may be due to the presence of œstrogen, and justify further work, which is planned, to examine various aspects of the theory in greater detail.

S. BARTLETT
S. J. FOLLEY
S. J. ROWLAND
National Institute for Research in Dairying,
Shinfield, near Reading.
D. H. CURNOW
SYLVIA A. SIMPSON
Courtauld Institute of Biochemistry,
Middlesex Hospital, London, W.1.

Aug. 13.

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Atypical Growth, Abnormal Mitosis, Polyploidy and Chromosome Fragmentation Induced by Hexachlorocyclohexane

THE best insecticides and fungicides will be those which kill the plant parasites without affecting the plant organism. In fact, they all affect the host plant more or less in various ways and degrees[1–4]. A series of fungicides and insecticides may have very similar effects on the plant organisms. Ethylmercury-chloride (CH_3CH_2HgCl), which is the active substance (2 per cent) of the fungicide 'Granosan', induces atypical growth, abnormal mitosis and polyploidy[3,4], reminding one of the effect of colchicine and acenaphthene[5,6]. A similar and very strong effect of this kind is produced by hexachlorocyclohexane—another chlor-organic compound—which is the active substance of a series of very effective insecticides, recently recommended under various names. The insecticides 'Agrocides' (7, 3, etc.), for example, the active substance of which is the gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane ('Gammexane'), induce atypical growth, suppressing the development of the roots, stems and coleoptyles of gramineous plants, producing very striking thickening of these organs, especially of the growing points (root tips and coleoptyles).

Active insecticides, manufactured in various countries (hexachlorane, 666, etc.), and containing several isomers of hexachlorocyclohexane, including the gamma isomer, act in a similar though not in an identical way. Hexachlorane, for example, stimulates the germination of certain Cruciferæ (*Brassica nigra*) and other plant seeds during the first two days, so that they were even ahead in growth, when compared with the control samples, and much ahead when compared with the germinating seeds treated with 'Agrocide 7'. But soon after this, the controls grow on, while the growth of the treated seedlings becomes strikingly suppressed. We have treated with insecticides containing hexachlorocyclohexane the seedlings of the following plants: *Zea mays, Triticum vulgare, T. durum, T. monococcum, T. compactum, Secale cereale, Helianthus annuus, Crepis capillaris, Vicia faba, V. sativa, Brassica nigra*, etc.

The cytological studies of the affected root, stem and coleoptyle tissues show that these agents act first of all upon the cytoplasm and interfere with the cytoplasmic processes involved in the formation of achromatic figures. The chromosomes do not arrange themselves in an equatorial (metaphasal) plate after prophase, but remain scattered, as they are during the prophase. They appear less bent than usual. The thickening of the chromosomes, that is, the accumulation of nucleic acids (nucleoproteins) on the chromosomes and the reproduction and splitting of the chromosomes, proceeds, although the processes involved in the formation of achromatic figures are highly disturbed or even entirely inhibited. The chromosomes thus reproduce, but remain where they are, without moving toward the poles. In fact, poles are not formed. After such a reproduction, the chromatolytic (nucleoproteolytic) processes proceed and a nucleus is formed containing twice as many chromosomes as before the beginning of the abnormal mitotic processes. The main trend of the processes of chromosome doubling reminds one of those induced by colchicine, acenaphthene and other polyploidizing agents.

Since the insecticide continues to act further, the next abnormal mitosis ends with a second chromosome doubling and so on. Thus tetraploid and octoploid cells appear, and cells of a much higher degree of polyploidy. Alongside these, certain diploid cells that have not yet undergone the abnormal mitosis can still be found.

Chromosome multiplication leads to increase of the size and occasionally of the number of the nuclei, and further to increase of the size of the cells. Thus the cells grow instead of multiplying and differentiating, leading to swelling of the roots, stems and coleoptyles.

The solubility of hexachlorocyclohexane in water is very low, therefore it is applied as powder. Its effect is so striking that it can be used as a polyploidizing agent, especially when one considers the fact that it is much cheaper than other polyploidizing agents.

In certain cases a chromosome group or groups may move slightly in some direction or directions into the cytoplasm. Such a slight separation may occasionally end with formation of two, or more than two, aneuploid nuclei; thus polynucleate, or cells with monstrously deformed nuclei, appear. In certain cases cell wall is formed between such nuclei. This leads to formation of cells with aneuploid chromosome numbers. Dead cells were occasionally found in the roots, stems and in the coleoptyles. They may have been aneuploid. All these phenomena are due to the activity of the agent upon the cytoplasm.

But the active agent also induces certain changes in the nuclear elements, namely, in the chromosomes, no matter how rarely they may occur. Fragments of one chromatid or of a chromosome (both chromatids) were also observed, although very rarely.

Such insecticides or fungicides, when applied, may increase the hereditary changes in the cultivated varieties ('pure lines'), leading thus to more rapid degeneration of the highly bred uniform varieties. This means that when one applies such insecticides or fungicides, the seeds of the varieties being propagated should be changed more often, so as to provide new non-degenerated stocks.

DONTCHO KOSTOFF

Institute for Applied Biology and
Organic Development,
Academy of Sciences, Sofia.

June 12.

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Mutations Induced in *Coprinus fimetarius* (L.) by Nitrogen Mustard

DURING recent years, numerous experiments have been performed in order to induce mutations in various fungi belonging to the Ascomycetes group. Of special interest are the mutations affecting physiological characters in *Neurospora*[1] and *Ophiostoma*[2] produced by irradiation, mustard gas or nitrogen mustard. These investigations led me to perform similar experiments with a Basidiomycete, *Coprinus fimetarius*.

In the first experiments, basidiospores from sporophores formed in pure culture were subjected to ultra-violet radiation from a quartz lamp (Original, Hanau), plated out on malt agar, and the developing monosporous mycelia isolated and studied. Even after a very long irradiation, however, the treated spores possessed the same germination capacity as untreated ones, and no morphologically deviating mycelia were observed. Thus the irradiation did not seem to exert any mutagenic effect upon the spores. The surprising resistance might be due to the thick epispore of the *Coprinus* basidiospores, which probably absorbs the ultra-violet rays.

Treatment with nitrogen mustard ($(\mathrm{Cl.CH_2.CH_2})_2.\mathrm{N.CH_3}$), on the other hand, gave positive results. In the first of the two experiments with this compound, the spores were suspended in a 0·25 per cent solution of nitrogen mustard at *p*H 5·6. After 30 min. the treatment was broken off by diluting the suspension twenty-five times and plating out the spores on malt agar plates. The percentage germination was 2·4 per cent compared with 25 per cent in untreated spores. From the plates, 462 monosporous mycelia were transferred to flasks containing 5 ml. of a synthetic nutrient solution ('minimum solution') giving optimal growth for *C. fimetarius*, wild type[3].

Many of the spores treated with nitrogen mustard developed morphologically deviating mycelia; but only the physiologically deviating mycelia, however, were more closely studied. The mycelia which did not develop in the minimum solution were transferred to malt agar tubes and their specific requirements examined. Three physiological mutations (0·6 per cent) were found, two of which (Nos. 23 and 32) required hypoxanthine or adenine for growth; the third mutant (No. 17) requires an as yet unidentified amino-acid, or a combination of amino-acids.

In the second experiment, the spores were treated with 0·5 per cent nitrogen mustard. The percentage germination was 1·9 per cent (against 32 per cent in the control), and 454 mycelia were isolated. Two of them (Nos. 54 and 78) were mutants, both growing with methionine or cystein, and thus probably representing induced parathiotrophy (Volkonsky[4]).

In one case, No. 32 (hypoxanthine-less), the inheritance of the induced character was studied. *C. fimetarius* being a tetrapolar, heterothallic fungus[5], four test mycelia (Nos. 7, 3, 5 and 1) could be isolated representing the mating types a_1b_1, a_2b_2, a_1b_2 and a_2b_1, respectively. No. 32 conjugated with No. 7 (a_1b_1), and the dicaryotic mycelium formed was inoculated into a flask with sterile horse manure. Despite the fact that half the nuclei in the mycelium were hypoxanthine-less, several normally shaped sporophores developed in the flask in eleven days. Spores from them were plated out on malt agar, and 46 monosporous mycelia were isolated; 21 of them turned out to be hypoxanthine-less, the remaining 25 representing the wild type. The hypoxanthine-less mycelia were segregated into all the four mating groups, three mycelia representing a_1b_1, six a_2b_2, three a_1b_2 and nine a_2b_1. To judge from these figures no strong linkage seemed to exist between the mutated gene and the incompatibility factors, *a* and *b*.

A back-cross between No. (32 × 7)11, a_1b_1, and No. 32, a_2b_2, gave a completely hypoxanthine-less dicaryotic mycelium, which grew well on sterile manure but did not form any sporophores.

The hypoxanthine-less No. 32 (a_2b_2) and the parathiotrophic No. 54 (a_1b_1) conjugated and formed a dicaryotic mycelium capable of growing in the minimum medium just as well as the wild type. This mycelium obviously represents a case of 'intracellular symbiosis' analogous to the heterocaryotic mycelia of *Neurospora*[6], but probably differing from them in that the two sorts of nuclei always occur in equal numbers, because of the conjugate divisions. Sporophores were formed on sterile manure, but no spores have as yet been obtained.

LISBETH FRIES

Institute of Physiological Botany,
University of Uppsala.
June 25.

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Some Stereochemical Aspects in Genetics

It is a fundamental concept in modern chemical genetics that a separate gene is responsible for each step in the enzymatic biosynthesis of a given compound. Since *in vitro* the precursor (or precursors) of the compound would also be able to produce substances other than that formed in the tissue, a gene, as is well known, displays a chemical steering power which is directed toward a single structural target.

We suggest that in the evaluation of the degree of selectivity in this steering function of some genes, one has to go further than usual by thinking in stereochemical rather than in purely chemical terms. In the case of those carbon compounds which are able to assume two or more *cis-trans* forms, their biosynthesis can be effectively steered in the tissue towards a single spatial model. This can be demonstrated in the field of the carotenoids, which are produced annually on the hundred-million-ton scale in the vegetable kingdom. In the overwhelming majority of the plants, only the all-*trans* configuration appears. For example, during the biosynthesis of lycopene in the ripening of ordinary tomatoes, this particular configuration is selected out of the seventy-two stereochemical possibilities, and none of the other seventy-one stereoisomers can be found in fresh extracts by careful adsorption analysis.

That a stereochemical steering factor must be made responsible for this spatial selection and not an excessive lability of all *cis-trans* isomers neglected *in vivo* follows from the appearance, in exceptional cases, of such poly*cis* forms of lycopene, which can be crystallized easily and show a degree of thermostability similar to that of the all-*trans* compound. The first such reported case was the occurrence of 'prolycopene' in the 'tangerine' variety of tomatoes[1].

There are three genetically different flesh colours known in tomatoes: yellow, orange and red. The yellow fruits carry the recessive form, *r*, of the basic gene for lycopene formation. Both the orange and red fruits possess the dominant gene, *R*. In addition, however, the orange-coloured tomatoes, which contain the poly*cis* compound, prolycopene (besides other *cis* lycopenes), is recessive in the gene *t*; and the red fruit which exclusively produces the all-*trans* form of lycopene has dominant *T*. Whereas the biosynthesis of either all-*trans*-lycopene or prolycopene requires the dominant gene, *R*, the gene pair *T* and *t* determines the spatial configuration of the lycopene molecule[1].

We expect that other instances may be found in which one gene is responsible for the building up of the chemical structure proper of a compound, and another gene steers the molecules thus formed into a predetermined stereochemical configuration.

A spatial difference (*cis* or *trans*) around a double bond does not modify only a detail in the polyene molecule but also, as models show, it profoundly changes its overall shape[2]. While an all-*trans*-lycopene molecule has a rod-like form, this becomes a V-like pattern when a centrally located double bond assumes *cis* configuration. Again, when several more such rearrangements take place around other double bonds, the molecule straightens out.

Of course, not each of the sterically possible geometrical forms of a given compound can fit equally into a biological system. Hence, it is an important function of some special genes to secure the most suitable spatial configuration; however, if a compound is not subject to stereoisomerism, its genetics can be satisfactorily treated in terms of two-dimensional structural chemistry.

While so far our discussion has referred to the morphology of single molecules of relative simplicity, some bio-processes which consist of arranging many building stones into high-molecular complex structures may also be considered on similar lines. One can conceive a difference between such genes the function of which is to link building units together, and others which arrange the biosynthetic end-product into a predetermined spatial pattern. The first type of genes, which are being studied with so much success, for example, in the case of *Neurospora*[3], determines the chemical composition of the tissue; but the second type is concerned with the organic form. It may also determine the spatial relationship of the constituents within a cell or the specific arrangement of molecules into some micro- and macroscopic structures. In this respect one should also consider genes which affect the symmetry of organisms. An interesting example is that of a freshwater snail in which the direction of coiling of the shell is genetically determined by a single gene-pair[4].

The original concept of the gene took into account both its effect on chemical composition and form. While important modern studies are stressing typical biochemical effects in genetics, recent stereochemical observations on some natural pigments may contribute to the emphasis on the three-dimensional form, that is, the genetically predetermined spatial shape of both simple molecules and complex organic structures.

L. ZECHMEISTER
F. W. WENT

California Institute of Technology,
Pasadena.
June 18.

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Local Action of Calciferol and Vitamin A on Bone

IT has been shown[1] that if the parathyroid glands of young mice are attached to small, excised pieces of parietal bone, and the two grafted together to the cerebral hemisphere of a litter-mate, intense osteoclastic resorption of the bone in the immediate vicinity of the gland is demonstrable after 10–14 days. The same method has now been used to study the local action of calciferol, vitamin A and œstradiol on bone.

The small crystals of powdered calciferol were cemented together into lumps about 0·5 mm. in diameter with human fibrinogen and thrombin solutions, and these pellets were attached with the same medium, plus penicillin, to the centre of pieces of parietal bone 2–3 mm. square, cut from 10-day-old *C.57* black mice. The grafts were thrust vertically into the cerebral hemisphere of a litter-mate through a narrow hole made in the skull and were examined in saline after 10–14 days. Similar experiments were performed using cholesterol. In some cases the crystal-pellet could be seen after removal, and its position correlated with the structure of the adjacent bone as revealed in the dry specimens after maceration in potash. In other cases the pellet was displaced or detached in removal. The three 14-day calciferol grafts (Fig. 2) all showed very definite resorption in the central region, corresponding closely to the site of the crystals, and in two of them the bone was perforated. The five 10-day grafts also showed definite, but less pronounced, erosion. In all specimens resorption was irregular and appeared to involve the widening of pre-existing spaces and foramina over a fairly large area. The cholesterol grafts (Fig. 1), in contrast, showed no evidence of local resorption, the bone surface being smooth and dense, and with a certain amount of irregular thickening, particularly at the periphery; previous experience shows this to be common in all types of grafts with parietal bone, even if no crystals are attached. The experiments strongly support McClean's[2] suggestion that the osteoporosis which results from massive doses of calciferol is due, at least in part, to a local action of the vitamin on the bones.

Six grafts performed with single small chips of crystalline vitamin A acetate showed intense and more sharply localized resorption after 14 days. Four of them (Fig. 3) were perforated by a large hole, at the sharp edges of which osteoclasts could be seen after supravital staining with neutral-red in the manner I have described[3] previously. Two others showed a concave depression formed of thin bone, with minute perforations in some regions of it. Neutral-red staining revealed approximately 150 osteoclasts spread over each of these concavities, which are apparently due, as in parathyroid grafts, to new bone formation on one surface keeping pace with resorption on the other. The sharpness of the perforation as compared with calciferol grafts may be due to the use of a single fragment, which was therefore not interpenetrated by fibrin. It is very unlikely that the effect is due to mechanical pressure, since

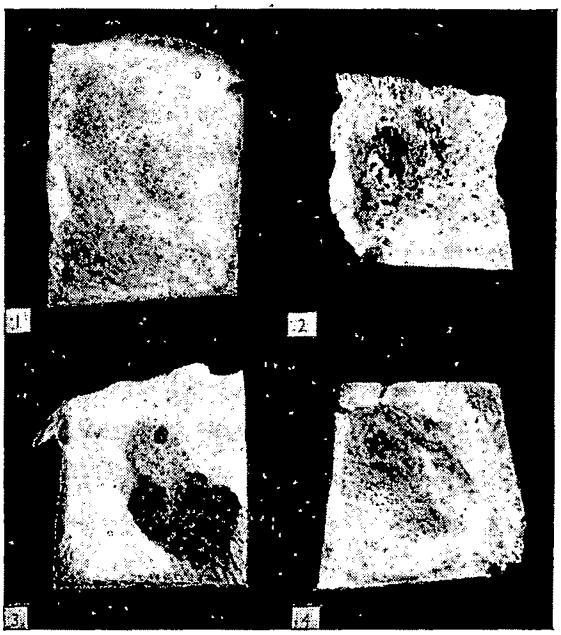

Fig. 1. Cholesterol graft. Fig. 2. Calciferol graft.
Fig. 3. Vitamin A graft. Fig. 4. Vitamin A graft.

fragments of glass did not produce resorption, and in one specimen the glass became closely embedded in the bone surface without perforating it. The local reaction of the bone to the pressure of a grafted fragment may, of course, be modified if the fragment also exerts a physiological effect by virtue of its chemical character. Grafts performed with carotene, made up in fibrinogen–thrombin clot, showed no resorption or other noteworthy effect. It appears that the fractures observed by Moore and Wang[4] and others in rats given massive doses of vitamin A may be attributable to local action on the bones, and the results are interesting in relation to Mellanby's[5] findings on the effect of vitamin A deficiency on osteoclasis. As might be expected, carotene is evidently not converted to vitamin A by bone tissue, at least to any considerable extent.

Ten grafts (five into male and five into female hosts), using small single chips from a fused œstradiol tablet, showed no evidence of either local resorption or increased local bone deposition. Increased deposition might, perhaps, have been anticipated in view of the known action of injected œstrogens in promoting bone-formation in the medullary cavities of the long bones. Sutro[6] claims that osteosclerosis of the calvarium also occurs in young mice of either sex given prolonged œstrogen treatment. The character and degree of the response to œstrogens apparently varies in different regions of the skeleton: thus the pubic bone undergoes resorption; in the long bones only endosteal bone formation occurs; and the magnitude of the effect depends on dose – time relations. Further graft experiments, taking these factors into account, will be needed before the local action of œstrogens can be satisfactorily assessed.

The detailed results, including histological findings, will be reported elsewhere at a later date.

I wish to thank Prof. Daryll Forde for allowing me to complete the work while attached to his Department, Mr. F. J. Pittock for taking the photographs, and Miss I. Slowgrove for technical assistance. I am also indebted to Dr. W. F. J. Cuthbertson, of Glaxo Laboratories, Dr. S. P. Datta, Dr. Gordon Kennedy and Sir Edward Mellanby for the pure compounds used in this work.

N. A. BARNICOT

Department of Anthropology,
University College, London.
June 23.

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Effect of Pantothenic Acid on the Infection of *Trypanosoma evansi* in Rats

WITHHOLDING of pantothenic acid from the diet has been shown by Becker, Mansera and Johnson[1] to interfere with the production of ablastin, the trypanosome-reproduction inhibiting antibody, formed by rats infected with *Trypanosoma lewisi*. An investigation of exploratory nature was undertaken to ascertain if pantothenic acid had a similar effect on the course of *T. evansi* infection in rats.

Experiment 1. Six rats, all kept on bread and milk, were used in this experiment. The diet of three of these was supplemented by pantothenic acid at the rate of 200 mgm. a rat daily for five days prior to infection and continued until the end. All the rats were infected on the same day with 3,000 trypanosomes each by the subcutaneous route. On the fifth day after infection, two out of three rats of the control batch showed trypanosomes in their peripheral circulation, while all three of the acid group remained negative. On the sixth day, only two rats of the acid group showed trypanosomes in the tail blood, while the third remained negative; in all the controls the parasites were swarming in the blood, and one died during that night. On the seventh day one rat of the acid group died, while two others had a rise in the number of parasites; controls showed an even greater number and died during the night; the remaining two of the acid group, on the other hand, died twenty-four hours later.

Experiment 2. The dietary and other conditions were the same as above; but the dose of the trypanosomes was increased to 46,000 a rat. The rats of both groups became positive on the third day; but the number of parasites in the controls was appreciably larger than those receiving pantothenic acid. One control rat died on the fourth day and the remaining two during the night; in the acid group, on the other hand, all three showed swarming parasites on the fourth day, survived the fifth day and died during the night.

Experiment 3. The conditions were slightly varied. A batch of ten rats was kept for fifteen days on a vitamin-free diet consisting of casein (vitamin-free), 20 parts; coco-nut oil, 5 parts; dextrinized starch, 71 parts; salt mixture (Osborn and Mendel), 4 parts. Five of these, in addition, received pantothenic acid as above. On the sixteenth day the rats received a dose of 2,500 trypanosomes each subcutaneously. In the control batch two rats were positive on the fifth day and all on the sixth day; while in the acid group one became positive on the sixth day, and with an addition of one on each day to the positive group, all were positive by the tenth day. Commencing from the night of the tenth day, all the controls died within the next forty-eight hours; whereas in the acid group the first death occurred on the twelfth day and within the next forty hours all were dead.

Though further experimental observations have yet to be made before any generalization can be attempted on the subject, the results presented here are interesting enough to merit publication. The results perhaps justify a tentative suggestion that pantothenic acid exerts an influence on the rate of multiplication of *T. evansi* in rats, although finally the host is overwhelmed by parasitæmia.

Bovines in India are considered to be 'carriers' of *T. evansi*, and the pantothenic acid reserve in these animals may play the important part of maintaining the 'carrier' condition. Sporadic fatal outbreaks of surra in bovines are, however, not uncommon in India, and the cause for this may perhaps be found to be correlated with the interference of pantothenic acid balance in these animals.

Our thanks are due to Dr. N. D. Kehar and Dr. N. B. Das for their help in these experiments.

H. N. RAY
S. HARBANS

Subsection of Protozoology,
Indian Veterinary Research Institute,
Mukteswar-Kumaun.

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Role of the Inorganic Constituents of Wheat Bran Extract in Streptomycin Production

WHEAT bran has been frequently used as an ingredient in media for culturing micro-organisms. Good results have been recorded from this laboratory for penicillin production by *P. notatum*[1] and streptomycin formation by *S. griseus*[2]. Detailed systematic investigations carried out to discover the factors in wheat bran extract responsible for these results have shown that the ash of the extract is mainly concerned so far as streptomycin is concerned.

Streptomycin fermentations were conducted in a manner described previously[3]. Streptomycin titre and the reaction of the culture fluids were studied daily. Antibiotic activity was determined from a standard curve obtained by the cup plate method. The following media were used:

I. Aqueous extract of wheat bran with total solids adjusted to 2 gm. per 100 ml.; pre-adjusted to *p*H 6·8.

II. 'Difco' peptone, 0·5 gm.; glucose, 1·0 gm.; sodium chloride, 0·5 gm.; distilled water, to 100 ml.; pre-adjusted to *p*H 6·5–7.

The inoculum consisted of a spore suspension of a Waksman's strain of *S. griseus*. The ash of the wheat bran extract was obtained by heating the total solids in an electric furnace at a temperature of about 1,000° C. for 10–14 hours. No attempt was made to dissolve the ash before adding it to the medium.

The accompanying table shows that addition of the ash at 500 mgm. per 100 ml. to medium II increased the streptomycin production to practically the same as that when *S. griseus* was grown in medium I. The ash content of medium I is 453 mgm. per 100 c.c.

Effect of wheat bran extract ash on streptomycin formation

Medium	Ash in medium (mgm./ 100 c.c.)	Reaction of medium (days)						Streptomycin in μgm. per ml.					
		4	5	6	7	8	9	4	5	6	7	8	9
I	Nil	7·1	7·2	7·6	7·7	7·9	7·9	69	111	114	109	92	91
II	Nil	6·9	7·4	7·4	7·5	7·6	7·6	24	24	25	28	24	24
	100 mgm.	7·1	7·2	7·3	7·4	7·6	7·9	24	28	36	64	64	48
	200 ,,	7·3	7·3	7·4	7·6	7·8	7·9	22	28	45	78	76	78
	400 ,,	7·4	7·5	7·6	7·8	7·9	7·9	28	28	54	98	85	88
	500 ,,	7·5	7·6	7·8	7·9	7·9	7·9	25	28	61	108	93	92

A similar observation regarding the role of inorganic constituents of corn-steep liquor in penicillin formation has been recorded[4]. Recently fatty acid-like components have been isolated[5] from solid wheat bran, and it has been suggested that these might explain the good antibiotic production by micro-organisms in wheat bran. Neither the aqueous extract of wheat bran used by us nor its petrol-soluble fraction has shown any antibacterial activity. The data presented above suggest that the good yields obtained by using the bran or its aqueous extract is independent of any influence likely to result from the antibacterial activity of the fatty acid component of the bran. Further work regarding the role of the different elements present in the ash is in progress.

My thanks are due to Dr. K. M. Pandalai for his suggestions, to Prof. V. Subrahmanyan for his interest, and to Merck and Co., Rahway, N.J. I acknowledge the financial support from the Council for Scientific and Industrial Research, India.

R. RAGHUNANDANA RAO
Department of Biochemistry,
Indian Institute of Science,
Bangalore. May 17.

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Inhibition of a Succinic Aerodehydrogenase System by Surface-active Agents

A NUMBER of detergents of different types have been found to depress the oxygen uptake of a homogenate of rabbit liver in presence of succinate (see accompanying table).

Compound tested	Class of detergent	Oxygen uptake 1/ml./ 30 min.	Concentration of compound	% Inhibition
Sodium cetyl sulphate	anionic	45	*M*/1,5000 *M*/7,500	70 16
Sodium salt of *iso*-propyl-substituted naphthalene-sulphonic acid	anionic	100	*M*/300 *M*/1,500	62 25
Bile salts. (Sodium taurocholate, sodium glycocholate, mol. wt. taken as 500)	anionic	52	*M*/300 *M*/1,500	97 39
Cetyl polyethylene-oxide	neutral	54	*M*/7,500 *M*/200,000	88 33
Cetyl trimethyl ammonium chloride	cationic	131	*M*/500 *M*/2,500 *M*/12,500	98 40 −32*
Dodecyl pyridinium bromide	cationic	97	*M*/500 *M*/2,500	100 −22*

* Stimulation of 32 and 22 per cent respectively.

The functioning of the enzyme system studied appears to be profoundly disturbed by a change in the surface activity of the preparation irrespective of the specific nature of the substances producing this change.

My thanks are due to I.C.I. (Dyestuffs), Ltd., for gifts of chemicals.

DONALD HOCKENHULL
College of Technology,
Manchester 1.

Vascular Wilt Disease of Oil Palms in Nigeria

IN 1946, I observed and diagnosed a vascular wilt disease of oil palms (*Elæis guineensis*) in the Belgian Congo, a strain of *Fusarium oxysporum* being consistently associated with the necrosed wood vessels[1,2]. An investigation in 1947 of diseased oil palms in various Nigerian plantations by Messrs. S. de Blank and F. Ferguson, of the United Africa Co., led them to the conclusion (private report) that vascular wilt disease was also present in Nigeria. Cultures which they submitted to me for identification consisted of strains of *F. oxysporum* very similar to those which I obtained in the Belgian Congo. During the present year, in an inspection of oil palm plantations in Nigeria, I obtained full confirmation of the presence of vascular wilt disease. Some plantation areas show how severe this disease can be, many 8–12 years old palms being killed off, together with the younger replacements. An important addition to our knowledge is that infected vascular strands can be observed in seedlings 18–24 months old: from these, *Fusarium oxysporum* and other species of *Fusarium* have been isolated. This fact may materially shorten the programme of breeding resistant varieties.

In Nigeria, as in the Belgian Congo, a leaf disease known as patch yellow has also an associated strain of *Fusarium oxysporum*, this strain being different from that isolated from necrosed vascular strands[2].

These observations give me an opportunity of saying that, broadly speaking, the major plantation problems are common to the whole oil palm region of West and Central Africa. Accordingly, it is to be hoped that the closest co-operation will be maintained by all bodies interested in the welfare of this important industry.

C. W. WARDLAW

Department of Cryptogamic Botany,
University of Manchester.
Oct. 11.

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Bacteriophage Typing of Untypable *Salmonella typhi* Organisms

STRAINS of *S. typhi* reported as being untypable by bacteriophage figure largely in previous reports and vary between 30 and 8 per cent of the total[1].

Using a modification of the method described by Craigie for typing, the group of untypables can be divided into three more or less distinct sub-groups. The first is characterized by all specimens from the same source of infection giving a standard pattern throughout with certain Type II bacteriophages. This pattern reaction identifies the close relationship of the strains to one focus, but does not allow the strains to be classified into any one of the recognized twenty-four groups. The second subgroup, and the larger in my series, are strains which give no reaction with Type II 'phages, but react to pooled Types I and IV 'phages with clear, complete, confluent lysis. These types may easily be considered to be new types; but with the technique to be described, most can be classified into the existing ones. The third group are those in which Types I and IV 'phages have little or no reaction, although the organisms may or may not have a *Vi* antigen content.

From a series of symptomless carriers in one area there were isolated "rough" typhoid organisms, suggested by the biochemical findings, for they were auto-agglutinable in both normal and 0·2 per cent saline solution. Observation of the cultures showed them to be heavily contaminated with a naturally occurring anti/*O* 'phage. When the 'phage content was reduced in amount, the agglutinations were characteristic, and the organisms reacted with confluent lysis to I and IV 'phages and also were all lysed by specific Type II *G* 'phage. This series was presumed to be an example of excessively 'phage-contaminated Type *G S. typhi*, which had spread from one person to another in the roughened form.

This technique of growth in anti-phage serum was applied to a series of previously untypable strains, and most of them have now been assigned to known 'phage types. Most difficulty arises with the subgroup characterized by its pattern reaction, for although these strains can be altered to the second group (that is, lysis only with pooled I and IV 'phages), so far it has not been easy to classify them further.

These three subgroups would seem to be due to the same biological process in action. The groups are not clear cut and merge into one another. The individual variation of $V — VW — W$ seems to run parallel to the colonial population change of smooth to rough in that the roughness is due to the same process acting on smooth organisms.

It would seem that bacteria contaminated with bacteriophage show the phenomenon of partial and complete interference to specific 'phage action. The loss or lowering of bacterial resistance to concomitant 'phage is responsible for the change from $V—VW—W$ and even to *rho* forms. Outbreaks of typhoid fever have occurred, where the *S. typhi* isolated gave partial or complete interference to specific 'phages and rendered the organisms untypable, in that they could not be assigned to group 1—24. It is of interest to note that untypable forms occur towards the end of outbreaks caused by specific 'phage types. When these previously untypable strains are rendered typable by the above method, they are found to be of the same 'phage type as the outbreak. As with communities, so with individuals, it is not infrequent that in a clinical relapse the organism isolated is of the untypable group. Examples of these untypable *S. typhi* from relapses have been identified as being of the same 'phage type as the initial infection.

Bacteriophage is widely distributed in Nature. Among the Gram-negative bacilli, 'phages have been isolated here from *S. typhi*, paratyphi *A*, *B* and *C*, various other members of the *Salmonella* group, most strains of dysentery, *Proteus*, *Pyocyaneus* and Coliforms, and they are especially numerous on Paracolon organisms. It would seem as if most of these organisms have the weakness whereby they lose their resistance to 'phage and become contaminated. From this point of view, it is not happy symbiosis, for the contamination alters the organism.

JAMES M. DUNBAR

Central Pathological Laboratory,
M.E.L.F.

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Distribution of Shell Porphyrins in Mollusca

RED fluorescence due to porphyrins in molluscan shells has been known for some years (Furreg and Quemer, 1929; Fischer, 1930, 1934, 1937; Waldenström, 1937; Tixier, 1945); but its exact distribution has not been described. In an investigation of the phylogenetic relationships of shell pigments, I have examined some three thousand species from many gastropod and pelecypod genera by ultra-violet fluoroscopy. Detailed findings in this investigation, together with data on the chemistry of shell porphyrins and other acid-soluble pigments, will appear in due course in the *Biochemical Journal*.

The distribution of porphyrins follows the known anatomical affinities of molluscs very closely. They occur widely in the Archæogastropoda, but disappear among the Turbinidæ, in which Krukenberg (1883) and Tixier (1947) have demonstrated a predominance of linear tetrapyrroles, and are absent from the Mesogastropoda as far as the Lamellariacea. A focus of porphyrin deposition covers this section and overlaps into the Cypræacea. The characteristic fluorescence recurs in the tectibranch opisthobranchs and in *Umbraculum*. Isolated species of *Marginella*, and one species of *Torinia*, also deposit porphyrins. Among the pelecypods, I found them in the Anomiidæ, Pinnidæ and Pteriidæ, and in *Venus* (*Clausinella*) *fasciata*, *Gafrarium divaricatum* and *Sunetta solanderi*.

They were absent from other pelecypods examined. No porphyrins were detected in the shell of any land form, or of any freshwater pulmonate.

The main genera in which shell porphyrins have been shown to occur are listed below, the sign * indicating that the property is widespread in the group.

Clypidina
*Fissurella
Lucapina
Acmæa
*Trochus
*Clanculus
*Ethalia
*Isanda
*Monilia
Thalotia
Elenchus
*Umbonium
Gibbula
Livona
Monodonta
*Angaria
Leptothyra
Lithopoma
Tricolia
Theodoxus
Neritodryas
Neritina
Torinia
*Trivia
*Erato
*Velutina
Cypræa
Marginella
Hydatina
*Bulla
Acteon
Haminea
*Aplustrum
*Umbraculum
Enigmoma
Anomia
*Pteria
*Pinctada
*Malleus
Isognomon
Pinna
Venus

They occur also in several Loricates, and in two Scaphopods.

Distribution in the outlying groups is well localized: in *Cypræa* it is confined to the section *Luria* (*cinerea, isabella, pulchra*), *Erronea subviridis* and *Cypræa mappa*. In *Marginella*, it centres round *M. ornata*. Individual variation is very marked. The pattern of distribution in an individual species may or may not coincide with the visible pigment; in some forms it is generalized, in others confined to a single band or patch. In *Gibbula cineraria*, only the topmost whorl and protoconch usually fluoresce.

The porphyrin content of most forms is chromatographically separable from the main colouring matter. Details of the pigments detected, which are numerous, and of the identity of the porphyrins, will be given in forthcoming papers.

Marked porphyrin fluorescence was detected not only in *Gibbula cineraria* from the Clyde Beds (post-Pleistocene), but also in *Pteria media* from the London Clay and several species from the Calcaire Grossier (Paris Basin, Upper Eocene), namely, *Fissurella squamosa* Desh., *Angaria calcar* Lk., *A. lima* Lk., *Tectus crenularis* Lk.

The following is a list of British recent Mollusca found to deposit shell porphyrin:

Patelloida virginea Mull.
Gibbula magus da C.
Gibbula cineraria L.
Cantharidus striatus da C.
Monodonta lineata da C.
Tricolia pullus L.
Theodoxus fluviatilis L.
Velutina velutina Mull.
Erato voluta Mont.
Trivia monacha da C.
Trivia arctica Mont.
Acteon tornatilis L.
Venus fasciata da C.

ALEX. COMFORT

Department of Physiology,
London Hospital Medical College,
London, E.1.
June 12.

Oscillographic Analysis of the Gravity and Vibration Responses from the Labyrinth of the Thornback Ray (*Raja clavata*)

IN a recent communication[1], one of us (O. L.) reviewed the results so far obtained, by the oscillographic method, in the study of the non-acoustic function of the vertebrate ear. In that review a preliminary account was given of the reaction to gravitational stimuli and linear accelerations of the otolith organ in the recessus utriculi of the elasmobranch labyrinth. It was shown that the otolith organ of the utriculus is sensitive to positional changes about any horizontal axis, and to linear acceleration during straight-line translations. The fact that the organ is not restricted to respond to displacements in only one plane of space invited the conclusion that the utriculus may well be the only otolith organ concerned with the maintenance of equilibrium, leaving the otolith organs of the pars inferior of the labyrinth (sacculus and lagena) free for the reception of vibrational stimuli. This function has, in fact, been conclusively demonstrated to be localized in the pars inferior of the labyrinth of bony fish[2,3].

During the past summer we have been able to extend our electrophysiological experiments on the labyrinth of the ray to the pars inferior, and we have succeeded in obtaining, by direct recording from the nerve branches supplying all its sensory epithelia, single-fibre responses of accurately localized origin. The results, the quantitative aspects of which are at present being analysed and prepared for publication elsewhere, can be qualitatively summarized as follows.

In the elasmobranch labyrinth the utriculus is not the only gravity receptor. Equally good but qualitatively different gravity responses can be recorded from the otolith organs of the sacculus and of the lagena. In the lagena the whole macula acts as a gravity receptor, whereas in the sacculus gravity responses are confined to the posterior part of the macula immediately adjoining the lagena. The lateral part of the sacculus macula, which is innervated by a number of separate branches of the ramus inferior of the eighth nerve, shows clear and characteristic nerve-impulse responses to low-frequency vibrations of the substrate. These spike responses are accompanied, but in our opinion not caused, by the well-known Wever – Bray or 'cochlea' effects, which can always be picked up from the membranous wall of the exposed labyrinth during vibrational stimulation[3-7].

Apart from the lateral part of the sacculus macula, the sacculus was found to contain yet another highly sensitive vibration receptor. This is the macula neglecta, which is lodged in the medio-dorsal aspect of the sacculus and is innervated by a separate long nerve branch, containing relatively thick and therefore rapidly conducting fibres. The sensorium of the macula neglecta is small and not covered by a lime-encrusted otolith membrane. It lies opposite a large membrane-covered window in the dorsal wall of the cranium, which was first described by Scarpa[8] as fenestra ovalis, a term which assumes a new significance in the light of our experiments. This is, so far as we are aware, the first information about the hitherto completely unknown function of the macula neglecta of the vertebrate labyrinth.

The vibration response of the elasmobranch labyrinth is, however, not confined to the pars inferior. The utriculus macula is only partly covered by its lime-encrusted otolith membrane. An uncovered portion of it, the lacinia, extends upwards to the roof of the recessus utriculi. We were able to isolate the nerve twigs supplying the lacinia and obtain single-fibre spike responses to vibrational stimuli, which did not materially differ in range and sensitivity from the saccular responses. In contrast to the immediately adjacent parts of the otolith-bearing utriculus macula, the lacinia does not respond to positional changes.

The experiments described above thus bring to a conclusion the point by point oscillographic analysis of the function of all known sensoria of the elasmobranch labyrinth on the basis of accurately localized single-fibre responses.

This summer's work was again carried out at the Laboratory of the Marine Biological Association at Plymouth with the aid of a Royal Society grant from the Parliamentary Grant-in-aid of Scientific Investigations, while one of us (O. L.) was privileged to hold the Physiological Society's Table at that Laboratory. Our special thanks are due to the director and staff of the Laboratory for their most generous support in providing the considerable amounts of living material and technical research facilities without which the work would have been impossible.

OTTO LOWENSTEIN
T. D. M. ROBERTS

Zoology Department,
University of Glasgow.
Sept. 20.

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Delayed Neutrons

IN his paper "Mechanism of Nuclear Fission", Bohr[1] has explained the emission of delayed neutrons from certain members of the fission chains as due to the product being in a sufficiently highly excited state after the emission of β-particles. Of the other possibilities, production of delayed neutrons by (γ,*n*) reaction by the γ-rays after a β-disintegration, following Bohr, can be excluded simply because of the absence of sufficiently energetic γ-rays in fission chains reported in the Plutonium Project Report[2].

There is, however, another type of reaction, namely, electro-disintegration or (*e*,*n*) reaction, the possibility of which for the emission of delayed neutrons cannot be ruled out. Recent experiments of such reactions on heavy elements by Skaggs *et al.*[3] have shown that these reactions have cross-sections less than those for photo-disintegration only by a few hundred times, and the reports[4,5] of photo- and electro-disintegration of Be^9 show definitely that their threshold energies are exactly equal. These facts lead to the conclusion that photo- and electro-disintegrations are sister reactions differing in their cross-sections only. As a matter of fact, we may infer that delayed neutrons would be ejected, by a process similar to electro-disintegration, spontaneously in the nucleus itself, by those particles of unusually high energy emitted by certain members of the fission chains, for example, Kr^{87} and Xe^{137}. As a result, though the neutron emission is instantaneous, they will be emitted throughout the half-life of β-emission analogous to the case of the γ-emission which, though instantaneous, yet follows the preceding β-life. This has been found actually to be the case for Kr^{87} and Xe^{137}, where neutrons follow the β-life. Our inference is that the high-energy electrons are responsible for ejection of neutrons from Kr^{87} and Xe^{137} by electro-disintegration.

Recently, workers[6] in the Berkeley Laboratory have detected a delayed neutron emitter in the low mass-number region by bombardment of the oxygen nucleus with 195 MeV. deuterons. According to them, N^{17} changes to O^{17} by emission of β-rays, and this O^{17} in its turn ejects delayed neutrons. But from the point of view of electro-disintegration, we may infer that it is N^{16} which emits β-rays of $\sim 6{\cdot}2$ MeV. and goes over to O^{16}. The remaining nuclei of N^{16} are undergoing electro-disintegration simultaneously by these high-energy β-particles, and become N^{15} by emission of delayed neutrons, so that N^{16} and not O^{17} is the delayed neutron emitter. This assignment of N^{16} fits in exactly with the scheme of disintegration found in the case of Kr^{87} and Xe^{137}, whereby the nuclei of the same element emit β-radiation and neutrons simultaneously.

S. DAS

Institute of Nuclear Physics,
92 Upper Circular Road,
Calcutta.

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Reduction of Dead Times in Geiger – Müller Counters

THE significance of the positive ion sheath, formed in the immediate vicinity of the wire in a Geiger – Müller counter during a discharge, has been discussed by the Montgomeries[1] and by Stever[2]. According to them, the positive ion sheath is directly responsible for the dead time occurring in the counter after each discharge; the dead time is identified with the time necessary for the sheath to move sufficiently far from the wire for the field to be restored to a value at which the next event can be detected. Following this, Simpson[3] and Hodson[4] investigated the possibility of reducing the dead time by bringing the ion sheath back to the central wire and collecting it there. For this purpose they employed circuits by means of which the wire potential could be switched about 100 volts negative with respect to the cathode for a few microseconds after each discharge. Dead times as low as 20–30 microsec. were obtained in this way.

A consideration of this problem suggested that the major part of the reduction in dead time achieved was not due to positive ion collection but to the localization of the ion sheath, which is thus prevented from spreading along the whole of the wire, leaving the remainder of the counter sensitive to further ionizing events. This possibility is consistent with the known spread velocity of the ion sheath[5–7] and with the estimated operating speed of the circuit.

In order to confirm this suggestion, and to show that it is not necessary to reverse the wire potential and resort to ion collection to obtain shorter dead times, a circuit has been used to reduce the wire potential to within 20–30 volts of that of the cathode for about 1 microsec. after each count. Pulses from a counter operated in this way have been observed on a triggered cathode ray oscillograph, and dead times of 3–4 microsec. have been obtained, the limit being imposed by the recovery time of the electronic circuit. The dead times in this case refer to the counter as a whole; individual parts of the counter involved in any one count may be insensitive for much longer periods.

Further confirmation has been obtained in an experiment using a brass-walled counter, 38 cm. long and 2 cm. in diameter, filled with 10 cm. pressure of argon and 1 cm. of alcohol. This counter was operated both with and without the switching circuit. Photo-multipliers (RCA 931 *A*), mounted opposite mica windows in the counter wall at each end of the tube, registered the counts occurring in these regions of the counter. A suitable counting-rate was obtained when beta-rays from P^{32} were passed into the counter, at right angles to the wire, through an aluminium window at one end.

	End near source (counts per min.)	End remote from source (counts per min.)
Normal operation	3614	3736
Counter operated with switching circuit	3526	42

The results quoted in the table are average values and have been corrected for the background. The first column gives the counting-rate registered by the photo-multiplier at the end of the counter near the source, while the second column shows the counting-rate at the other end. It is seen that when the circuit was operating, 99 per cent of the discharges did not reach the far end of the counter and were localized near the source end of the counter.

A similar experiment, performed with a collimated beam of gamma-rays and using a divided cathode counter, kindly lent by Dr. Craggs, has shown the same effect.

Circuits in which the wire voltage is reduced instead of being reversed have the great advantage that spurious counts are less likely to occur. This is so because, in the case of positive ion collection on the wire, there is a possibility of producing secondary electrons from the wire by the ionic bombardment[8] and subsequent formation of negative ions. An increase in the rate of spurious counts has indeed been observed when reversing circuits have been used under the same conditions.

Finally, it is suggested that the pulses from a photo-multiplier, used to detect the light produced during the formation of the ion sheath, might find applications where fast rise times are required. This possibility is being investigated.

B. COLLINGE

George Holt Physics Laboratory,
University of Liverpool.
June 17.

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Crystal Structure of *d*-Tartaric Acid

WE have been making a study of the crystal structure of *d*-tartaric acid by X-ray analysis. This is a classical substance which presents some little difficulty in complete analysis owing to its low symmetry and to the absence of a heavy or replaceable atom.

The unit cell dimensions obtained by us were in agreement with those reported by Astbury[1] and by Reis and Schneider[2], but the structure suggested by Astbury did not agree with our X-ray intensity data. We took sets of Weissenberg photographs about the three principal crystallographic axes, and calculated sections of the Patterson function at various *y*-levels. These sections enabled an approximate structure to be derived quite quickly. This structure gave fair intensity agreement of the (*hk*0), (*h*0*l*) and (0*kl*) planes, and permitted the evaluation of Fourier projections down the three axes. These projections are now being used to obtain more accurate values of the parameters.

A complete description of the structure is as follows: class, monoclinic sphenoidal; space group $P2_1$; cell dimensions, $a = 7{\cdot}73$, $b = 6{\cdot}05$, $c = 6{\cdot}18$ A., $\beta = 100^\circ\ 17'$, containing two molecules $C_4H_6O_6$; parameters in hundredths of cell edges (apart from a possible inversion through the origin):

	x	*y*	*z*		*x*	*y*	*z*
O_1	35	0	51				
O_4	43	0	99	C_2	30	99	28
O_5	61	99	31	C_3	45	1	19
O_7	31	41	26	C_6	20	21	17
O_9	94	8	17	C_8	3	22	26
O_{10}	98	40	34				

The molecule has essentially the same configuration as in Rochelle salt[3], and neighbouring molecules are held together by a system of hydrogen bonds. The structure is still in need of refinement, and it is hoped to publish later more accurate values of the parameters, together with fuller details of the work summarized above.

C. A. BEEVERS
F. STERN

Dewar Crystallographic Laboratory,
University of Edinburgh,
Edinburgh 9.
June 26.

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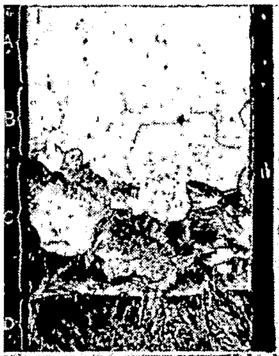
Intergranular Corrosion of Pure Aluminium in Relation to the Behaviour of Grain-Boundaries during Melting*

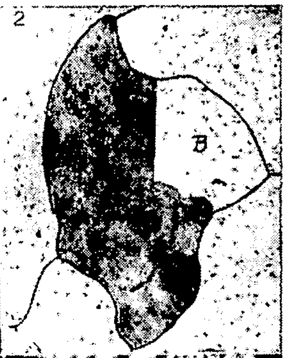
IN two previous papers[1,2] we showed in the case of pure aluminium recrystallized by the 'critical deformation' method that the rate of etching of the grain boundaries by hydrochloric acid was more influenced by the relative orientations of adjoining crystals than by impurities in the metal itself. Thus the grain boundaries in two aluminium specimens of 99·99 and 99·998 per cent purity were corroded at the same rate in the case of crystals oriented at random, whereas the boundaries separating crystals of nearly identical relative orientations, or straight twin boundaries[2], were not corroded at all, regardless of the duration of etching and the concentration of the reagent. We have already reported a similar effect[3] when studying the micrographic etching of boundary lines in high-purity aluminium.

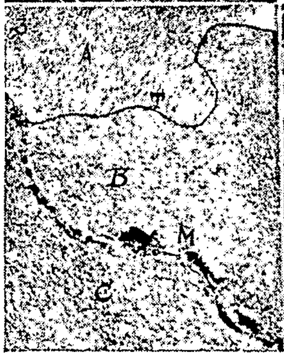
In order to compare the crystal boundaries obtained by recrystallization in the solid state with those obtained by solidification, we have been led to a careful study of the melting process itself. Chalmers[4] showed that the grain boundaries of high-purity tin had a melting temperature lower than that usually accepted for tin in the mass. We have now observed a similar effect in the case of high-purity aluminium by employing a simple device which was used by one of us[5] in the study of supercooled aluminium.

* Translation by Dr. N. Stuart.

A rectangular piece of metal, 1 mm. thick and 10 mm. × 130 mm. surface, was heated on a perfectly horizontal kaolin block inside a furnace permitting of a temperature gradient of 10° between the ends of the sample, so that one end may be molten while the other remains solid. If the metal is previously polished electrolytically, a zone may easily be observed (Fig. 1) as hollow lines where only grain boundaries are molten. The twin boundaries remain unaltered, however, thus giving evidence of a melting temperature nearly or quite equal to that of the crystals themselves (Fig. 2), and, as in the case of intergranular corrosion by hydrochloric acid, these also possess peculiar properties.







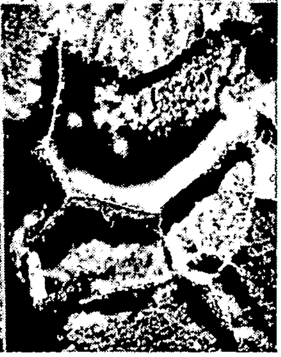


Fig. 1. Transition of melted to solid metal: *A*, entirely solid metal; *B*, boundaries only melted; *C*, partially melted crystals; *D*, entirely melted. (× 1)

Fig. 2. Unmelted twin boundary among melted ordinary boundaries. (× 5)

Fig. 3. Difference of intergranular corrosion between an unmelted boundary *T* and a melted boundary *M*. (× 5)

Fig. 4. Inverted corrosion by 30 per cent hydrochloric acid on pure aluminium heated for 15 hr. near the melting point. (× 5)

It might be thought that this characteristic behaviour of the boundaries during melting is related to their more or less disordered 'transition' structure, and that as a consequence of this their etching by hydrochloric acid would be different according to the relative orientations of adjacent crystals. Actually, as is shown in Fig. 3, the width of the intergranular groove due to etching in 30 per cent hydrochloric acid is very small and constant in the case of a sinuous twin boundary which had not been melted, whereas it is very large and irregular in the case of the molten boundary separating crystals of random orientation.

In conclusion, when the metal was heated for a long time (15 hr.) near the melting point, we observed, in certain cases, an inversion of the corrosion; for example, hydrochloric acid only dissolved the bulk of the crystals, leaving their boundaries uncorroded as a very thin surviving partition (Fig. 4). We intend to investigate how this inverted corrosion occurs.

G. Chaudron
P. Lacombe
N. Yannaquis

Laboratoire de Vitry,
Centre National de la Récherche Scientifique,
Vitry (Seine), France.

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A New Carbide in Chromium Steels

In the course of X-ray investigations on the carbides formed in chromium and tungsten steels, a phase was encountered of a crystal structure identical with that of austenite, which at first it was thought to be. In fact, it proved to be a true carbide of iron and chromium. Its carbon content of 9·4 weight per cent carbon is similar to that in Cr_7C_3 (9·1 per cent C), compared with the maximum carbon solubility in austenite of only 1·7 per cent (at the eutectic in the iron–carbon system, chromium only decreasing this value). The carbides known in plain chromium steels since Westgren's[1] early researches are $(Cr,Fe)_{23}C_6$, $(Fe,Cr)_3C$ and $(Cr,Fe)_7C_3$, all of which, as well as the present one, I found it possible to produce in the same steel by different heat-treatments. The carbide is believed to be of interest for its own sake, but also for more fundamental reasons given below.

The structure, as in austenite, is face-centred cubic, with interstitial carbon to approach the NaCl type of lattice possessed, for example, by titanium, vanadium and niobium carbides. The cube edge is $a_0 = 3\cdot6111$ kX. ± 0·0002, but variations in Cr : Fe ratio, and in carbon content, and therefore spacing, are liable to occur, and the lattice is probably a defect one. The carbide is non-magnetic.

The compound is stable only at high temperatures, but by quenching the steel it can readily be retained at room temperature in a metastable state. On annealing at 1,000° C. or at lower temperatures, true trigonal $(Cr,Fe)_7C_3$ is formed. The carbide was obtained by electrolytic extraction from a 6 per cent chromium, 1 per cent carbon steel, quenched from 1,250° C., the resulting phase-constitution being:

Extract	Bulk steel (before extraction)	
'Austenite'—large amount.	Martensite—large amount	(*A*)
$(Cr,Fe)_7C_3$—small amount.	'Austenite'—small amount.	

After a heat-treatment aimed at low-temperature equilibrium (anneal at 800° C., 3 hr., then 590° C., 3 hr.), the same steel showed, in contrast:

Extract	Bulk steel	
$(Cr,Fe)_7C_3$—almost pure	Ferrite—large amount.	(*B*)
Cementite—trace.	$(Cr,Fe)_7C_3$—medium amount	

The carbon analysis of extract *A* gave 9·4 per cent carbon, of *B*, 8·7 per cent carbon, that is, both closely surround the Cr_7C_3 value of 9·1 per cent carbon. (The slight deficiency in *B*, if significant, falls into line with the presence of cementite, while the excess in *A* suggests a stoichiometric formula for the cubic carbide, yet richer in carbon than *Me*$_7$C$_3$, such as *Me*$_2$C.) To differentiate the carbide from austenite it will here be referred to as 'ψ'.

From the point of view of structure chemistry, the present carbide may be shown to fall naturally into place. Petch[2] has shown that in austenite the carbon atoms occupy the octahedral positions; but, even for maximum saturation, only one among twelve of these sites is filled. On the other hand, within the group of carbides of NaCl type of structure, carbon atoms begin to be omitted from the ideal *Me*C lattice in a manner complementary to the austenite solid solutions, as becomes apparent when arranged according to the periodic table:

$$\begin{tikzcd}
\text{Group:} & \text{IV} & \text{V} & \text{VI} & \text{VII} & \text{VIII} \\
\text{Cubic carbides:} & \text{TiC} \arrow[r] & V_4C_3 \arrow[r] & \begin{array}{c}\psi\text{-phase}\\ (Cr,Fe)_7C_3 \text{ approx.}\end{array} \arrow[rr] \arrow[dr] & & \begin{array}{c}\text{austenite}\\ (Fe,Mn,Co,Ni)_nC\end{array} \\
 & \text{ZrC} \arrow[r] & Nb_4C_3 & & {[(Cr,Mn,Fe)_{23}C_6]} \arrow[ur] & \\
\text{Metal/carbon atom ratio:} & 1 & 1{\cdot}3 & 2{\cdot}3 & 3{\cdot}8 & \geqslant 12
\end{tikzcd}$$

In this series, chromium and manganese occupy transitional positions; of their carbides, one simulates the cubic, one the hexagonal, and one the orthorhombic symmetry of those of the surrounding elements (V_4C_3, Mo_2C and Fe_3C respectively). But $(Cr,Mn,Fe)_{23}C_6$, though belonging to the cubic class, does not actually adopt the NaCl structure, having a complex unit cell with 116 atoms. The ψ-phase thus bridges a gap between austenite and the rock-salt type of carbides, being isomorphous to both and consistently falling into the above sequence of metal/carbon ratios. In this light, austenite may, incidentally, be itself regarded as a 'carbide', being the ultimate member of the cubic group.

The substitution in ψ of chromium by manganese, to give an analogue to ψ in plain manganese steels, is highly probable, though its existence has not, to my knowledge, been reported and may well in the past have been obscured by the predominant austenite.

The following implications of the ψ-carbide are suggested.

(1) Its existence imposes caution in interpreting an apparent austenite as such, when occurring in a ferrite or martensite matrix. Spacing measurements or the microscope will not necessarily decide between austenite and ψ. In high-speed steels, for example, the 'persistent' portion of retained austenite which only repeated tempering can destroy is quite liable to involve carbon-enriched ψ, or a solid solution of its type.

(2) The carbide can be produced in chromium-bearing tool or magnet steels, where, in view of its structure and composition, it would tend to induce physical properties compromising between a hard carbide and the more ductile austenite.

(3) Being stable only at high temperatures (though metastable at lower ones) and tending to transform into either trigonal $(Cr,Fe)_7C_3$, $(Cr,Fe)_{23}C_6$ or cementite, or assemblies thereof, the carbide holds promise of showing precipitation hardening effects, that is, by one carbide nucleating within another.

(4) Since the lattice dimensions are favourable to the formation of high-temperature solid solutions with austenite in chromium–nickel heat-resisting and stainless steels (but only for certain composition ranges), its tendency to segregate from the matrix and at the same time itself to decompose is likely to influence creep-resistance and high-temperature strength. X-ray analysis conducted in these laboratories on heat-resisting steels actually reveals sequences of ostensible 'austenites' of varying lattice parameter, some of which probably represent ψ-phases intermediate in composition to the austenite base and the co-existing close-packed cubic TiC type carbides.

(5) Prepared synthetically, ψ is a carbide of possible interest in sintered hard-metal materials, particularly being isomorphous with titanium carbide as well as with metallic cobalt and, on structural grounds, probably also intersoluble with tungsten carbide.

An account of the work on carbides in steels, of which this forms part, will be published elsewhere. I wish to thank Mr. D. A. Oliver, director of research, B.S.A. Group of Companies, for his interest and encouragement, and Mr. E. Harpham for the carbide extractions.

H. J. GOLDSCHMIDT

B.S.A. Group Research Centre,
Sheffield, 11.
June 24.

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Photochemical Action of Ethylorthoformate

Ciamician and Silber[1] showed that when an ethyl alcohol solution of benzophenone is exposed to sunlight, the alcohol is oxidized to aldehyde and the ketone reduced to benzpinacol; in the place of ethyl alcohol, *iso*propyl alcohol has frequently been used[2].

$$2\,Ph_2C:O + CHMe_2OH \xrightarrow{\text{sunlight}} Ph_2COH.COHPh_2 + Me_2CO.$$

A large number of benzophenone derivatives react in the presence of alcohols as above[3].

In a number of cases, pinacols have frequently been obtained from diaryl ketones, as by-products, when the ketones were treated with aromatic hydrocarbons, for example, toluene[4], or ether, *iso*-amylether, acetal and dimethylether of glycerol[5], or with esters, such as ethyl acetate, ethyl malonate[5], or acids, for example, phenylacetic acid[6]. The action of aliphatic alcohols on quinones, for example, *p*-benzoquinone in sunlight, yields hydroquinone[7]. Benzil, in absolute ethyl alcohol, forms benzilbenzoin[8].

Recently, I have found that on exposure to sunlight of benzophenone, *p,p'*-ditolylketone, *p,p'*-dimethoxybenzophenone and *p,p'*-dichlorobenzophenone with ethylorthoformate in sealed 'Pyrex'-glass tubes, the corresponding pinacols, namely, benzpinacol, 4 : 4′ : 4″ : 4‴-tetramethyl-, 4 : 4′ : 4″ : 4‴-tetramethoxy- and 4 : 4′ : 4″ : 4‴-tetrachlorobenzpinacol were obtained; deoxybenzoin gave a deoxybenzoin-pinacol, whereas benzil yielded benzilbenzoin. On the other hand, the action of ethylorthoformate on *p*-benzoquinone, toluquinone, chloranil and phenanthraquinone, yielded hydroquinone, toluhydroquinone, tetrachlorohydroquinone and 9 : 10-dihydroxyphenanthrene respectively. Identification of the photo-products was carried out by melting point and mixed melting point determination with authentic specimens. In all these experiments, the fate of ethylorthoformate has not yet been investigated. Control experiments in the dark, but otherwise under identical conditions, showed no reaction.

The application of ethylorthoformate as a photochemical reducing agent in sunlight is still under investigation.

AHMED MUSTAFA

Chemistry Department,
Faculty of Science,
Fouad I University,
Abbassia, Cairo.
May 28.

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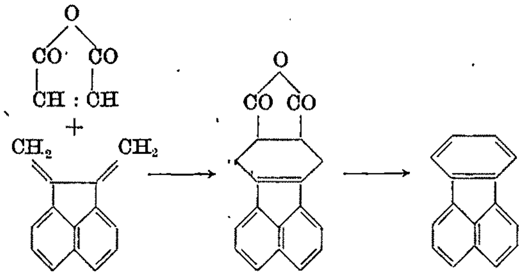
Fluoranthene Syntheses

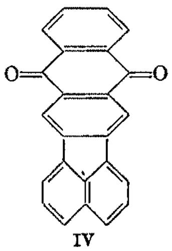
THE recent communication by Bergmann[1] on the formation of fluoranthene from acenaphthylene and butadiene prompts us to report briefly two somewhat similar syntheses of the hydrocarbon which have been developed in our laboratories.

trans-9 : 10-Dimethylacenaphthene-9 : 10-diol[2] when heated with acetic anhydride and maleic anhydride readily gives 10 : 11 : 12 : 13-tetrahydrofluoranthene-11 : 12-dicarboxylic acid anhydride (II), presumably by formation of the intermediate 9 : 10-dimethyleneacenaphthene (I)[3]. Dehydrogenation and decarboxylation of the product yield fluoranthene (III).

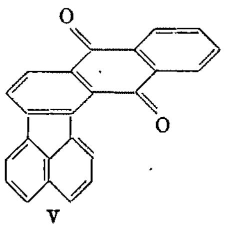


I II III

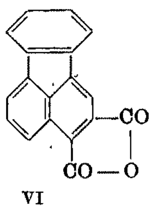
It is obvious that, by the use of substituted acenaphthenes or acenaphthenediols and replacement of the maleic anhydride by other ethylenic components, substituted fluoranthenes of known structure can be obtained. For example, substitution of maleic anhydride by α-naphthoquinone in the above reaction gives a quinone, melting point higher than 300°, which must have structure IV. The compound prepared by another method and regarded as having this structure[4] must be the isomeric quinone with formula V.



IV



V



VI

9-Methylfluorenol is known to undergo dehydration to the unstable 9-methylenefluorene[5]. By heating the carbinol with acetic anhydride and maleic anhydride, the intermediate methylene compound gives fluoranthene-3 : 4-dicarboxylic acid anhydride (VI), one of the nuclear double bonds being sufficiently reactive to participate in the Diels – Alder reaction. Decarboxylation gives fluoranthene (III). The reaction does not take place so readily as in the first method, but the structures of the products are unambiguously established.

Details of these and related experiments will be published elsewhere.

NEIL CAMPBELL
R. S. GOW
H. WANG

Chemistry Department,
University of Edinburgh.
June 11.

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Sulphur-containing Steroid Derivatives

PREVIOUS communications[1,2] have recorded the synthesis of antibacterial compounds derived from bile acids and sterols which contained basic groups, such as the amino-, amidino- and guanido-groups. In general, these derivatives were bacteriostatic for Gram-positive bacteria, but had little activity against Gram-negative organisms. Whereas surface tension measurements seemed to reveal a relationship between the bacteriostatic and surface activities of the bile acids and their anionic derivatives[3], no such relationship was apparent in the properties of a series of the basic steroid compounds[4]. In an extension of these studies, we have synthesized and investigated several water-soluble, sulphur-containing, steroid derivatives.

A series of mercaptals has been obtained by the condensation of thioglycollic acid with various keto-derivatives of steroids, a reaction which occurs without a catalyst and appears to be specific for a keto group at position 3. For example, 3 : 7 : 12-triketocholanic acid yielded 3 : 3-di-(carboxymethylmercapto)-7 : 12-diketocholanic acid, m.p. 203°, $[\alpha]_D^{24°} + 55\cdot0°$; (trimethyl ester : m.p. 78°, $[\alpha]_D^{17\cdot5°} + 51\cdot3°$); 3-keto-7 : 12-dihydroxycholanic acid gave 3 : 3-di-(carboxymethylmercapto) - 7 : 12-dihydroxycholanic acid, m.p. 141°, $[\alpha]_D^{20°} + 35\cdot7°$; and Δ^4-cholesten-3-one afforded 3 : 3-di-(carboxymethylmercapto)-Δ^4-cholestene, m.p. 122–124°, $[\alpha]_D^{18°} + 108°$. 3 : 3-Dithiophenyl-7 : 12-diketocholanic acid was derived from the condensation of thiophenol with 3 : 7 : 12-triketocholanic acid by a modification of the method of Mylius[5]. In a similar manner, 3 : 3-di(N-acetyl-*p*-aminothiophenyl)-7 : 12-diketocholanic acid : m.p. 165°, $[\alpha]_D^{18°} + 13\cdot0°$, was obtained by the condensation of N-acetyl-*p*-aminothiophenol with 3 : 7 : 12-triketocholanic acid. The monobasic, sulphur-containing acid, 3-carboxymethylmercapto-Δ^5-cholestene, m.p. 145°, $[\alpha]_D^{21°} - 34\cdot2°$, was obtained by the reaction of thiocholesterol with monochloroacetic acid.

Treatment of the sodio-derivative of thiocholesterol with methyl iodide afforded the methyl thioether, m.p. 141°, $[\alpha]_D^{18°} - 24\cdot6°$, which gave, upon further treatment with methyl iodide, Δ^5-cholestene-3-

dimethyl sulphonium iodide, m.p. 165°, $[\alpha]_D^{19°}$ $-27 \cdot 7°$. This basic derivative was water-soluble, and its antibacterial activity against *Staph. aureus* was among the highest yet reported for a steroid derivative. A more detailed account of these and related studies will be published elsewhere[6].

An indication of the bacteriostatic activity shown by the new compounds against *Staph. aureus* is shown by the data below. The figures in the second column refer to the limiting dilution bacteriostatic for *Staph. aureus*, tested for 24 hours at 37° C.

3 : 3-Di(carboxymethylmercapto) 7 : 12-dihydroxycholanic acid	1 : 4,000
3 : 3-Carboxymethylmercapto-Δ^5-cholestene	1 : 2,500
3 : 3-Di(N-acetyl-*p*-aminothiophenyl)-7 : 12-diketocholanic acid	1 : 10,000
Δ^5-Cholestene-3-dimethyl sulphonium iodide	1 : 20,000

A. S. JONES
F. SMITH
M. WEBB

Chemistry Department,
University,
Edgbaston, Birmingham, 15.

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Construction of Troughs for Use in Chromatography Tanks

PREVIOUS workers[1-3] have described methods for the construction of troughs for use in chromatography. In this laboratory, a simple method of making troughs has been evolved which does not require any special apparatus or skill. The finished trough, owing to the uneven edge of the glass, does not require a glass rod or strip to hold the papers in place.

The materials required are 'Pyrex' or other similar glass tubing of the required bore (1–1½ in.), a gas-air blow-pipe and a 6-in. file with pointed tang. Any type of file or similar instrument will do, providing that the tang is about 2 in. long and the blade big enough to hold in the hand. The selected length of tubing is held securely on an asbestos-topped bench by an assistant. The operator warms about 4–6 in. of the end with a brush flame, and then, using a small intense flame, heats an area about ½ in. square until soft, at which stage the file tang is pushed in and the glass pulled out towards the operator. The flame is brought backwards about ½ in. and the above repeated until a slit 4–5 in. long has been produced: the ragged edges are now heated and smoothed back with the file, and the whole annealed with a brush flame. A further 4–5 in. is now done and the above repeated until a slot of the required length has been obtained. The ends of the tube are left open until the slot is finished, as this allows the flame to pass down and anneal the glass.

The trough is closed at each end by drawing out the tubing, and is adjusted in length by pressing the still hot ends on to an asbestos sheet. If a trough should fracture during manufacture or be accidentally broken, the pieces may be sealed at the ends and used in single-phase tanks. In this laboratory, two people, both unfamiliar with glass-blowin technique, can produce a 36-in. trough in half an hour

H. F. ATKINSON

Department of Prosthetics,
University of Manchester.
Oct. 1.

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[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, 38 224 (1944).

[2] Longenecker, W. H., *Science*, **107**, 23 (1948).

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Origin of Fluctuating Galactic Noise

SINCE the discovery of discrete sources of radio radiation in the Milky Way, special attention ha been given to the rapid fluctuations shown by som of these. It seemed possible that these could be o the same kind as the 'bursts', occurring in the sola radiation of radio-frequency.

Ryle and Smith, studying the source in Cassiopeia at 80 Mc./s., made the very interesting observation that the variable component is probably not circularly polarized, and they therefore conclude that its origin must be different from that occurring near sunspots[1]

I should like to point out that at least three components of the solar radio-radiation should be distinguished: (1) the radiation of the quiet sun (2) the radiation of the disturbed sun, varying only slowly and depending on the number of spots; (3) the bursts. Component (2) shows circular polarization *but the bursts do not.* This seems to be well established by the observations of Payne-Scott, Yabsley and Bolton[2], at frequencies of 60 and 100 Mc./s.

Even if their result should not be general, it is clear that the random polarization of the fluctuation in Cassiopeia gives no evidence against an origin similar to that of the solar bursts. It therefore remains possible that these fluctuations are produced in individual stars. That they could be analogous to the disturbed solar radiation was already very improbable owing to the rapidity of the fluctuations and is entirely disproved now.

M. MINNAERT

Sterrewacht "Sonnenborgh",
Utrecht. Sept. 30.

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[1] Ryle and Smith, *Nature*, **162**, 462 (1948).

[2] Payne-Scott, Yabsley and Bolton, *Nature*, **160**, 257 (1947).

PROF. MINNAERT has pointed out the distinction between the three components of solar radiation. We would like to make it clear that the primary objec of the experiment described in our previous communication[1] was to investigate the origin of the *steady* component of the radiation from the two intense galactic sources. The results which we obtained suggested that the steady component is produced by a mechanism similar to that of the 'thermal' radiation of the quiet sun.

The additional evidence, that the variable component appears to be unpolarized, has suggested to Prof. Minnaert that this component is analogous to solar 'outbursts'. We would agree that such a mechanism may be responsible, although we do not feel satisfied that there is sufficient evidence for the conclusion that solar 'outbursts' are unpolarized.

M. RYLE
F. G. SMITH

Cavendish Laboratory,
Cambridge.

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[1] Ryle and Smith, *Nature*, **162**, 462 (1948).

A TRAVELLING-WAVE LINEAR ACCELERATOR FOR 4-MeV. ELECTRONS

By D. W. FRY, R. B. R.-S.-HARVIE, L. B. MULLETT and W. WALKINSHAW
Atomic Energy Research Establishment, Harwell

THE basic principles of this type of accelerator and the details of a first model producing 0·5-MeV. electrons have already been described in *Nature*[1]. The accelerator here described follows the same general design, and as the phase velocity approaches the velocity of light the ratio of the inner radius of the corrugated guide to the air wavelength tends towards the same limit, namely, 0·2. The length has been increased to two metres with a radio-frequency power of 2·0 megawatts so as to accelerate electrons to the region of 4 MeV.

The corrugated wave-guide was designed to accept 45-keV. electrons from the gun and to bunch them about a stable phase position 45° in front of the point of maximum accelerating field, when the radio-frequency power is 2·0 MW. In the first 40 cm. of guide, the phase velocity was designed to be greater than the velocity of the stable electron, and such that the centre of the bunch moves from 45° to 35° as the phase oscillations die away. The accelerating field experienced by the stable electron increases from 17·5 kV./cm. to 20·5 kV./cm. (the peak field being 25 kV./cm. for 2·0 MW. of radio-frequency power). At 40 cm. the phase velocity was reduced to that of the stable electron and the phase angle maintained at 35° for the remainder of the two metres[2]. The measured phase error for the full two metres of corrugated wave-guide was found to be only 18° in 22 wave-lengths. The overall loss, including the improved form of feeds from rectangular to corrugated wave-guide, was 2·5 db.—hence the accelerator is still short of the efficient length[3,4].

The completed equipment, Figs. 1 and 2, resembles the first accelerator and has, in addition, a mismatch unit and phase shifter in the input rectangular wave-guide in order to pull the magnetron frequency, and an arrangement for automatically sweeping the magnetic field of the spectrometer in order to present a spectrum of output current versus energy directly on a cathode ray tube with a long afterglow.

The accelerator was first operated in February 1948. X-ray output was obtained immediately, at an energy between 3 and 5 MeV. (from lead absorption measurements). The energy was confirmed as being 4 MeV. with a simple form of spectrometer. The pulse of 4-MeV. electrons observed through the spectrometer was extremely narrow for low radio-frequency powers and was confined to the beginning of the 2-microsec. radio-frequency pulse. For larger radio-frequency powers the remainder of the pulse appeared at a somewhat lower energy. A small output was also obtained at about 1 MeV., the precise quantity and energy varying greatly with the general setting of the various controls and in particular the currents in the focusing coils. Under normal optimum conditions for 4 MeV., the 1-MeV. output was only a few per cent of the total.

Great difficulty was experienced in trying to measure directly the electron currents falling on the first collimating slit of the spectrometer, due to the large quantities of gas liberated by the radio-frequency power with the accompanying ionization effects. The beam was therefore allowed to pass into air through a copper window 0·005 in. in thickness (later replaced by the same thickness of aluminium). A lead target ⅛ in. thick was then used and a maximum X-ray yield of 3 roentgens per minute at a metre was obtained (this being limited by the maximum safe emission from the 0·2-mm. tungsten filament then in use). According to conversion figures then available, the mean current at 4 MeV. was computed as ¾ microamp. A direct measurement of the electron current falling on the lead target gave the considerably larger result of 3 microamp. The radio-frequency duty cycle was 1 part in 10,000 throughout (2-microsec. pulses—50 c./s.), giving a peak current of 7·5 milliamp. for a mean current of ¾ microamp. For a mean input power of 200 watts (2-MW. peak) the energy in the 4-MeV. beam was of the order of 3 watts; this was considered to constitute no appreciable loading during the measurements taken with the automatic spectrometer.

Since there was evidence that the beam was somewhat off the axis of the corrugated guide, the beam position and size were investigated with a fluorescent screen (willemite on mica) and a periscope system. The effect of the various focusing devices was readily

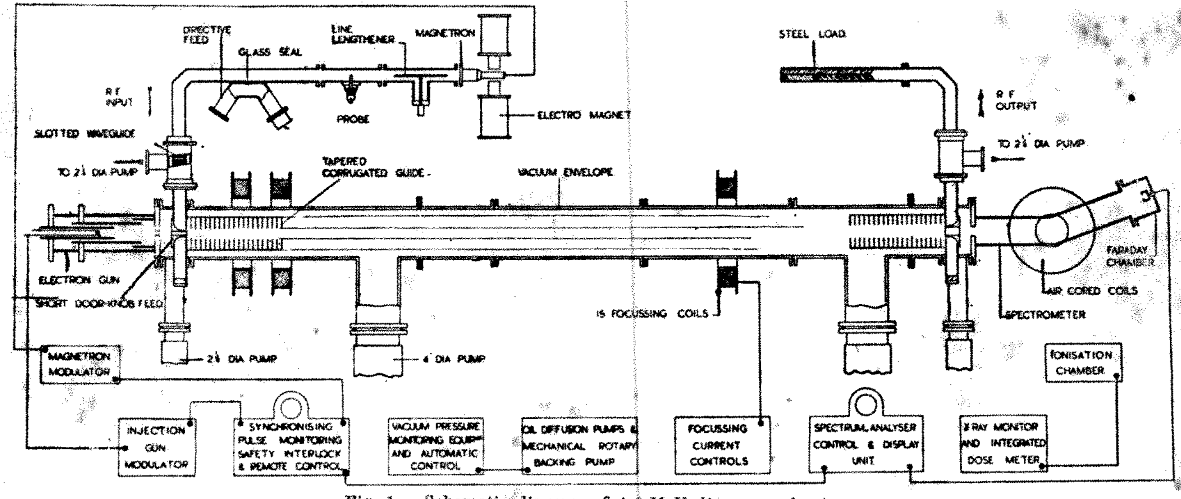

Fig. 1. Schematic diagram of 4·0-MeV. linear accelerator

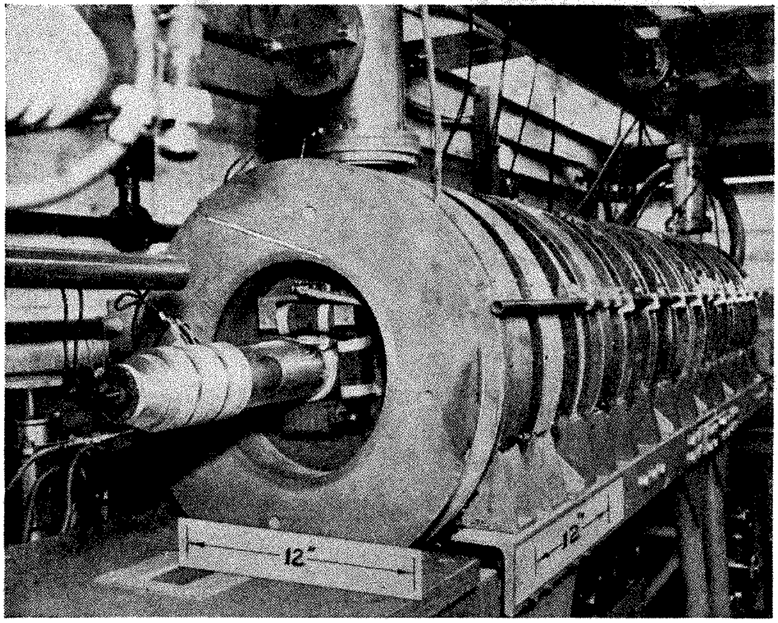

Fig. 2. Photograph of 4·0-MeV. linear accelerator, from gun end

observable. Under optimum conditions the spot size was certainly less than 1 cm. in diameter and probably of the order of 7 mm. No visible change occurred when a 2-mm. aluminium filter for 1-MeV. electrons was inserted. The spot was certainly off centre and could not be moved by varying the angle of injection of the 45-keV. electrons from the gun. Correction was eventually made with a small vertical magnetic field about 50 cm. down the accelerator.

A systematic investigation was then carried out using the automatic spectrometer for varying radio-frequency powers over a considerable range of radio-frequencies. A few energy spectra (Figs. 3 and 4) are given to illustrate the various phenomena observed. At the same time, X-ray measurements were taken as a rough indication of the number of accelerated electrons.

The design frequency was chosen to be 2997·8 Mc./s. ($\lambda = 10{\cdot}00$ cm.). Allowing for the measured phase discrepancy in the corrugated guide, the working frequency should be 2998·1 Mc./s. At the lower frequencies the stable phase position should move towards the peak of the wave as the electrons move along the accelerator, and eventually when the peak is reached there will be no stable position. This was observed to happen around 2995·5 Mc./s.—there being a very small output with an energy in the region of 3·6 MeV. for a frequency of 2995·6 Mc./s. At 2996·6 Mc./s. the spectrum was observable for a radio-frequency power equal to or greater than 1·9 MW. At 1·9 MW. (Fig. 3*a*) the spectrum had two distinct lobes which occurred at widely different energies. The output pulse, viewed on a time instead of an energy scale, consisted of a short spike (about ¼ microsec.) occurring at the front of the 2-microsec. pulse, and then the remainder of the pulse was not seriously broken up. This spike always provided the higher-energy component. As the radio-frequency power was increased, the total output current invariably rose and the spike or higher-energy component was drastically reduced. The presence of the spike is not understood, and it cannot be correlated with the frequency-time spectrum of the radio-frequency pulse, since it occurred for any radio-frequency spectrum provided that radio-frequency power and frequency were sufficiently low. In some cases it was interesting to note that the relative amplitudes of the higher- and lower-energy lobes could be altered considerably by varying the amount of external focusing. As the frequency was increased, the high-energy spike became almost unobservable except at the very lowest radio-frequency powers, and at 2998–2999 Mc./s. the width of the spectrum between half-amplitude points could be reduced to the order of 0·3 MeV. (Fig. 3*b*). It was suspected that some of this width was still due, however, to time modulation during the 2-microsec. pulse. At still higher frequencies the high-energy spike appeared again at the higher radio-frequency powers, together with a general broadening of the half-amplitude width.

The variation of energy of the spectrum peak with frequency for 2·0 MW. of radio-frequency power is shown in Fig. 4. It is evident that the accelerator functions in a satisfactory manner over a range of about 3 Mc./s. and is generally at its best at approximately 2998 Mc./s.

Having chosen a satisfactory working frequency (2998·8 Mc./s.) with 2·25 MW. of radio-frequency power, the effect of varying the gun voltage was investigated. There was a distinct threshold at 17·5 kV. and a steady rise in current output from this point upwards. The energy of the peak in the spectrum was about 4·5 MeV. at the threshold and

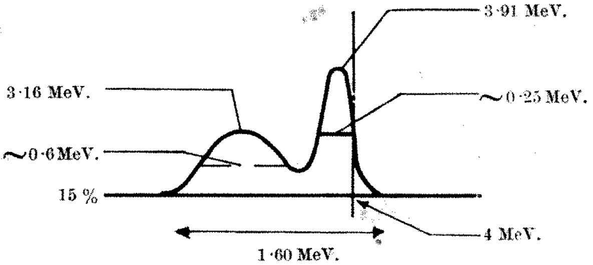

Fig. 3*a*. Radio-frequency 2996·6 Mc./s.; radio-frequency power, 1·9 MW.; ion chamber, 0·18 (full scale, 1·0)

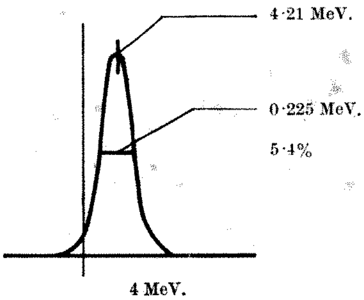

Fig. 3*b*. Radio-frequency, 2998·2 Mc./s.; radio-frequency power, 2·2 MW.; ion chamber, 0·36

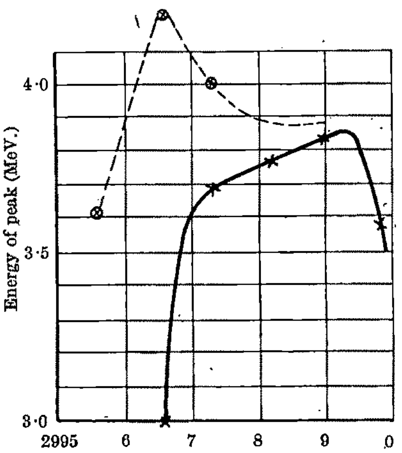

Fig. 4. Variation of the energy of spectrum peak with R.F. frequency. ⊕, high *E* spike

fell steadily to 3·85 MeV. at a gun voltage of 45 kV. The half-amplitude width of the spectrum increased rapidly, being 0·27 MeV. at 30 kV. and 0·42 MeV. at 40 kV. This behaviour was identical with that of the shorter 0·5-MeV. accelerator and can be explained in precisely the same manner. It was significant, however, that with the longer length of guide the energy variation was not so pronounced, although even in this case electrons at low injection voltages being picked up near the peak of the wave were still moving relatively slowly down to the true stable phase position.

Using the optimum conditions so far determined, and increasing the injected current by increasing the gun filament from 0·2 mm. tungsten to 0·3 and then 0·4 mm., the X-ray yield using a lead target ⅛ in. thick (and a 2-mm. lead filter for soft radiation) has been increased to 30 roentgens per minute at a metre at 50 c./s. recurrence-rate. By increasing the recurrence-rate the output has been scaled up to 66 r./min. at 100 c./s. and 132 r./min. at 200 c./s. The maximum permissible recurrence-rate, determined by the magnetron, is 500 c./s., giving a potential X-ray yield of 300 r./min. The output reached a maximum with the 0·4-mm. tungsten current at 12·6 amp., and no further increase could be obtained by going up to 14·0 amp., which should represent an enormous increase in emission. It was evident from the fact that at 30 r./min. a hole was very soon burnt through the lead target (and at 132 r./min., even with a strong blast of air on the bombarded side, burn-out was quite common) that the mean power in the beam was quite large and easily measurable by calorimetry. (It is interesting to note that the hole burned in the target was invariably about 7 mm. in diameter.) A continuous-flow water calorimeter was therefore constructed consisting of a lead target ⅛ in. thick with a circulating water film 7 mm. in thickness on the bombarded side. A small spiral heater of diameter comparable with that of the beam was mounted in the water near the target spot on the lead. Direct comparisons could then be made of beam power and power required in the heater to produce the same temperature difference between inflow and outflow as indicated by a thermocouple system. In this way it was established that the mean power in the beam at 50 c./s. under conditions which gave an X-ray yield of 30 r./min. was almost exactly 60 watts, giving a mean current of 15 microamp. and a peak current of 150 milliamp. if the energy was taken to be 4 MeV. Hence the highest current which has so far been obtained is 60 microamp. with a possible maximum of 150 microamp. at 500 c./s., the highest magnetron recurrence-rate. The efficiency in terms of radio-frequency power being fed into the accelerator is 30 per cent, and since the radio-frequency losses in the system are normally 2·5 db., it is understandable that no further increase in efficiency is readily obtainable. It has also been observed, using the spectrometer again, that the width of the spectrum is generally unaffected by increased beam current, but the energy of the peak falls by about 250 keV.

Acknowledgment is made to the assistance given to this project by our colleagues. This work was carried out by the Electronics Group of the Atomic Energy Research Establishment, at the Telecommunications Research Establishment, Malvern, and acknowledgment is made to Sir John Cockcroft for permission to publish these results.

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[2] Walkinshaw, W., *Proc. Phys. Soc.*, **61** (Sept. 1948).
[3] Mullett, L. B., and Loach, B. G., *Proc. Phys. Soc.*, **61** (Sept. 1948).
[4] R.-S.-Harvie, R. B., *Proc. Phys. Soc.*, **61** (Sept. 1948).

SOUTH AFRICAN MUSEUMS

THE appointment of a commission to investigate and report upon the future policy of certain State-aided institutions in South Africa is the subject of an announcement by the Department of Education in the *Government Gazette* (*Pretoria*) of October 8, 1948. It is understood that State-aided institutions include museums, art galleries and zoological gardens. The members of the commission are Dr. P. J. du Toit (chairman), Dr. G. von Welfligh Eybers, Prof. J. J. Smith, Dr. S. H. Haughton and Dr. S. H. Skaife.

This announcement will be welcomed by South African museum directors generally, but it seems a pity that the scheme could not have been extended to embrace all museums in the Union, for all are faced with similar problems affecting adequate housing accommodation, up-to-date equipment, and staffs trained in modern museum methods and technique. Nevertheless, the present action is a step in the right direction, for the Government has now taken a lead which ultimately may influence all provincial and municipal museums, irrespective of whether they do or do not receive a Government grant.

Generally speaking, there is at the present time a considerable amount of room for the improvement of South African museums in relation to their appeal and use to the general public. Although in one or two of the larger institutions exhibition rooms have been improved by the introduction of the animal habitat group, dioramic backgrounds, and models, etc., museum exhibition in the Union on the whole lacks imaginative construction. In many cases the presentation of collections is along old and stereotyped lines; labelling is often poor and inadequate for purposes of sufficient instruction; related subjects are badly linked—or not linked at all; while some are so scantily treated as to be of little or no value in the museum concerned. Again, the special temporary exhibition of current or topical interest seems to find no place in South African museum administration; and lectures, informal talks, or classes upon subjects of particular interest in the museum do not seem to be a regular, or even frequent, feature of the work of the officials. Introductory series, so useful where the uninitiated and schools are concerned, are usually absent; and very rarely indeed, if at all, are collections used to illustrate or teach such matters as, say, the impact of geology upon the mining and building industries, upon road and railway construction, or upon water-supply, etc.; or again, the impact of biology upon medical and veterinary research, upon agriculture, horticulture, and matters of human health, and so on. The average archæological collection (and most South African museums are rich in this material) neither tells the 'story' of prehistoric man in South Africa nor illustrates archæological method. A great deal more, also, could be effected with the usually abundant collections of native material—in the more graphic portrayal of tribal customs, mode of life and social organisation, for example. The brilliant exhibit of life-like models of Bushmen (both male and female) in the South African Museum at Cape Town well illustrates the possibilities in this direction. These figures, set up in astonishingly realistic attitudes, wear Bushman clothing and carry Bushman weapons of the chase or war, and associated with them are Bushman domestic utensils. Cast from life, these 'living' records of a practically extinct people make the Cape Town Museum unique among all others in the Union.

With few exceptions, the congestion of the average South African museum exhibition-case leaves no room for the treatment of subjects in some of the ways suggested; but considerable improvement would be possible (even without building extensions) if a good half of some of the material exhibited were to be transferred behind the scenes—not to be lost or neglected, but to be suitably and systematically stored for the better use of the student and specialist worker. Several museums, in this way, could make room for better exhibition work in the public galleries.

Other matters which strike one as requiring consideration in the museums of the Union are appointments and retiring ages. At the present time some appointments seem to go to individuals who have already retired from some other walk of life. In the case of directorships or curatorships, especially, it is important that appointments should go to those who have had training and wide experience in museum work and methods, and who can put in a sufficient number of years of service before reaching retiring age. As yet, there seems to be no hard and fast rule as to the age at which a museum official should retire. It is clear, however, that this should be fixed in the interests of any progressive policy of work and service. New ministerial blood at prescribed intervals is a necessity to any institution the primary function of which is public service—and service suitable to the times.

There is, no doubt, a big future for South African museums; in a rapidly developing country they are a cultural necessity. South African museums have already carried out much useful work in scientific research, and vast fields for further study and collection lie before them. As has already been suggested, however, there is room for better work in their educational function, the function which, in the long run, will determine not only their use to the community, but, in addition, their status within it.

J. R. Harding

TWENTY-THIRD ANNUAL CONFERENCE OF ASLIB

During September 17–20, the twenty-third annual conference of Aslib was held at Ashorne Hill, near Leamington Spa. This Conference resumed, for the first time since 1938, Aslib's residential conferences, which, with the fast-expanding number of special librarians and information officers, are essential if the old and experienced members are to mix informally and discuss the difficulties of the younger and comparatively inexperienced information officers. Some idea of the extent to which this is necessary is given by the growth of Aslib's membership: 1,010 on June 30, 1948; 827 in 1947; and 712 in 1946. At the beginning of the War it was less than 300. Of the total, research associations and learned societies account for 33 per cent, industrial and commercial organisations 20 per cent, individuals 22 per cent, overseas members 17 per cent, and British Government Departments 8 per cent. These figures give some idea of the extent to which the information officer and special librarian have become essential members of any well-conducted, modern research establishment and progressive industrial concern.

The report by the director (Miss E. M. R. Ditmas) of the work of Aslib, 1947–48, pointed out that 'Aslib' is now a registered name, and since the amalgamation with the British Society for International Bibliography on January 1, 1948, no longer stands for "Association of Special Libraries and Information Bureaux". The amalgamation added a couple of score of members. The increased amount of work means that a series of afternoon meetings will be held between October 1948 and April 1949, besides the annual conference. Instead, therefore, of an annual publication of *Conference Proceedings*, there will be a new journal, *Aslib Proceedings*.

In March 1948 Aslib called the meeting which is now working towards an Institute of Recorded Sound; sixty students attended the Aslib Study Group in August 1947, and seventy in April 1948, and a memorandum on "Training of Information Officers" was drawn up by a Sub-Committee of the Education Committee; the Information and Library Section recorded 2,521 inquiries, had 66 requests for registered translators and supplied 2,275 items through the Documentary Reproduction Service. The Aslib library receives regularly more than 100 periodicals; but lack of suitable premises makes 52 Bloomsbury Street badly overcrowded. At the request of the Department of Scientific and Industrial Research, Aslib set up, in June 1947, its Committee on the Mechanized Distribution of Information to discuss the uses of mechanization in library and technical information work, and supplied a statement to the Royal Society's Conference. In December 1947 the Committee on the Format and Efficiency of Periodicals was set up.

Naturally, Aslib has taken much part in the documentation work of the British Standards Institution, the British National Committee on Documentation and many international and foreign organisations. Sir Richard Gregory was made an honorary member during the year.

Usually the annual conference of Aslib is organised almost as a symposium of papers on one or, perhaps, two subjects of universal interest. This year it was a miscellaneous collection dealing rather more with the existing problems in the fields of the information officer and special librarian than with the uttering of any startling ideas or announcements.

Saturday morning, September 18, opened with Dr. R. E. Priestley (vice-chancellor and principal of the University of Birmingham) in the chair. Mr. B. Fullman (British Non-Ferrous Research Association, chairman Aslib Education Committee) opened the proceedings on "The Training of the Information Officer", basing his arguments on a statement which had been circulated confidentially to Aslib members. "Information officers," he said, "are fashionable and no home is complete without them, and they are budgeted for as a matter of course." He urged that Aslib should consider issuing a diploma to ensure that organisations would, in the future, obtain properly qualified people. He emphasized how diverse, yet specialized, is the information officer's work compared with that of the librarian as normally considered. He endorsed a flexible arrangement with the Library Association, but emphasized that the scientific world needs information officers and special librarians who have first obtained a science degree.

Mr. J. S. P. Paton (Metropolitan-Vickers) discussed the questionable necessity for the prospective information officer to have to take the whole of the Library Association's course. He pointed out the need for such special requirements as languages, the ability to speak the language of scientific colleagues and for the necessity for good practical experience of research departments.

Mr. F. G. B. Hutchings (Leeds City librarian and chairman of the Education Committee, Library Association) endeavoured to minimize the difference between librarians and special librarians and information officers by emphasizing the amount of inquiry in public libraries and their closer association with local industrial and scientific organisations. He said that the new Library Association syllabus is "getting to be bibliographical rather than literary". Therefore, why a special Aslib diploma and course ?

The lively discussion from the floor emphasized that the industrial and research intelligence officer makes use of information besides collecting and collating, the necessity for the initial scientific training and the fact that ability in this field cannot always be assessed by examination, but is a natural aptitude. It resulted in the whole matter being referred back to the Aslib Council for further consideration after this preliminary airing of many views.

The Saturday afternoon session, under Dr. E. Marsden (New Zealand Scientific Liaison Office, London), was devoted to Prof. J. D. Bernal talking on "The Significance to Special Librarians and Information Officers of the Royal Society's Scientific Information Conference". He opened by stating, "it depends upon Aslib and Aslib members as to whether the resolutions of the Royal Society are implemented". He referred to Dr. D. J. Urquhart's "Survey of Scientific Reading Habits" and gave in some detail the figures and conclusions given in his own paper, "Preliminary Analysis of Pilot Questionnaire on the Use of Scientific Literature" at the Society's Conference. He raised again the necessity for reprints, or 'separates', and the necessity for the relinquishing of copyright by authors of papers, so that they may be freely reproduced from journals. He asked, "Is the liaison between user and the information officer sufficient ?" He mentioned the non-co-ordination between the libraries of scientific institutions in the Bloomsbury area, and how co-ordination had been achieved in his own subject of physics.

Mr. J. E. Cummins (Australian Scientific Research Liaison Office) sketched the library position in Australia, stressing the need for the librarian there to cease "to look upon himself as a keeper of books". Dr. S. R. Ranganathan (president of the Indian Library Association) said that "work in the library world is going on in a casual way without any planning", and called for a special study of 'librometry'. The need for proper co-ordination of abstracting and suggestions that abstracts be available before or as soon as a paper is ready to be read, and not after the now delayed publication, was mentioned in the discussion, in which a large number partook. It emphasized the difficulties and problems of getting the right information to the right person at the right time. The increasing need for this over the years was clearly recognized when Aslib was founded twenty-four years ago to start creating order out of confusion and to be the prime mover ever since.

Sunday morning, under the chairmanship of Mr. J. F. Stanley (British Standards Institution), opened with Mr. Eric Smythe (librarian and research officer of *Reynolds News*) discussing the organisation and working of a newspaper's press-cutting library and the mechanics of storage. He emphasized the speed and efficiency with which such a library should work, and that facts are wanted sometimes on immediate notice five minutes before going to press.

Sir Cuthbert Whitaker, in his fifty-fourth year of editorship of *Whitaker's Almanack*, gave a straightforward account of the "History and Compilation of *Whitaker's Almanack*". He mentioned how his father, the late Joseph Whitaker, while pacing up and down a garden path, in 1868, remembered the "Commonplace Book" he had compiled when conducting the correspondence columns of the *Gentleman's Magazine*. He thought its publication in an organised form, together with meteorological data, which Sir George Airey was delighted to supply, thus justifying the term 'almanack', would be welcomed by the public.

The first *Almanack* for 1869 appeared on December 10, 1868, and had 363 pages and an index of 1,100 entries. The 1948 edition has 1,092 pages and 35,000 references. The plan of the *Almanack* was so carefully designed by Joseph Whitaker that the main part of the work ever since has been "submitting proofs and reducing the exuberance of corrections".

With Dr. J. C. Withers (Shirley Institute) as chairman, Dr. Hugh Clegg (editor of the *British Medical Journal*) and Mr. R. Brightman (Imperial Chemical Industries, Ltd.) talked on "The Art and Technique of Book Reviewing". They both emphasized the importance of a review of a scientific or technical book giving "a clear account of what the book is about, indicating both the scope of the book, the scale on which the subject is treated, and the particular type of reader for whom it is intended". Dr. Clegg strongly advocated that all authoritative book reviews should be signed by the reviewer.

Sunday evening was devoted to a discussion on "Practical Applications of International Collaboration in Documentation", opened by Mr. E. J. Carter (head of the Library Section, Unesco), who said, "It is becoming clearer that documentation and library services are the very roots of international collaboration". It was essential to bring practical people together to collaborate and surmount language difficulties to give complete and efficient transmission of ideas. This means a properly organised and adequate secretariat. "Delegates to international conferences must have documents beforehand in their own language to be able to discuss them with their own people." This was strongly supported by Dr. Ranganathan, who pointed out that many conferences fail because of quite inadequate preliminary documentation. He also advocated that older delegates to conferences should be accompanied by a younger man, who would thus be properly experienced when it became his turn to lead. He emphasized how adequate documentation overcame language difficulties, while the use of a universal classification system, such as the U.D.C., prevented misunderstanding as to the precise definition of a subject. Dr. P. Bourgeois (director, Swiss National Library) pointed out that this was not generally being done, and instanced some recent international conferences, which had achieved little because of the paucity of their practical application of documentation.

Mr. A. B. Agard Evans (Ministry of Works Library) said that there were far too many international resolutions, and not enough practical activity. This was due, in some instances, to the lack of national collaboration first, and he directed attention to the fact that the building industry was one of the wealthiest in the world, yet it had little international collaboration.

In association with the conference, Aslib arranged an exhibition of representative bibliographies and abstracting journals. IVOR B. N. EVANS

INDIAN DAIRY SCIENCE

THE immense importance of a substantial increase in production and consumption of milk and milk products, both to the balance of Indian agriculture and in contributing protein, fat and minerals to the very largely cereal diet of the 320 ± 20 million inhabitants of present-day India is being increasingly appreciated in that country. For perhaps two decades, real efforts have been made to improve the dairy industry in India both as regards milk production (in which Mahatma Gandhi took a personal interest) and as regards milk distribution and manufacture. Progress, hindered by religious as well as economic obstacles, has, however, been rather disappointing.

This slow development has also been due, in no small part, to other causes—paucity of knowledge, the serious shortage of trained dairy husbandrymen and of satisfying opportunities for their activity, the acute lack of dairy scientists, technologists and engineers and the absence of more than a small handful of research workers in dairying. Research is clearly needed in two directions: first, the application to the severer climatic and other conditions of India of the knowledge already applied in the more progressive dairying countries in the temperate zones; and secondly, basic study of the nutrition, breeding and physiology of dairy stock in India and of the microbiology, biochemistry and engineering underlying modern dairying operations.

The recent formation of an Indian Dairy Science Association with similar objects to those of the Society of Dairy Technology in Great Britain, namely, the advancement of dairy science, the provision of opportunities for the exchange of knowledge and ideas, and the encouragement of scientific inquiry into problems arising in the industry, is a step in the right direction. The Association is fortunate in having Sir Datar Singh, the energetic chairman of the Indian Council of Agricultural Research, as its first president. The Association has just issued the first number of a new journal, the *Indian Journal of Dairy Science*, which is to appear quarterly under the editorship of the director of the Indian Dairy Research Institute at Bangalore, Dr. K. C. Sen (Indian Dairy Science Association, Hosur Road, Bangalore, India. 12 rupees per annum).

The present number contains six original articles dealing with aspects of milk production, control of milk keeping quality, milk composition, milk phosphatase, vegetable rennet and indigenous butter. While it would be unfair to apply too critical an eye to some of these early contributions, they are all of value, and one at least, by Krishnamurti and Subrahmanyan, is outstanding. A promising start has been made, and several in Britain who know at first hand of the immense difficulties which have still to be overcome before the mutually dependent partners, dairy science and the dairying industry, can flourish in India, will look forward with great interest to the future progress of this *Journal*.

H. D. KAY

FOREST POLICY IN UGANDA

A STATEMENT on the forest policy for Uganda was recently issued by His Excellency the Governor and published as a Supplement to the *Uganda Gazette* of June 15, 1948.

This statement is of interest as it is promulgated by the Governor himself. The main points are as follows: 1. (i) To reserve in perpetuity, for the benefit of the present inhabitants of Uganda and of posterity, sufficient land (either already forested or capable of afforestation) to maintain climatic conditions suitable for agriculture, to preserve water supplies, to provide forest produce for agricultural, industrial and domestic purposes, and to maintain soil stability in areas where the land is liable to deterioration if put to other uses. (ii) To manage this forest estate to obtain the best returns on its capital value and the expenses of management, in so far as such returns are consistent with the primary aims set out above. (iii) To foster, by education and propaganda, a real understanding among the people of Uganda of the value of forests to them and their descendants. (iv) To encourage and assist the practice of sound forestry by local authorities and private enterprise; and to educate selected Africans in technical forestry.

It is of interest to note that these points in forest policy were first laid down by the Secretary of State for India in London as far back as 1862. They have since been repeated by many governments in many parts of the world, but only rarely have been given practical effect.

The Governor continues: 2. To achieve the first objective of this four-point policy, namely, the creation of an adequate forest estate, the following guiding principles shall be observed: (i) The climatic and physical conditions of the country must be preserved and, if possible, bettered, by first, the reservation of suitable land, and secondly, the maintenance, improvement or re-establishment of vegetation on the most important catchment areas and on other strategic positions. (ii) The supply in perpetuity of the many forms of forest produce required satisfy the wants of the people of Uganda both w and in the future must be assured by the servation, preservation, development and manage- ent of the minimum area of forest land needed for is purpose.

3. It is accepted that the satisfaction of the needs the inhabitants of Uganda must take precedence ver purely financial considerations and the estab- hment of an export trade; and that only when ese needs have been satisfied can the aim of anagement be directed, in production reserves, to taining the greatest revenue compatible with a ntinuous yield, and to promoting an external trade timber and other forest produce.

The statement lays down some general conditions r the implementation of forest policy and the mediate steps to be taken to implement it. In e last paragraph it is said that in the opinion of e Government the primary tasks of the Forest epartment during this decade must be to complete e formation of the forest estate.

The Governor may be congratulated on having rmulated in his statement a true outline of what rest management plans for. In the first thirty ears after the formation of the Indian Forestry epartment in 1864, the formation of the forest tate had to a great extent been completed, it aving been laid down that this was the first object be attained. It is a pity that so many of the lonial forestry services did not undertake this dispensable work during the early years of their nbodiment.

INSTITUTION OF CIVIL ENGINEERS

AWARDS

THE following awards have been announced by the Council of the Institution of Civil Engineers r the session 1947–48:

James Alfred Ewing Medal for 1947: Sir John ockcroft (see *Nature*, April 17, p. 592).

Telford Premiums: B. D. Richards, for his paper n "Tidal Power: its Development and Utiliza- ion"; R. W. S. Thompson, for his paper on "The econstruction of Bamford Filters"; W. J. O. Scott, r his paper on "Roads and their Riding Qualities"; . F. J. Bradbeer and Prof. C. A. Hart, jointly for heir paper on "Photographic Surveying in Relation Road Engineering in Highly-developed Countries"; . V. Blumfield, for his paper on "The Development od Use of Barrel Vault Shell Concrete"; E. A. G. ohnson, for his paper on "Flooding in the Fens and emedial Measures Taken"; W. R. Greathead and . D. Hawkins, jointly for their paper on "First tages in the Construction of the Jan Smuts Airport, ohannesburg"; Dr. S. L. Bey, for his paper on Stresses and Temperature Effects in Dams, with articular Reference to Aswan Dam"; D. H. B. eynolds, for his paper on "The Movement of Water the Middle and Lower Chalk of the River Dour atchment"; F. R. Melville and R. le Geyt Hether- gton, jointly for their paper on "The Pegu Yomas cheme for the Water-Supply of Rangoon"; B. J. horpe, for his paper on "High-Altitude Test Plant: ew Ancillary Services for Testing Engines, Car- urettors, and Aircraft Components under High- ltitude Conditions".

Coopers Hill War Memorial Prize: Prof. A. L. L. Baker, for his paper on "The Heysham Jetty".

Webb Prize: C. E. Dunton and K. Brinsmead, jointly for their paper on "Design, Installation and Maintenance of Long Welded Rails".

Indian Premium: C. G. Sexton, for his paper on "Pre-stressed Reinforced-Concrete Hangar at the Civil Airport of Karachi".

James Prescott Joule Medal and *Miller Prize:* S. Rodin, for his paper on "Site Exploration".

James Forrest Medal and a *Miller Prize:* D. M. Beaton, for his paper on "Coast Protection and Land Reclamation in Holland".

Miller Prizes: S. B. Hart, for his paper on "The Clifton Suspension Bridge"; T. K. George and K. Balasubrahmanyam, jointly for their paper on "The Rational Design of Settlement Tanks"; J. R. Smith, for his paper on "Surveying for Tunnels"; A. R. Goode, for his paper on "Gas Turbines as a Means of Propulsion"; J. D. Harris, for his paper on "Pre-stressed Concrete"; E. Lightfoot, for his paper on "The Open Frame Girder and its Analysis"; R. Franklin, for his paper on "Notes on Surveying from Air Photographs".

Institution Medal and Premium of £10: P. G. Bedson, for his paper on "The Design of Buttress Dams".

Charles Hawksley Prize: J. Black, for his design of a railway station, and a special prize of £50 to J. R. Stanley, for his design of a water tower.

Bayliss Prize: W. E. A. Skinner.

Special thanks of the Institution are accorded to H. J. B. Manzoni, for his paper on "Winter Conditions and the Civil Engineer: Municipal Engineering"; and to W. K. Wallace, for his paper on "Winter Conditions and the Civil Engineer: Railways", who, as members of Council were not eligible for awards.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 29

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. E. D. Edwards: "Education for International Understanding—China".*

ENGINEERS STUDY GROUP ON ECONOMICS (at the Central Hall, Westminster, London, S.W.1), at 7 p.m.—Sir John Boyd Orr, F.R.S.: "An Approach to World Government".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the WOOLWICH POLYTECHNIC CHEMICAL SOCIETY, at Woolwich Polytechnic, Woolwich, London, S.E.18), at 7.30 p.m.—Mr. M. S. C. Birbeck: "The Electron Microscope".

Tuesday, November 30

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. E. M. Barlow: "Modern Electric Lighting Technique", I.*

(Second Lecture will be given on Thursday, December 2.)

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Mr. Lionel Curtis: "The Atomic Age—The Political Repercussions".*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 6 p.m.—Annual General Meeting; Mr. R. Donaldson: "The Measurement of Colour".

ASSOCIATION OF BRITISH SCIENCE WRITERS (at Shell Film Theatre, Shell-Mex House, Strand, London, W.C.2), at 7 p.m.—Lecture on "The Scientific Film".

INSTITUTION OF THE RUBBER INDUSTRY (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Mr. T. R. Dawson: "Lignin".

Wednesday, December 1

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. J. W. Trevan: "Statistics from the Standpoint of a Pharmacologist".* (Further lecture on December 8.)

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. R. Coursey: "Fixed Resistors for use in Communication Equipment, with special reference to 'High Stability' Resistors".

Linnean Society of London (in conjunction with the Systematics Association, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Demonstration: "Taxonomy up to and including Linnæus".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. F. Fancutt and Mr. J. C. Hudson: "The Protection of Iron and Steel against Corrosion".

Institute of Welding, Manchester and District Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. C. Schofield: "Fabrication of Resistance Welding".

Society of Public Analysts and other Analytical Chemists (joint meeting with the Food Group of the Society of Chemical Industry, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 7 p.m.—Discussion on "Food Standards and Labelling".

Society of Chemical Industry, Plastics Group (joint meeting with the Northern Ireland Section, at the Royal Belfast Academic Institution, Belfast), at 7.30 p.m.—Dr. R. G. R. Bacon: "Some Chemical Aspects of Plastics Manufacture".

Thursday, December 2

Chadwick Public Lecture (at St. Mary's Hospital Medical School, Norfolk Place, Praed Street, London, W.2), at 4.30 p.m.—Dr. C. Seeley: "Preventive Medicine and Clinical Medicine in relation to the Public Health" (Malcolm Morris Memorial Lecture).*

Chemical Society, Liverpool Section (joint meeting with the Local Sections of the British Association of Chemists, the Royal Institute of Chemistry and the Society of Chemical Industry, at the University, Liverpool), at 4.30 p.m.—Sir John Lennard-Jones, F.R.S.: "Modern Theories of Chemical Valency".

Institution of Mining and Metallurgy (at Film House, Wardour Street, London, W.1), at 5 p.m.—Film on "Atomic Physics".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. G. Milnes: "Magnetic Amplifiers"; Mr. H. M. Gale and Mr. P. D. Atkinson: "The Theory and Design of Magnetic Amplifiers".

University of London (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. E. D. Hughes: "The Kinetics and Mechanism of Reactions" (Inaugural Lecture).*

Chemical Society, Sheffield Section (joint meeting with the Local Section of the Royal Institute of Chemistry and the Sheffield University Chemical Society, in the Chemistry Department Lecture Theatre, the University, Sheffield), at 6 p.m.—Sir Wallace Akers: "Problems in the Production of Useful Power from Nuclear Energy".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. G. R. Edwards: "Problems in the Development of a New Aeroplane".

Leeds Metallurgical Society (in the Chemistry Department, The University, Leeds), at 7 p.m.—Dr. J. Ward: "Recent Developments in Photoelasticity".

Royal Institute of Chemistry (at Acton Technical College, High Street, Acton, London, W.3), at 7.30 p.m.—Dr. N. Booth: "Careers for Chemists".

Society of Chemical Industry, Chemical Engineering Group (joint meeting with the Bristol Section of the Society of Chemical Industry, in the Chemistry Department, the University, Bristol), at 7 p.m.—Dr. Katherine Williams: "The Physiological Effects of the Products of Nuclear Fission".

Friday, December 3

Chemical Society, Glasgow Section (in the Royal Technical College, Glasgow), at 2.15 p.m.—Scientific Papers.

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. H. R. Ing: "The Pharmacology of Homologous Series".*

Geologists' Association (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. H. H. Read, F.R.S.: "International Geological Congress, London, 1948".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. F. E. Zeuner: "Time in Evolution".

Saturday, December 4

Biochemical Society (at the Middlesex Hospital Medical School, London, W.1), at 11 a.m.—Scientific Papers.

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Dr. Reginald Le May: "The Ancient Monuments of Cambodia, including Angkor".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Physics—The Principal, Acton Technical College, High Street, Acton, London, W.3 (December 4).

Lecturer in Textiles at Coventry Technical College—The Director of Education, Council House, Coventry (December 4).

Assistant Lecturer in Pharmaceutical Chemistry at Bradford Technical College—The Director of Education, Town Hall, Bradford (December 4).

Editor—The General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1 (December 4).

Vice-Principal (Ref. G.479/48A) and Assistant Lecturers Ref. G.480/48A) for the West Sussex County Agricultural Executi Committee's Agricultural Training Centre at Brinsbury, Pulborough The Ministry of Labour and National Service, Technical and Scient Register (K.), York House, Kingsway, London, W.C.2, quoting t appropriate Ref. No. (December 4).

Assistant Lecturer in Geography—The Secretary, Lond School of Economics, Houghton Street, Aldwych, London, W.C (December 6).

Senior Lecturer in Agriculture (with special qualifications Crop Husbandry and with teaching experience)—The Registrar, T University, Leeds 2 (December 6).

Junior Assistant Physicist in the Clinical Physics Depar ment—The Secretary and House Governor, Mount Vernon Hospi and the Radium Institute, Northwood, Middx. (December 8).

Statisticians in various Government Departments—The Secreta Civil Service Commission, 6 Burlington Gardens, London, W.1, quoti No. 2316 (December 11).

Candidate with a research degree and qualification in chemi engineering (Ref. TT/107), and a Candidate with chemical engineeri qualifications and considerable research experience (Ref. TT/10 for two appointments in the Central Research Establishment of t National Coal Board at Stoke Orchard, Cheltenham—The Natio Coal Board, Establishments (General) Branch, Hobart House, Gr venor Place, London, S.W.1, quoting the appropriate Ref. N (December 13).

Deputy Director and Senior Lecturer in the Department Chemical Pathology—The House Governor, St. Mary's Hospi and Medical School, Paddington, London, W.2 (December 13).

Departmental Demonstrator in Geology and Petrology The Professor of Geology, University Museum, Oxford (December 1

Senior Research Officer (Ref. No. 1987), a Technical Secreta (Ref. No. 1988), and five Research Officers (Ref. No. 1989), the staff of the Coal Survey Section of the Council for Scientific a Industrial Research, Sydney—The Chief Scientific Liaison Offic Australian Scientific Research Liaison Office, Africa House, Kingswa London, W.C.2, quoting appropriate Ref. No. (December 18).

Lecturer in Biochemistry, a Demonstrator in Biochemistr and a Demonstrator in General Physiology—The Registr University College of South Wales, Cathays Park, Cardiff (Decemb 18).

Professor of Physics, and a Lecturer in Bacteriology, in t University of Queensland—The Secretary, Association of Universiti of the British Commonwealth, 32 Woburn Square, London, W.C (December 31).

Senior Lecturer or Lecturer in Mathematics, and a Seni Lecturer or Lecturer in Physical Chemistry, in the Universi College of the West Indies—The Secretary, Inter-University Coun for Higher Education in the Colonies, 8 Park Street, London, W (February 15).

Mycologist as *Oidium* Research Officer to the Rubber Resear Scheme, Ceylon—The Secretary, London Advisory Committee f Rubber Research (Ceylon and Malaya), Imperial Institute, Sou Kensington, London, S.W.7 (February 28).

Lecturers (2) in the Department of Physics, Sunderland Tec nical College—The Director of Education, Education Offices, 15 Jo Street, Sunderland.

Chemist (Scientific Officer grade) for fundamental research physical chemistry of metal systems at higher temperatures, and Research Assistant for work on physical chemistry of metal syste in which radioactive tracer techniques are employed—The Person Officer, British Iron and Steel Research Association, 11 Park La London, W.1.

Lecturer in the Department of Chemistry and Biology—T Registrar, Municipal College, Portsmouth.

Research Technician in the Dental School—Prof. Matthew The University, Manchester 13.

Physical Chemists (Senior Scientific Officer and Scientific Offic grades), an Organic Chemist (Scientific Officer grade), Chemis (Experimental Officer grade), a Chemical Engineer (Scientific Offic grade), and Engineers (Experimental Officer grade), in a Minist of Supply research and development establishment in Lancashire The Ministry of Labour and National Service, Technical and Scienti Register (K.), York House, Kingsway, London, W.C.2, quoti F.936/48A.

Editorial Assistant for the *Journal* of the Institution—T Secretary, Institution of Electrical Engineers, Savoy Place, Victo Embankment, London, W.C.2.

Honours Graduate in Physics or Electrical Engineerin to assist in the further development of a 2 million volt electrosta generator and to co-operate in radiobiological research using t neutrons and X-rays from this machine—The Director, Radi therapeutic Research Unit, Hammersmith Hospital, Ducane Roa London, W.12.

Educational Psychologist—The Chief Education Officer, Educ tion Office, Warrior Square, Southend-on-Sea.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Nuffield College. The Problem facing British Universities. Pp. 13 (London: Oxford University Press, 1948.) 5s. net. [

British Journal of Herpetology. No. 1, June 1948. Pp. 38. (Lo don: British Herpetological Society, c/o British Museum (Natur History), 1948.) 4s. [

Reports on the Progress of Applied Chemistry. Vol. 32, 194 Pp. 518. (London: Society of Chemical Industry, 1948.) [

XVIII International Geological Congress. Symposium on t Geology, Paragenesis and Reserves of the Ores of Lead and Zi Edited by K. C. Dunham. Pp. 230. (London: Geological Surv and Museum, 1948.) 15s. [

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PROFESSIONAL STATUS OF THE BIOLOGIST

ONE of the paradoxes of civilized life is the lowly position occupied among the sciences by the study of living things. There seems, in Great Britain at least, to be a general disposition to regard biology as something in the nature of a pastime, while the physicist and the chemist are held in respect as serious practitioners. Only in the treatment and, to a modest degree, the prevention of disease, and in agriculture, has biological science a recognized position. That the well-being of the human race is closely bound up with the ineludible facts of life, which together constitute the equilibrium of Nature, is not generally recognized.

It was, therefore, with special interest that we studied the presidential address of Sir Henry Tizard at the recent meeting in Brighton of the British Association, and especially his conclusion that "Whatever new comforts and luxuries may be provided in future by the advancement of physical science, it is on the development of the biological sciences that the peace and prosperity of the world will largely depend". With this view we are in hearty agreement, though we should prefer to substitute for the word "largely" the word "ultimately". Sir John Boyd Orr expounded a similar view when addressing the Summer School in 1942 of the British Social Hygiene Council held in Cambridge.

But, if biology is to play the part required of it, it must be recognized as a profession, not as a hobby. It must be placed on the same professional level as chemistry, physics, engineering and medicine, with a corresponding prestige. For this reason we welcome the announcement, referred to on p. 878, of the proposal to establish an Institute of Biology. The other sciences to which we have referred have their professional organisations competent to give advice on questions involving the training, employment and remuneration of its members. Biology has no such comprehensive organisation, and, in consequence, many of those who wish to be recognized as professional biologists are led to refer to their membership of one of the academic societies, which does not necessarily involve, and is commonly quite independent of, professional qualifications. A notorious example of this practice is the use of the letters F.Z.S., which has compelled the Council of the Zoological Society of London to introduce a rule requiring all candidates for election to sign a declaration that they agree not to use these letters in furtherance of business interests.

Apart from being of real benefit to the individual biologist, an Institute of Biology would be a valuable, indeed an essential, asset to Great Britain and the British Commonwealth. On biological progress depends much that is inherent in the plans for the development of the Colonies, for example. Young biologists who take their first posts abroad in a British Colony frequently find themselves cut off from important biological contacts. An Institute could help such men in many ways, and could keep records of their service; then, in the event of their appointment being terminated for, say, political reasons (as has happened in India, Burma and Palestine), the Institute would be available for helping these men to find appointments elsewhere which are commensurate with their records, experience and qualifications.

It has been suggested that it may prove difficult to form an Institute of Biology because of the acute jealousies and antagonisms to which this field of science has appeared to give birth, and the consequent difficulty of persuading any group of biologists to agree on a common policy. It is to be hoped that such reasons will not adversely affect the final outcome; for it is quite clear that an Institute of Biology is badly needed in Britain. Moreover, coming from the Biological Council, the proposal presumably has the support of the leading biological societies and associations in Britain; these are listed at the end of the article already referred to. The founding of an Institute should be the main objective of all recognized biologists; its constitution, aims and objectives will have to be thrashed out around the conference table afterwards.

MICROWAVE TECHNIQUES

Microwave Transmission Circuits

Edited by George L. Ragan (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 9.) Pp. xvii+725. 51*s*.

Technique of Microwave Measurements

Edited by Assoc. Prof. Carol G. Montgomery. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 11.) Pp. xix+939. 60*s*.

Microwave Duplexers

Edited by Louis D. Smullin and Assoc. Prof. Carol G. Montgomery. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 14.) Pp. xiv+437. 39*s*.

Crystal Rectifiers

By Assoc. Prof. Henry C. Torrey and Assoc. Prof. Charles A. Whitmer. Edited by S. A. Goudsmit, James L. Lawson, Leon B. Linford and Albert M. Stone. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 15.) Pp. xiii+443. 36*s*.

Microwave Mixers

By Robert V. Pound; with a Chapter by Eric Durand. Edited by C. G. Montgomery and D. D. Montgomery. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 16.) Pp. xii+381. 33*s*.

Microwave Receivers

Edited by Assoc. Prof. S. N. Van Voorhis. (Massachusetts Institute of Technology: Radiation Laboratory Series, No. 23.) Pp. xviii+618. 48*s*.

(New York and London: McGraw-Hill Book Co., Inc., 1947–48.)

As readers of these columns will be aware, workers in the Radiation Laboratory of the Massachusetts Institute of Technology are producing a series of books on microwave techniques which, when complete, will contain twenty-eight volumes, one of which is to be an index of the whole series. Reviews of several books of the series have already appeared in *Nature*, and the present notice deals with a further six volumes, namely, numbers 9 11, 14, 15, 16 and 23.

According to the general foreword to the series the aim has been to make widely available, as soon as security regulations permitted, the results of the enormous research and development effort on radar and related techniques which took place during the Second World War. It is further stated that: "The work described is the collective result of work done at many laboratories, Army, Navy, university, and industrial, both in this country [that is, United States of America], and in England, Canada and other Dominions".

It would be easy to criticize each one of these volumes in detail, and to point out faults here and there in matters of presentation, to suggest that some things might have been better said and that some might with advantage have been left out, or that there is an unnecessary amount of duplication of materia between volumes. Nevertheless, if all this were done, one must still be full of admiration for the manner in which such a great task has been accomplished in so short a time, and, with all its faults on the whole so successfully. It might also be said that some of the techniques described are already out of date; but that is inevitable in a subject which has developed as rapidly as has the study of microwave phenomena in the past few years. It must be said, however, that despite the statement in the foreword, most of the work described in detail is o American origin, and that, with a few notable exceptions, references to British work are infrequent This is probably not due to any ulterior motive on the part of the various authors, but simply arises from the fact that much British material which might, and could otherwise, have been used had not been 'declassified', and so was not available for reproduction at the time these books were written.

The duplication of a certain amount of subject matter in several volumes is perhaps inevitable since the whole field has been split up into so many parts and some of these naturally overlap. On the othe hand, in reading any given volume one may occasionally be aware of certain gaps in the presentation for, in the process of the development of each book subjects more properly dealt with in one of the companion volumes are touched upon. A certain amount of cross-reference from volume to volume is therefore necessary; if this were not to be expected the degree of duplication would become even more marked.

Volume 9, entitled "Microwave Transmission Circuits", is concerned with the problem of the transmission of power at microwave frequencies from one place to another. In the course of some 700 pages many aspects of this problem are dealt with in very great detail. Most of the designs described in these pages were developed in the war-time Radiation Laboratory of the Massachusetts Institut of Technology, though workers in this field in Grea Britain will recognize many features which could just as well have been described as originating here In the first two chapters a discussion of conventiona transmission-line theory leads to a treatment of th guided wave concept, and of the more common type of wave-guide. There then follow chapters dealin with such subjects as materials and construction techniques, rigid and flexible coaxial lines and wave-guides, coupling units and rotary joints in transmission systems. Tuners, power dividers and switches are described in Chapter 8. The last two chapters, 9 and 10, are devoted to a discussion of microwave filters, the first from a theoretical and the second from a design point of view. The principles of filter theory put forward here are not merely extensions to microwave frequencies of principles already in use at lower frequencies; they represent rather a significant contribution to the subject along entirely new lines, and the results should find many useful applications in the design of filters for low frequencies.

Many readers will probably find Volume 11, on the "Technique of Microwave Measurements", one of the most valuable in the series, in that it contains much that will continue to be of great use over the whole field of microwave applications in the future. Throughout the book, in the consideration of the design and construction of equipment for microwave measurements, one is continually reminded that it is here necessary to think in terms of the electromagnetic field rather than in terms of current and voltage, the usual practice at lower frequencies. The volume is divided into four main parts in which are described power generation and measurement, wave-length and frequency measurements, the measurement of impedance and standing waves, and finally attenuation and radiation measurement. There are fifteen chapters, and the topics treated in detail include microwave oscillators and devices by means of which their frequency may be stabilized, measurement of radiofrequency power at low, medium and high levels, and the design of signal generators and noise sources. In Part 2 the use of wave-guides and cavity resonators in the measurement of wave-length and frequency is described, and also the determination of pulse shape and associated frequency spectrum. Part 3 contains a description of the measurement of standing waves and the use of various types of impedance bridge. Part 3 further includes a long and interesting chapter (Chapter 10) in which methods of determining dielectric constants are discussed, and one is pleased to note here considerable reference to British work. The final part of this volume (Chapters 11–15) deals with the construction of such items of apparatus as microwave attenuators, both of the wave-guide 'cut-off' and resistive types, and directional couplers. There are also chapters on the measurement of attenuation and on radiofrequency phase and pattern determinations.

"Microwave Duplexers", Volume 14, is of rather more specialized interest than the two books discussed above. It is concerned largely with the design and behaviour of switching devices which enable a common aerial system to be used for a high-power transmitter and a receiver, and which are therefore of fundamental importance in the construction of radar sets. The characteristics of these switches at both low- and high-power levels are discussed, the high-power level operation being dealt with in considerable detail; and the properties of various gases which are used in the switches are described. The final chapter (9) includes a description of techniques whereby a measurement of the performance of the switches, as well as of the duplexer as a whole, may be made. These special switches were a war-time development, and naturally the only thing of importance at that time was that they should work; much of the knowledge we have of them is still of an empirical nature. Chapter 5 is, however, devoted to a theoretical treatment of the gaseous discharge at very high frequencies. This is admittedly a most difficult subject—our understanding of the phenomenon even at lower frequencies is still incomplete—but the author presents much that is known in a very satisfactory manner.

"Crystal Rectifiers" is the title of Volume 15, and in this book we see how an early radio component, which has been but little used since the invention of the thermionic valve several decades ago, has once again become an important element in microwave equipment. The crystal rectifier is now compact and stable, and is superior to the thermionic diode in many applications. Its most extensive use so far in the new field has been as a frequency converter in microwave receivers, where its performance is unequalled, and also as a low-level detector. Volume 15 is divided into three main parts, the first of which deals with the general fundamental properties of the crystal rectifier, and in Chapters 3 and 4 we have an extensive treatment of the theory of semi-conductors and point-contact rectifiers. These two chapters include a discussion of such subjects as electron distribution in semi-conductors, work functions and contact potentials, conductivity and Hall coefficients, barrier-layer rectification, formation and structure of the barrier layer, depletion layers and rectification at very high frequencies. It is well known that the theory of many of these phenomena is as yet far from complete, and no attempt is made to disguise this fact in the present treatise or to gloss over experimental results which are not in accordance with the theory as it now stands. Part 2, comprising Chapters 5–10, deals with the crystal as a frequency converter and continues with a discussion of noise generation in crystals, of loss and noise measurements, of the theory and experimental information on the burn-out of crystals, test equipment for the measurement of conversion-loss and noise, and finally manufacturing techniques. All the examples given, and nearly all the manufacturing processes quoted, are American. 'Special types' are described in Part 3 (Chapters 11–13). The properties of crystal rectifiers used for detection at low power-levels are considered in Chapter 11, while Chapters 12 and 13 are concerned with a study of high-inverse-voltage rectifiers and welded-contact germanium crystals. Many would probably say that some of the types discussed should no longer be regarded as 'special'.

The volume on "Microwave Mixers" (No. 16) necessarily duplicates a certain amount of the material of Volume 15, since it deals mainly with the use of the crystal as a frequency converter in superheterodyne radar receivers. After an introductory chapter, therefore, in which there is a classification and description of types of microwave receiver, and Chapter 2, which contains a treatment of the physical characteristics of crystals and of network equivalences for crystal mixers, the emphasis in the succeeding chapters is almost entirely on the design and construction of mixer circuits and on allied problems. Simple microwave crystal mixers for the centimetre-wave band are described in Chapter 3, and multiple-function mixers in Chapter 4. Then follow chapters on local-oscillator noise and on balanced mixers, including some discussion on the characteristics and uses of the 'Magic-T'. Chapter 7 contains a description of various types of frequency-control circuit, and the last chapter (8) deals with special measurement techniques for such properties as noise-figure and admittance loss of mixers.

The subject-matter of Volume 23 is "Microwave Receivers". Here again we find a certain amount of duplication, particularly with Volumes 14 and 16, since duplexers and mixers are naturally associated with receivers, but it is not so extensive as to prove irksome. One might, however, have expected a more logical arrangement of the subjects treated in the early chapters. Duplexers, microwave mixers and local-oscillators are dealt with briefly in Chapter 2—local-oscillators, in fact, too much so. Chapters 3, 4, 5 and 6 are concerned with automatic frequency-control systems, intermediate-frequency input circuits, very high frequency amplifiers, mixers and oscillators, and intermediate-frequency amplifiers respectively. Second detectors are described in Chapter 7, video-amplifiers in Chapter 8 and gain control circuits in Chapter 9. There are then three chapters on the mechanical construction of receivers, radiofrequency and intermediate-frequency test equipment. Chapters 13–17 give details of the design and construction of several specific receivers, including an airborne centimetre wave-length type, an automatic tracking radar, a two-band 200 Mc./s. superheterodyne receiver and a wide-band frequency-modulation receiver. In the last four chapters, 18–21, there is a more general discussion of beacon superheterodyne receivers, crystal-video receivers, supergenerative receivers and, finally, moving-target indication systems. It might, perhaps, have been better to sacrifice a little of the extensive detailed treatment of the intermediate- and video-frequency circuits for a rather more comprehensive account of the radiofrequency aspect of the problem, since this seems to have been passed over all too briefly. Of the six volumes here discussed the present reviewer found this one perhaps the least satisfactory in the matter of general presentation and balance of subject-matter.

There are remarkably few typographical errors in all of these volumes despite the conditions of speed under which they must have been prepared. They are all further characterized by a great wealth of circuit diagrams, line drawings and, in many instances, by photographs of equipment. These features will be welcomed by, and will be of great value to, anyone wishing to design and construct microwave equipment, and to such—or indeed anyone interested in microwave techniques—these books may certainly be recommended. J. A. Saxton

POPULAR BOTANY

The Growing Plant

By Prof. W. Neilson-Jones. Pp. 206+8 plates. (London: Faber and Faber, Ltd., 1948.) 16*s*. net.

The popularization of science has become an important social activity. Unesco holds conferences on how it should be done; and the Russians have a special government department to manage it in the Soviet Union. The public demand for it is sufficient to support numerous books on popular science, and recurrent publications such as *Science News* and *New Biology*. Already the difference between books on science and books on popular science has become indistinct: there is continuous variation, from the monograph by a specialist for a few specialists, to the article by a journalist for a million newspaper readers. There is an increasingly important demand for books lying between these two extremes, for the reader who knows some science already. This sort of reader is not easy to satisfy. He does not want catalogues of 'wonders of Nature'; he is annoyed if he is mystified; and he demands a high standard of accuracy. The journalist who has 'cashed in' on the popularity of science cannot write popular science at this level; it must be done by a professional scientific worker, and it is exasperatingly difficult.

Prof. W. Neilson-Jones is to be congratulated on having written a book which will go a long way toward satisfying the reader who is already familiar with some science. His book is (as one would expect) accurate, though many botanists will disagree with some of his views on vernalization and photoperiodism. It is written in an easy (though occasionally ambiguous) style, with a pleasant dry wit. It is a series of independent essays on some aspects of botany which are not treated well in elementary text-books: the plant as informant, chimæras, plant hormones, the control of flowering, plant nutrition, and the story of the soil. The book contains much of what our grandfathers called 'curious information': the difficulties in making floral clocks, the use of tomatoes to locate escaping gas, the occurrence of daisies on prehistoric trackways, and so on. However, the author does not try to impress the reader by means of staggering statistics or arresting adjectives, and he draws his examples from a life-time of experience and thought.

On the dust cover it is said that the book is for the general reader; but it would be unfair on the book to judge it by this criterion. It is rather an anthology of what a botanist thinks will interest other scientific workers. He would be a hardy general reader who could read comfortably that "the fully oxidised tetravalent form of manganese" is not available to plants, and that "no plastids from the pollen grains are brought into the egg cell at fertilization". However, as a book for the science master, the chemist whose hobby is gardening, the horticulturist, the first-year student, the reader (in brief) of *New Biology* and *Science News*, "The Growing Plant" can be recommended with confidence. The book is well produced and well illustrated, although there is an unaccountable transposition of words on page 19. E. Ashby

CONGRESS OF BIOLOGICAL CHEMISTRY

Un symposium sur les proteines

Par A. Tiselius, D. P. Riley, E. Gorter, D. G. Dervichian, M. Joly, J. Brachet, P. Rebuffat, R. Vendrely, C. Wunderly, V. Desreux, H. Dieu, M. Dubuisson, J. Jacob, E. J. Bigwood, M. Jutisz, E. Lederer, G. Hamoir, P. Desnuelle, M. Rovery et M. Errera. (Médecine et biologie, Monographies publiées sous la direction de Marcel Florkin, No. 5.) Pp. 284. (Liége: Éditions Desoer; Paris: Masson et Cie., 1947.) 165 francs.

The Seventh Congress of Biological Chemistry was held at Liège in October 1946. It was thus the first large international gathering of biochemists to be held in Europe after the War. The collection of seventeen papers, contributed to the general discussion on proteins, has now been published under the title "Un symposium sur les proteines". It is of particular interest to the general reader in chemistry and biochemistry since it reveals trends of thought that are forming the background for the present remarkable developments in experimental technique.

The subject-matter of the opening paper by A. Tiselius was happily chosen in that it served as a logical introduction to many of the later contributions to the discussion. Prof. Tiselius dealt with the general strategy of the attack on a problem that has long intrigued chemists, biochemists and physicists interested in proteins, namely, that of the detailed orientation of the amino-acid residues in the protein molecule. The logical way of attacking this problem is by a process of successive fragmentation of the protein chain. If large fragments could be isolated, they could again be broken up into smaller fragments, the constitution of which could be determined by methods already available. The problem is, of course, mainly one of technique, but, as further contributions to the discussion showed, a rich field is developing in the isolation, determination and synthesis of oligopeptides and polypeptides; and although it may be too much to hope that the complete constitution of a natural protein will be determined in the near future, it is clear that a concerted attack on these lines by the many workers already engaged would yield an understanding of the main features of protein structure.

Another important aspect of the problem is the study of the natural protein molecule as a whole, since it is clear that no real advance can be made by the method of successive degradation until adequate proof is available that the protein is, in fact, a single molecular species. The importance of this point is now well appreciated, and the newer physical and chemical methods are increasingly employed in the search for protein preparations of proved molecular homogeneity. This search is proving more difficult and more prolonged than was at one time expected, and several of the papers, reporting studies of proteins by use of X-ray diffraction, electrophoresis, and the spreading of layers on water, emphasized the extreme complexity concealed by the terms 'albumin' and 'globulin'.

THE MIND OF THE CHILD

Childhood and After

Some Essays and Clinical Studies. By Dr. Susan Isaacs. Pp. viii+245. (London: Routledge and Kegan Paul, Ltd., 1948.) 15*s.* net.

THIS volume of selected papers, nearly all of which have already appeared in journal form, furnishes a representative sample of the late Mrs. Isaacs' contributions to the theory and practice of child psychology during the past twenty years [see p. 881]. The contents comprise five papers dealing with general aspects of child welfare and eight of a more specialized nature devoted to problems in the field of psycho-analysis. The general papers include a competent review of recent advances in the psychology of young children, an essay on the mental hygiene of the pre-school child and a discussion of the educational value of the nursery school. Included also is a report dealing with the question of children in institutions, originally presented as a memorandum to the Home Office Care of Children Committee in 1945 and here printed in full for the first time. Although some may feel that the arguments advanced in this report are based on a somewhat selective consideration of the evidence, their cogency can be denied by none who has to do with the institutional care of young children. The memorandum is a model of lucid presentation and persuasive discussion of a difficult problem.

The eight technical papers which make up the bulk of the volume will probably prove of greater interest to the scientific reader. Four deal with theoretical aspects of psycho-analysis and four with special aspects of child development considered from the psycho-analytic point of view. Much of the material discussed may appear bizarre, if not wholly improbable, to the reader unversed in Freudian psychology. It must, however, be borne in mind that the evidence in favour of what Freud called (rather misleadingly) infantile sexuality is nowadays extremely impressive. Although there is disagreement on points of detail, the broad principle of early psycho-sexual development is accepted by a great many psychologists outside the Freudian fold. This principle not only renders comprehensible a wide variety of psychoneurotic manifestations but also contributes in an important way to our understanding of the normal processes involved in the formation of character. One must, therefore, expect of the reader at least some understanding of the Freudian position if he is to follow the arguments developed in these papers. If he remains unconvinced of its basic validity, he would do better to turn to Freud's original writings than to persevere with a book such as this.

A striking impression which is left on the reader of these papers is the virtual impossibility of understanding the mind of the child in terms of adult psychology. Although we have long outgrown anthropomorphism in the biological field, something very like it appears to cling to us in our conceptions of the child's mentality. From the work of Mrs. Isaacs and other child analysts, we realize the futility of attempting to interpret the mind of the young child in terms of the attitudes and beliefs of adult life. The mind of the child, it appears, is a mind in which impulses of a primitive nature give rise to a wealth of phantasies, in part unconscious, which are apt to mingle freely with the world of sense perception. In this phantasy world, figures derived from the parents acquire qualities of beneficence or punitiveness out of all proportion to the child's actual experience. These phantasies not only influence the child's acquisition of conscience and character but also may lie behind a variety of psycho-neurotic manifestations. Their significance in relation to aggression and guilt, 'temper tantrums' and anxiety, is well brought out by Mrs. Isaacs in her clinical studies.

It must be mentioned that the author of this book, in common with so many protagonists of psycho-analysis, pays scant respect to the constitutional factor in neurotic illness. Although Freud himself admitted that all neurosis is at bottom a constitutional affair, this aspect is constantly neglected in neo-Freudian psychopathology. In this connexion, the medical reader will not be slow to note that several of Mrs. Isaacs' patients displayed pre-psychotic manifestations. The latter surely betray a constitutional element which cannot be neglected in theoretical interpretation. One might suggest that until the organic basis of psycho-neurotic illness is more fully considered by psycho-analysts, much of their doctrine will remain, in Freud's words, ". . . but a superstructure which will have to be set on its organic foundation". O. L. ZANGWILL

ROYAL SOCIETY

ANNIVERSARY ADDRESS BY SIR ROBERT ROBINSON, F.R.S.

On behalf of the Fellows of the Royal Society the following telegram was sent on November 16 to His Majesty the King: "Your loyal and dutiful subjects the President, Council and Fellows of the Royal Society of London beg leave to offer our respectful and sincere felicitations on the birth of the Prince".

A message was also sent to Her Royal Highness the Princess Elizabeth, as follows: "The President, Council and Fellows of the Royal Society of London send their respectful and sincere congratulations to Your Royal Highness on the happy event of the birth of the Prince".

We have received gracious acknowledgments in the following terms: "Please convey to the Council and Fellows of the Royal Society the sincere thanks of the Queen and myself for their kind message on the birth of our grandchild.

"George R."

"We are most grateful for your kind message of congratulations.

"Elizabeth and Philip"

AWARD OF MEDALS, 1948

Copley Medal

The **Copley Medal** is awarded to Prof. Archibald Vivian Hill, for his outstanding contributions to the physiology of muscular processes.

Towards the end of the nineteenth century physiologists discerned a field of investigation in the physical and chemical phenomena involved in the characteristic activity of muscle and nerve; but the questions propounded could receive no satisfactory answers, chiefly owing to the lack of adequate methods. Hill, during the last thirty-five years, has applied profound mathematical skill and a flair for the design and management of delicate instruments to the provision of a sound basis for experimental and theoretical advance. In his hands the thermopile was developed into an instrument of great precision and delicacy, and conditions for its use in relation to the material studied were established so as to provide significant results.

The work on heat production in muscle has led to a picture within a framework which can accommodate many contemporary biochemical studies in a harmonious fashion. Attention has constantly been paid to ensuring the thermodynamic soundness of the systems suggested. Moreover, he was able to exploit some of his findings on isolated muscle in the course of a study of the dynamics of muscular contraction in the living body, including that in the human subject.

A natural extension of Hill's researches has enabled him to contribute notably to our knowledge of the heat-production and excitability of nerve. Previous workers failed to detect any heat-production in nerve tissues, but Hill demonstrated the definite thermal changes that are associated with the passage of impulses. These were found to be so small that no one-way contemporary chemical reaction could account for them. It would be necessary to postulate reversible changes which proceed in both directions. This was a main factor in the elaboration of the modern view that the nerve impulse results in an altered state of polarization of the essential surface membranes. The heat change which occurs after the passage of the impulses was found to be small but definite, and was related to the energy expended in the recovery of the membrane.

Hill has made contributions of great distinction in other fields, and among other topics investigated by him is that of the physical chemistry of the oxyhæmoglobin equilibrium in the blood.

Hill has been a source of inspiration to many pupils, collaborators and colleagues, and has founded a school of research. His eminent services to physiology have been possible as the result of a happy combination of wide basic knowledge of the physical sciences, unusual skill in the design and execution of experiments, a philosophic outlook, and above all the curiosity and ambition to attack some of the most difficult problems in biophysics and biochemistry.

Rumford Medal

The **Rumford Medal** is awarded to Prof. Franz Eugen Simon for his distinguished researches on the properties of matter at low temperatures.

The school of low-temperature physics which Simon has created at Oxford is one of the leading centres of such research in the world and has achieved highly important results in the spheres of both theory and practice.

His great knowledge of thermodynamics was brought into service in the development of extremely simple methods for reaching the temperatures of liquid helium in the laboratory. He realized that at low temperatures adiabatic expansion of helium compressed into a small reservoir would absorb sufficient heat to liquefy the bulk of the gas and to cool the container and specimens under examination to liquid helium temperatures. Thus, provided reasonable supplies of liquid air are available, it becomes possible for any laboratory to carry out investigations at the lowest attainable temperatures with equipment which is inexpensive and simple to operate. Many other contributions to technique in this field have been made by Simon and his co-workers.

With the aid of these new or improved methods many interesting observations, with a bearing on fundamental knowledge, have been made. Outstanding problems in superconductivity, especially the part played by impurities, have been solved and the 'freezing out' of magnetic flux has been explained. The peculiar properties of liquid helium II and the transition to this state have been investigated intensively. The thermodynamics of the approach to absolute zero has been stated very clearly by Simon, and progress has been made in new methods for reaching this temperature. More recently, extended equipment has facilitated the study of the properties of atomic nuclei oriented in magnetic fields.

Simon has made significant contributions to the elaboration of devices for the separation of isotopes and to the design of plants in which thermodynamic considerations are of predominating importance.

He has aptly illustrated the thesis that, in the world of modern physics, discovery and the progress of theory follow surely on the introduction of new and powerful tools of research.

Royal Medals

A ROYAL MEDAL is awarded to Prof. Harold Jeffreys for his fundamental investigations in theoretical geomechanics.

Much of Jeffreys' well-known book "The Earth" (1924, 1929) is based on his own work, and this is especially true of the section on near earthquakes. However, the book owes its unique position not only to these original contributions, but also to the skill and insight shown in the building up of a self-consistent picture of the earth from the very diverse and apparently contradictory materials available at the time when it was written. Its great influence has been due to the width of interest and the critical skill as well as to the depth of learning of its author.

During the thirties Jeffreys' main interest was in seismology. In a series of papers he has discussed the available observations in detail and reduced the errors in the seismological time-tables by a factor of 10 or more. This work has had an important effect on our knowledge of the earth's interior and has yielded numerical information of surprising accuracy, and, for example, the radius of the earth's central core, is now known with an accuracy of a few kilometres.

Some of his early papers and the book "Scientific Inference" show an interest in the philosophical basis of the scientific method and in the theory of errors. This was intensified by the difficulties he met in adequately treating the seismological travel times, to which orthodox 'least square' methods are inapplicable. The discussion of these observations led to a series of papers on significance tests, and, finally, to a book, "The Theory of Probability", in which he discusses *de novo* the whole problem of the relation between observation and 'physical quantities'. The departures from orthodoxy have not proved universally acceptable, but it is generally agreed that Jeffreys has made an important contribution to a subject on which the last word has not yet been said.

Other topics to which Jeffreys has made material contributions are pure mathematics, the origin of the moon, the constitution of the planets, hydro- and aerodynamics. In particular, he gave the first mathematical discussion of the theory of aerofoils of finite thickness.

Other less relevant examples of the catholic interests of the Plumian professor of astronomy and natural philosophy could be cited. Whether as a specialized applied mathematician or as a teacher and leader of research, the eminent services he has rendered are most widely recognized.

A ROYAL MEDAL is awarded to Prof. James Gray for his distinguished work on the mechanism of posture and locomotion in vertebrate and other animals.

In 1933 Gray, by the use of cinematography, analysed the forces involved in the progression and turning of fish with long and short bodies. The inquiry reached its full development during the last ten years with the extension of these studies to vertebrates generally. In 1936 he discussed the swimming of dolphins; raising, the hydrodynamical problem of the type of water-flow past an undulating body. Later he analysed the locomotion of Amphibia and of snakes. The results of this part of the work led to a discussion of the mechanics of the tetrapod skeleton which was fundamental and placed an important part of the comparative anatomy of vertebrate animals on a functional basis for the first time. His work shows that the whole body of a tetrapod must be considered as a single functional unit; changes in the tension of one muscle being accompanied by a demonstrable pattern of changes in other muscles. Gray analysed and described the mechanical problems solved by tetrapods standing and moving over ground of varying slope and smoothness; he has also analysed the neuro-muscular phenomena responsible for the evident co-ordination of action. He showed the importance of peripheral reflexes in the initiation and maintenance of swimming movements in fish. This led him to the problem of the origin of locomotory patterns. His experiments on the neuromuscular system of annelids showed the major importance of patterns of peripheral stimuli.

This work, summarized in a Croonian Lecture, was later greatly extended by demonstration of the importance of peripheral reflexes in the locomotor activities of toads. It was found that there was no, positive evidence for the existence of central rhythm in these animals, while, on the other hand, the proprioceptive reflexes arising from the muscles provide an adequate basis for locomotor action.

Gray's work is responsible for an important change in the direction of research in the comparative anatomy of vertebrates. Before its appearance, skeletal structure was examined in extraordinary detail and yet little or no attention was paid to musculature and to the relation of structure to the whole system in action. More than any other, Gray has shown that comparative anatomy is certainly not a dead science.

Davy Medal

The DAVY MEDAL is awarded to Prof. Edmund Langley Hirst for his distinguished contributions to the chemistry of carbohydrates.

The first demonstration of the six-membered ring structure of an aldose derivative was offered by Hirst and Purves in their study of methylxyloside, which was published in 1923. Since then, in collaboration with Sir Norman Haworth over a number of years, and independently, Hirst has played a great part in the establishment of fundamentals in the field of carbohydrate structure. His prolific experimentation is characterized by the highest accuracy and has afforded conclusive answers to many questions of importance.

Of his joint work in the Birmingham School the following must be cited: the recognition of pyranose and furanose forms of the simple sugars, the isolation of a crystalline furanoside for the first time, and the determination of the constitution of sucrose and other disaccharides.

His independent work on optical rotatory dispersion in the carbohydrate derivatives introduced new methods of attack on constitutional problems, which were of immense service in his later work on the constitution of vitamin C. In that investigation of outstanding merit he determined the structure of ascorbic acid and studied a large number of related products. In 1933 he shared in the synthesis of ascorbic acid and in the study of the physiological activity of the synthetic vitamin.

His researches on the polysaccharides have been conspicuously successful over a wide field, and largely because of his development of new methods of end-group assay in the determination of structure. He has applied these methods successfully to starch, glycogen, and other polysaccharides, and to him we owe many advances in our knowledge of the nature of alginic acid, the plant gums and pectic substances.

The regularities and irregularities that have been disclosed have been of equal interest and unexpectedness.

Hirst has been a pioneer in unravelling the complexities of carbohydrate architecture, and to him must be attributed much of our present knowledge of this group of such great biological significance.

Darwin Medal

The DARWIN MEDAL is awarded to Prof. Ronald Aylmer Fisher for his distinguished contributions to the study of biological evolution.

A general principle that is consistently developed in Prof. Fisher's writings is that the course of evolution is not controlled by mutation but by selection operating upon the heritable variability which Mendelian recombination supplies.

In 1928 he was the first to suggest that dominance is the product of selection operating in the gene-complex of the organism. This theory he tested and confirmed experimentally with domestic poultry and later with mice.

The implications of his concept extend beyond the dominance phenomena, and underlie the whole theory of the modification of genic effects through selection acting on the gene-complex. This enables a character, even when under unifactorial control, to be adjusted to the needs of the organism. To Darwin, selection was a mechanism for rejecting the bad and conserving the good; it is largely to Fisher that we owe the view that it may mitigate the bad and enhance the good effects of the hereditary units.

The studies of Fisher on abundance and variability, the first of them undertaken in collaboration, have provided means for proving in general terms the proposition, implicit in the modern concept of evolution, that genes having minute favourable effects are in process of being spread through populations and are bringing about evolutionary change at the present time.

Fisher's methods of population analysis, developed from 1930 onwards, have made it possible to study the numerical aspect of animal communities with an exactitude previously unattainable.

The special opportunities for evolutionary study presented by polymorphism have always attracted Fisher, and he has repeatedly analysed the balance of selective agencies which may be involved. This point of view is apparent in his extensive work on human serology. He has also studied a polymorphism which had especially interested Darwin, that of the heterostyled plants, and he has extended the subject to elaborate the general theory of crossing-over in polyploids—a pioneer work of wide application.

Fisher's great contributions to statistics and to experimental design have provided tools now deemed essential to the quantitative biologist. But they are fundamental also to the experimental studies of evolution which have become so important a feature of modern biological research.

Hughes Medal

The HUGHES MEDAL is awarded to Sir Robert Watson-Watt for his pioneer researches in radio-telegraphy.

Watson-Watt has been a leader in the field of radio research since the early nineteen twenties. He began to work on the subject of atmospherics in 1915, paying attention at first to the subject of the direction of arrival. He published the first English studies on this subject, establishing the 'cum-solar' swing of the place of origin throughout the day. He developed the cathode-ray direction-finder as a means for finding the direction of arrival of individual atmospherics. This has proved of immense value in the location of thunderstorms during the War. With a number of collaborators he later studied the wave-form of atmospherics.

He has been the leading exponent of the use of the cathode-ray oscillograph for a great variety of purposes in physical research.

Watson-Watt was the leader of the earliest British work on radar, or radiolocation, as it was then called. Although the basic principles were known, enormous technical difficulties had to be overcome before radar could be developed in the form of an operational instrument. That these difficulties were, in fact, overcome was due, in Great Britain, more to Sir Robert Watson-Watt than to any other man. He is now turning with equal insistence to the peace-time applications of radar, especially in the service of civil aviation.

New Officers

Sir Alfred Egerton now lays down his office as Physical Secretary of the Society. During the past ten years he has shown a deep concern for the Society's welfare, and the utmost willingness to undertake onerous duties.

I would like to remind you of some of his many activities. In the early days of 1939 he was chiefly instrumental in the creation of a Central Register of Scientists. The significance of this action by the Society was by no means exhausted by the end of hostilities. Almost in the first month of the War he took a leading part in persuading the War Cabinet to set up a Scientific Advisory Committee. These efforts, after initial setbacks, succeeded in October 1940, and the Committee functioned usefully during the war period and was the forerunner of the present Advisory Committee on Scientific Policy. I cannot deal at length with his services in a more personal capacity, for example, to the Ministry of Fuel and Power, but we recall with gratitude his interest in the re-organisation of the Gassiot Committee and in the survey, which the Society conducted, of the needs of fundamental science after the War. He has been an ever-welcome guest overseas, and has a distinguished record as an ambassador of science. His great services to the Empire Scientific Conference of 1946 and its offspring, the Scientific Information Conference of the present year, are fresh in our memory. He worked zealously, carefully and effectively—an unusual and difficult combination—and the results will benefit every part of the Commonwealth in which scientific activity exists.

Sir Alfred will continue to act as virtual representative of the Society in several important capacities; if I may mention just one as an example, it may be as a member of the Scientific Advisory Council for the Festival of Britain, 1951.

We shall not be able to take so much advantage of his habitual generosity as in the past, but, in case of need, we shall certainly seek his help and advice.

Prof. David Brunt has been elected as the Physical Secretary of the Society. To him we offer the most cordial welcome and good wishes, coupled with thanks for his willingness to assume the duties and responsibilities of the office.

One of the most valuable of the traditions of the Society is our claim to exercise initiative when the circumstances suggest a new departure. So far as I am aware it has not previously been thought desirable to designate any person as honorary librarian to the Society; but the Council felt that the present chairman of the Library Committee had given services which were probably without precedent. Prof. E. N. da C. Andrade's knowledge of the older scientific literature is unrivalled, and has been freely available to the great advantage of the Society.

The retirement of Mr. H. W. Robinson as librarian occurred at the end of March of this year. He joined the staff in 1902 and assisted the chief clerk and the librarian; in 1910 he became library assistant and in 1930 assistant librarian. He has been librarian since 1935. His work for the Society and its Library has been invaluable, and we may recall with special gratitude the care he showed in the safe bestowal of our treasures in the time of danger. An earnest student of the history of science, he has paid special attention to the study of Robert Hooke, on whose life and work he is a recognized authority. In expressing our gratitude for his devoted labours, we note with pleasure that Mr. Robinson will continue to assist Prof. Turnbull in editing the Newton letters.

Scientific Information

The outstanding event of the past year in connexion with the Society has been the Scientific Information Conference. We welcomed delegates from the countries of the Commonwealth and also from the National Academy of Sciences of the United States, and from Unesco. It can thus be claimed that the whole of the English-speaking scientific world was well represented. More than half of all scientific literature is written in English, and in making such a comprehensive review of scientific information services, I think the Society may be judged to have taken a timely initiative. We were gratified by the interest shown by Fellows and the time and energy so freely given by them to ensure the success of the Conference.

The Council of the Royal Society received from the Conference many recommendations dealing with the publication of papers reporting original work, abstracting services, reviews and annual reports, library services, classification and indexing, and other relevant matters. It has been decided to implement these, so far as proves possible, with the aid of a Treasury grant, and for this purpose the Council has set up an Information Services Committee, which has just held its first meeting. I believe that an energetic follow-up of the recommendations will result in real progress. The value of the Conference itself, irrespective of these recommendations, should not be under-estimated. Divergent points of view were advocated, and many of the difficulties besetting the free and rapid communication of new knowledge were at least recognized as the result of discussion and, in many cases, were removed. The problem is a complex one, and its solution demands both due regard for traditional methods and an acute appreciation of novel techniques.

Having given this lead, the Society will now be expected to play an increasingly important part, nationally and internationally, in improving scientific information services.

It is doubtful whether the general progress of science has ever been more impressive than at the present time, and this fact emphasizes the importance of adequate outlets for the publication of the great volume of original work that is being poured out. Formidable archives are undoubtedly accumulating. To meet the demand many new journals have been founded, and here is a short list of them. *Agricultural Chemicals*, Baltimore, 1946; *British Journal of Pharmacology and Chemotherapy*, U.K., 1946; *Hungarica Acta Chimica*, Budapest, 1946; *Journal of Colloid Science*, N.Y., 1946; *Journal of Polymer Science*, N.Y., started publishing 1946; *Zeitschrift für Naturforschung*, Wiesbaden, 1946; *Acta Chemica Scandinavica*, 1947, Chemical Societies of Denmark, Finland, Norway and Sweden; *Analytica Chemica Acta*, N.Y., 1947; *Biochemica et Biophysica Acta*, N.Y.; *Die Makromolekulare Chemie*, Basle, 1947; *Food Technology*, N.Y., 1947; *Heredity*, London, 1947; *Journal of Glaciology*, U.K., 1947; *Nucleonics*, N.Y., 1947; *Acta Crystallographica*, U.K., 1948; *Acta Physica Austriaca*, Vienna, 1948; *Annali di Geofisica*, Rome, 1948; *Australian Journal of Scientific Research*, Australia, 1948; *Deutsche Hydrographische Zeitschrift*, Hamburg, 1948. Furthermore, the scientific reviews are constantly being extended in scope; one can even be thankful that they show a tendency to overlap. *Nature*, playing a more important part than ever before, is now supplemented by *Research*, while *Endeavour*, *Science Progress* and *Discovery* worthily maintain our reputation in the field of popular exposition. The Press is far better informed on scientific affairs than was the case a few years ago, and we can anticipate useful autocatalysis in the reaction between public appreciation and public information.

A Science Centre

A year ago I mentioned the formation of a committee to study the means whereby adequate accommodation for the scientific societies may be made available, and tactful reference to its activities will be found in the Report of Council. Without being too indiscreet, it is possible to provide some further information on a subject of great interest to the Fellows of the Society. In the first place, the Scientific Accommodation Committee has so far considered only the long-term problem, and it is matter for congratulation that representatives of so many interested parties reached full agreement on this aspect. It was unanimously agreed that the institution of a science centre would provide the best solution. Naturally, everybody would like to know where that will be and exactly what the proposal involves. In regard to the first point, a specific suggestion is being explored, and we hope that it will soon be possible to announce a definite outcome, such that a suitable site will be allocated for the eventual creation of a worthy science centre. It is unlikely that this site will please everybody; but we have reason to believe that a large majority will welcome it in view of the many advantages secured. In any event, we have the assurance that favourable consideration will be given by Ministers to transference to a better site, should such be found.

The course of the discussion showed that the co-operation of several scientific societies depended on that of the Royal Society, and your representatives accepted the flattering implications, though not without some hesitation. To speak directly, that means willingness, if necessary in the general interest, to leave Burlington House and to function as the heart of the science centre located elsewhere.

The elaboration of so far-reaching a scheme is not at all a simple matter, and involves polypartite negotiations and agreements. The Fellows of the Society will be directly consulted on the major issue just so soon as it can be put to them in a precise form.

One possibly related matter may be adumbrated at this early stage, so that we may think about it.

The Report of Council mentions the reconstitution of a 'Rutherford Memorial Committee', which has various schemes under consideration. At the last meeting of this Committee I ventured to suggest that, as one aspect of the memorial, a 'Rutherford Hall' of noble design should form a part of the science centre, and this was given general approval by the Committee and later by Council.

Freedom of Science

Unfortunately, I must now turn from these roseate dreams of future glory to an incident of the present which has rudely disturbed our peace of mind. It is possible that our information is incomplete, or even inaccurate; but it is probable that we have ascertained the more important facts of the case.

I refer to the report that eminent Russian biologists have been constrained to subscribe to interpretations of the data in the field of genetics which they had previously rejected, or perhaps had thought unworthy of serious consideration. According to *Pravda*, "The Academy of Sciences forgot that the most important Principle in Science is the Party Principle". That is a forthright declaration which leaves little scope for ambiguity. The incident is evidently of political, rather than of scientific, importance, and the Royal Society is not concerned with politics.

We regret that the Academy of Sciences of Moscow has broken off its long correspondence with us. We trust that the new conditions will not seriously impede the advance of biological science, for which such qualifications as 'Western' are as irrelevant as they would be for a multiplication table. We impute no blame and express no opinion as a body, but that does not mean that we must take no cognizance of the occurrence, which may have some lessons for us, at least by way of analogy. For example, we may observe that governments are not infallible, yet must be obeyed. This reflexion should make us more than ever alert to preserve intact the prized freedom of science in our own domain. Actually no direct attack is likely here, and should the unexpected happen it will certainly not be along the lines of compelling us to espouse some particular scientific theory or doctrine. Conceivably it could take the more subtle form of control of the character and direction of our scientific work. There is immediate danger in the current deprecation of fundamental research, not of course absolutely, but relatively, in comparison with technological applications. I hope it will be the opinion of all Fellows that the Royal Society should take a leading part in upholding our ideals and in clarifying ideas on these topics, and particularly in insisting on the vital role which the highest kind of disinterested investigation must take in the life of the community. It is certainly not sufficiently realized that the body scientific can only flourish when all its organs are in a healthy condition. As in a biological equilibrium, there is a natural interdependence between pure and applied research. Pure science is fertilized by the advance of technology and *vice versa*. It would be quite consistent, though lamentable, to take up the position that we will have no more research at all, and devote our energies to the exploitation of present knowledge. But it is impossible to dissect the elements of real progress. If we isolate one of the limbs of the organism it will not grow, and will soon die.

Progress of Science

I do not propose to add more than brief comment on new scientific discovery. It will be conceded that the great privilege of addressing the Fellows of the Royal Society is not without its own peculiar embarrassments. For example, I have recently delivered two lectures summarizing results of many years in my own field of work. If I venture on other ground I shall be speaking as an amateur to some of the leading specialists in the world.

Without attempting any kind of assessment of values, or any completeness of survey, I will mention a few things that have been brought to my notice in recent months, often as the result of casual conversation.

Two years ago I referred to the very great value of spectroscopic methods for the study of complex molecules of organic compounds. Since that time there have been striking applications of both ultra-violet and infra-red absorption measurements which have solved some otherwise intractable problems. But one difficulty that threatened to impede progress was the management of minute quantities of material, especially in the solid state.

Dr. C. R. Burch, Warren Research Fellow, has built a reflecting microscope which is perfectly achromatic, and this has now been harnessed to an ultra-violet spectrometer by Barer, Holiday and Jope, and to an infra-red spectrometer by Thompson, Barer and Cole. In the latter case the spectral range 1–14 μ can be covered, and the results are identical with those obtained with larger specimens in more usual apparatus.

The spectra of single biological cells or single crystals weighing less than 10^{-7} gm. have been measured. Polarized infra-red radiation has also been used, and this promises to open up a new method for study of biological specimens, such as muscle fibre, in which orientation exists, as well as new possibilities for crystal analysis. This arises from the relations existing between absorption and orientation of the vibrating groups, whence the angle between certain characteristic bonds and the crystal axis can be determined. Measurements have already been made with minute quantities of new antibiotics and similar substances in connexion with their identification, or the diagnosis of their molecular groups.

The importance of this advance for organic chemists and biochemists cannot be exaggerated. It will surely lead to the routine study of the infra-red absorption of many new compounds, and the relation between the spectra and constitution will therefore become still better known. As the method thus increases in power the demand for its help must also become more insistent.

I am most grateful to Dr. H. W. Thompson for advance news of this remarkable development in technique, details of which will be published in a short time. Soon we shall all be repeating the wistful inquiry that ends Barrie's play: "How much do they cost—those machines?"

I cannot pretend to be competent to discuss applied mathematics, astronomy, or physics; but it is obvious even to the uninitiated that great advances are being made in our knowledge of the mesons and of nuclear fission.

Sir George Thomson, in his Bakerian Lecture, gave a fascinating account of the evidence provided by study of the effects of cosmic rays on atoms, while Prof. E. O. Lawrence, with the aid of his new synchrocyclotron, has been able to produce mesons in the laboratory for the first time.

Prof. E. A. Milne's forthcoming new book will evoke lively discussion, for he tells me that acceptance of his theoretical system involves the assumption that Planck's constant h varies secularly with the time.

On the technical side we hear from America of a new type of valve, a crystal of germanium, which can be made to function as an amplifier.

Coming nearer to my personal interests, the chemists and biologists of Parke, Davis and Co. are to be warmly congratulated on their discovery and investigation of chloromycetin, a new antibiotic which has proved to be highly effective against scrub-typhus and certain analogous infections. The constitution of chloromycetin has not yet been disclosed; but it is said to be known, and apparently the substance has been synthesized. It makes possible the first satisfactory chemotherapy of a disease caused by a Rickettsia, and opens up the possibility of the control of virus diseases more generally.

Another discovery of vast medical, agricultural and biochemical interest arises from the isolation of the intrinsic anti-pernicious anæmia factor from liver. This brilliant consummation, a further triumph of modern chromatography, has been reached by A. Lester-Smith and his colleagues in the Glaxo Laboratories and by a team of chemists of Merck and Co. (New Jersey), led by K. Folkers. The red crystalline substance contains cobalt in a co-ordination complex which has a molecular weight of about 1,600 and probably includes three atoms of phosphorus. It is proposed to call the factor vitamin B_{12} and it is one of the most physiologically active of known substances, a dose of one microgram daily being fully effective therapeutically.

The picture is very quickly being filled in; we heard from Dr. Marston quite recently of his outstanding researches on the cobalt requirements of sheep. A defect of cobalt in the soil leads to sickness and stunted growth with anæmia. Other recent and related work by Drs. Tosic and Mitchell at Aberdeen concerns the assimilation of cobalt by micro-organisms. We may be sure that knowledge of the constitution of B_{12} will suggest other correlations, perhaps with nucleotides, perhaps with folic acid, which will be of vast significance. The molecule is not especially complex by modern standards and its structure can be determined, provided sufficient effort is made. If I am reminded that we are unable to synthesize penicillin, the reply would be that the problems are not comparable. Analysis of substances of this degree of complexity must nowadays always succeed, whereas synthesis may present a difficulty of a different order altogether. The trouble will be to get enough of the factor for investigation by ordinary methods, and this is a good illustration of the value of micro-physical devices. I am told that the infra-red absorption spectrum, determined by the new technique previously mentioned, has already given valuable information, confirming the presence of PO, NH and OH groups, and indicating absence of aliphatic CH, but probable presence of aromatic CH as in benzene or purines.

We seem to be on the verge of great discoveries in another field perhaps not entirely unconnected with the last-mentioned, namely, the problems connected with the effects of chemical substances on cell growth, including malignancy. There cannot be said to be any satisfactory treatment of cancer by chemical means, though various agents exert a beneficial effect in special cases. Such are stilbœstrol, testosterone and the so-called nitrogen mustards. Of these, stilbœstrol has the best claim to be regarded as a curative agent in a proportion of cases, and the halo-alkylamines ameliorate the condition of the patient. In the United States, Dr. Rhoads and his colleagues have paid much attention to antagonists of folic acid. These are synthetic compounds the molecules of which are planned to resemble those of folic acid. Several of them have been found to exert an inhibitory effect on the bone marrow, producing anæmia, which can be reversed by folic acid. Similar antagonism is observed with bacteria, and furthermore Hertz has reported that certain of these substances inhibit the action of stilbœstrol on the oviduct of the chick.

One of the most promising of the substances is called A-methopterin. This is folic acid with an amino-group replacing hydroxyl and a methyl group replacing hydrogen, quite a close analogue. The substance is anti-folic, anti-œstrogenic, and it has a definite inhibitory effect on the growth of tumours in laboratory animals, as well as of malignant cells in tissue culture. Folic acid is regarded as necessary for the growth of all cells, and the hope is to find a substance of low toxicity which will antagonize this factor to the level necessary to immobilize the more sensitive malignant growth without serious detriment to normal cells. It is known that laboratory work has encouraged clinical trials, but the results have not yet been disclosed.

Dr. T. B. Heaton and my wife have published a preliminary account of work which finds its origin in observations made many years ago on a growth-inhibiting constituent of yeast (Heaton, 1926). This was a differential growth-inhibitor affecting the connective tissue cells but not the epithelia of cultures *in vitro*.

They have now prepared carbohydrate material from wheat middlings which is either itself active, or more probably contains an active principle. This produces retrogression of the implanted Walker carcinoma in rats.

It is decidedly interesting to find such a substance in a foodstuff; it may even be a vitamin. Since in some of the earlier experiments the material had been held at a low pH, the formation of hydroxymethylfurfuraldehyde was a possibility, and it was known that many aldehydes possessed growth-inhibitory properties. It was found that hydroxymethylfurfuraldehyde, or better its polymeride, also caused the retrogression of the tumours. The connexion, if any, between these findings is not yet clear.

At the Chester Beatty Research Institute, Dr. A. Haddow and his colleagues have tested the effects on normal growth of a number of pyrimidine derivatives. The developments have sprung from experiments designed for other purposes—and the sequence is of more than passing interest. It started with the yellow enzyme and a series of experiments designed to test the effect on growth of a series of synthetic analogues of the flavins.

Administration of 9-phenyl-5 : 6-benzo-*iso*-alloxazine to albino rats was accidentally, and most unexpectedly, found to produce an orange-yellow pigmentation of the hair (Haddow, Elson, Roe, Rudall and Timmis, 1945). Pursuing this curious observation, other coloured substances of a similar type were tested, and among them xanthopterin, the butterfly wing pigment, first isolated by Wieland and Schöpf in 1925. This did not colour the coat but produced a significant enlargement in the size of the rat kidney. It was an actual growth of the organ due to a great outburst of cell division in the kidney tubules.

In the course of still another research, that on the carcinogenicity of many styrylpyrimidines (Haddow and Kon), it was found that two substances of this group closely allied to xanthopterin in structure had the same effect in increasing the growth of the kidney. This cannot be mere coincidence and proves that the effect is a primary one of xanthopterin and the related pyrimidines on the cell. The phenomenon has been observed in the rat, mouse, *Peromyscus*, the rabbit, hamster and guinea pig.

Now xanthopterin is of natural occurrence in the kidney and it is possible that it is present as a growth regulator. Its structural relationship with folic acid will not be overlooked. Haddow and his associates feel that it is at least as important to study the means by which normal growth is so delicately adjusted as to inquire directly why the malignant cell is unregulated.

There are further experimental foundations for these ideas which lead Haddow and his collaborators to surmise that the co-ordinated growth of the normal tissues may depend upon the supply of essential substances from an external source and that, contrariwise, malignant cells may have acquired the power to synthesize these essential substances, or their equivalents, themselves. Such suggestions are fully consonant with all that we know of the subject as a whole and give a new prospect for the chemistry of growth and differentiation.

I am much obliged to Dr. Haddow for kindly acquainting me with results and ideas which are not yet published in full and for permission to mention them to-day.

I would not like to leave this subject without an incidental reference to Berenblum's significant discovery of sensitization of tissues to the action of carcinogenic agents. The constituents of croton oil, for example, directly or indirectly, prepare the ground for a carcinogenic hydrocarbon in a remarkable manner. The underlying biochemical processes may be hard to bring to light; but the effort to do so would doubtless be repaid with interest.

As a drama like that of the pyrimidine group unfolds we can look back on the steps of the pioneers and be thankful that they selected the paths which led into such rich territory. But it often appeared to contemporaries that they were wandering into a barren wilderness. 'Whatever makes Hopkins think that there can be any possible interest in the pigments of butterflies? Why does Windaus waste his time and talent on that impossible substance cholesterol? I have heard those actual questions asked in past years and would invite consideration of the answers that can be given to them now.

Another thought arising from recent progress is that the world of biochemistry, though of vast extent and interest, is finite, and we are beginning to sense the existence of its boundaries. We seem to encounter the same thing more often than might be expected; coincidences are indeed of frequent occurrence.

An example has already been mentioned and another is the recent discovery that the photodynamic colouring matter of St. John's wort, hypericin (Brockmann *et al.*, 1939, 1942; Pace and McKinney, 1941; Dhéré, 1939, 1943), is closely allied to a pigment of the Aphididæ, erythroaphin, studied by A. R. Todd and his collaborators at Cambridge (1948). Further, these substances are related to a mould pigment, oxypenicilliopsin, isolated by Oxford and Raistrick (1940). The pigments are *bis*-anthracene derivatives of some kind and it is surprising to find these little investigated and highly characteristic substances so widely distributed in Nature.

A notable coincidence in my own field of work arose very recently from a theory of Woodward regarding the course of the synthesis of strychnine in the plant. He advanced what seemed at first the fantastic idea that a benzene nucleus, originally that of dihydroxyphenylalanine (or tyrosine), suffers fission so as to give two oxidized chains which enter into further transformations.

Transferring this mechanism piecemeal into an entirely different group of alkaloids, it was found to predict that constitution of emetine which can now be experimentally demonstrated to be correct. I am glad of this opportunity to say that I was unaware until quite recently of parallel, independent work by Dr. H. T. Openshaw on the constitution of emetine. This was submitted for publication some months ago and includes the establishment of one detail of the structure not fully proved by the work of Späth, of Pailer and of Karrer. A few months ago no connexion whatever could be discerned between strychnine and emetine, they seemed poles apart. Now at one stroke they are connected by recognition of a common and remarkable type of biogenesis.

A PROPOSED INSTITUTE OF BIOLOGY

By DR. J. F. DANIELLI

INSTITUTES or analogous foundations have rendered great services to physicists, medical men, engineers, chemists, anthropologists and many other professional groups. No such foundation exists to serve the needs of biologists. Recently the Biological Council, consisting of representatives of nineteen different biological societies, was asked by a number of these societies to examine the possibility of forming an Institute of Biology. In a preliminary investigation the views of a number of representative biologists were obtained, and information was also available from the Institute of Biology recently established in the United States under the auspices of the National Research Council.

There are two aspects of an Institute which are of general interest: on one hand there is the daily life of an Institute; and on the other hand, there is the long-term influence of an Institute on policy.

The setting up of an Institute would immediately give to biologists a central address and general office service, and should ultimately provide a club and meeting rooms. An Institute would produce a bulletin to carry news and notices, maintain a watch on legislation and international matters of interest to biologists, maintain an employment bureau, and protect the standards of employment of its members, if need be by providing legal aid. A public relations service would be maintained, members would be advised in their dealings with the Press and with publishing firms. Special income-tax problems would be considered and the establishment of special relationships with trading firms and with insurance offices would be sought. Such day-to-day activities constitute a group of sound reasons for forming an Institute.

Of equal importance are the arguments based on consideration of policy. These include:

(*a*) The lack of a representative body of biologists. This causes two difficulties. It is difficult for those who are not biologists to obtain a measure of the balance of biological opinion on matters which may, for example, come within their province of administration. It is also difficult for biologists to place proposals before Government and other bodies, since at present such proposals cannot receive the backing of a representative body.

(*b*) Biology is becoming of increasing importance in industry and for the economic and physical well-being of the country. But at present the authority of biologists in these fields is restricted, and often in consequence insufficiently serious consideration is given to the purely biological aspects of a problem. The modification of this position is hampered by lack of professional organisation, by the general ignorance of biological factors and by the prevailing dominance of the strong professional organisations of chemists, physicists, veterinarians and medical men.

(*c*) Many biologists are now going into industry and their numbers are likely to increase. In the absence of any recognized Institute of Biology there is a tendency for membership of academic societies to be quoted as a qualification. This is an undesirable practice which may reach serious proportions. It did so, for example, in the cases of the Chemical Society and the Psychological Society. The formation of a recognized Institute with established qualifications for admission would put an end to this practice.

(*d*) Biologists are still badly paid in comparison with other professional groups. It is felt that this is at least in part the result of there being no professional body to look after the interests of biologists.

(*e*) The channels whereby biologists may be recruited are sometimes inadequate, and appointments too often depend mainly on chance. This situation would be improved by formation of an Institute with an appointments register. It is of interest that, in one recent year, out of the ten thousand members of the Institute of Chemistry, no fewer than one thousand made use of the appointments register.

(*f*) The formation of an Institute of Biology, embracing both academic and applied biologists, would be of national service, since it could assist in securing better financial support for biological research. It would also perform a most valuable service in surveying the position of biological science in general education, and the more specialized training of professional biologists.

With these considerations in mind, the Biological Council has decided to conduct a postal ballot of biologists, the distribution of ballot papers being made by the affiliated societies. In this ballot biologists are asked to state whether they would support an Institute, and to give the Council their opinions on the formation of an Institute.

An Institute can be formed only if a sufficiently large number of biologists are prepared to support it. If this support is forthcoming, the Biological Council will call a central meeting of biologists, at which officers and a provisional council can be elected. For the first year of its foundation the Institute could be run on a largely voluntary basis, during which time a constitution would be evolved, office premises found, etc.

The Biological Council envisages the Institute being open to all who are engaged in biology as a profession. Those joining would probably fall into two categories of membership, namely, associate members, holding an honours degree in biology or its equivalent, and full members, holding a degree of D.Sc. or its equivalent. In addition, provision should be made for scientific societies to become affiliated to the Institute. The Council of the Institute we envisage as elected in two ways—some of the members being elected by the individual members of the Institute, and others nominated as representatives of the affiliated societies. But the final decision on these details would, of course, be taken when a constitution is agreed upon.

It is not intended to exclude people who have no degrees, or to limit full membership to those with D.Sc. degrees. There is no reason why a biologist should not be either an associate or full member while having no degree, provided he has a training, or has achieved a status, which can be regarded as equivalent to that indicated by a degree. However, it may well be that the foundation members will prefer to have only one category of membership. All decisions on such matters, including the constitution, will, of course, rest with those biologists who indicate, by voting in the Biological Council's ballot, a desire to participate in the formation of an Institute of Biology.

Biologists who are members of a society affiliated to the Biological Council will receive a ballot paper from their society. Those who are not members of an affiliated society may obtain a ballot paper from one of the joint secretaries of the Biological Council, namely, Dr. J. F. Danielli, The Chester Beatty Research Institute, Royal Cancer Hospital, Fulham Road, London, S.W.3, or Dr. W. P. K. Findlay, Forest Products Research Laboratory, Princes Risborough, Bucks, or Prof. J. Z. Young, Department of Anatomy, University College, Gower Street, London, W.C.1.

The societies affiliated to the Biological Council are: Anatomical Society, Genetical Society, British Mycological Society, Linnean Society, Nutrition Society, Society for General Microbiology, Pathological Society, Biochemical Society, Pharmacological Society, Physiological Society, Society for Experimental Biology, British Ecological Society, Royal Entomological Society, Marine Biological Association, Association of Applied Biologists, Royal Horticultural Society, Eugenics Society, Association for the Study of Systematics in Relation to General Biology, and Society of Applied Bacteriology.

OBITUARIES

Prof. E. F. Burton, O.B.E.

Eli Franklin Burton, director of the Physics Laboratory, University of Toronto, died in Toronto on July 6, 1948.

Born in February 1879, he attended high school in Toronto and took the honours course in mathematics and physics at the University of Toronto, graduating in 1901. His first researches were carried on under the late Prof. J. C. McLennan and included work on the penetrating radiation from the earth (they just missed discovering the cosmic rays). Burton then proceeded to Cambridge in 1904 as an 1851 Exhibition Scholar and worked under J. J. Thomson on colloidal particles. Returning to Toronto, he assisted McLennan in the fitting up of the new physics building (now called the McLennan Laboratory) and obtained his doctorate of philosophy in 1910. He was promoted to an associate professorship in 1911 and to full professorship in 1924. In the First World War he was a member of a team consisting of McLennan, Satterly, Dawes and Patterson (of the Meteorological Service of Canada), and occupied himself with the problem of the estimation of helium gas in the natural gas of Canada and its extraction therefrom for use in balloons. He also was acting head of the department when McLennan was called to Britain to assist in the scientific work at the Admiralty.

On the return of peace and McLennan, Burton and his assistants continued his work on colloidal solutions and later published a monograph on the physical properties of colloidal solutions. A third edition of this book was published with the collaboration of Miss May Annetts in 1936. At one time he was very interested in the application of colloidal arsenic solutions to abate the onset of cancer, and in this work he was assisted by Dr. Hendricks. Although he fought hard for recognition of his method and he had concluded from X-ray photographs that the method had some advantages, the medical profession remained cold and the work was eventually dropped.

Just after the beginning of the Second World War, Burton had the intuition that radio-location would play a vital part in the contest. He tried hard to interest the Services and to get them to send their brighter men to take a course in radar; but they declined. Then he enlisted the support of a Toronto Kiwanis Club, who provided sufficient monetary assistance to enable the Physics Department of the University of Toronto to run a summer course in 1940 for about twenty selected men. Burton had the satisfaction in later years of knowing that some of these men, in ship and on land, filled very important posts in the Empire radar services. In the succeeding years he almost forced the Services to start classes in radar not only in Toronto but also across the Dominion, for the Royal Canadian Air Force and the Canadian Army, and eventually a large number of men were trained who served in all parts of the world.

Burton was also a director of Research Enterprises, Ltd., a Crown research company managed by Colonel Eric Phillips, now chairman of the board of governors of the University of Toronto. 'R.E.L.', as it was called, built huge factories and laboratories at Leaside just outside Toronto in which all kinds of apparatus for war purposes were made and assembled; mention need only be made of radar outfits, optical glass, periscopes and range-finders. Because the men could work under better and quieter conditions than in Toronto, the very complicated radar sets for the large battleships of the Navy were built at Leaside. As side issues, Burton promoted (with Pitt) the invention and design of proximity fuses for shells, and other investigations on the flight of shells, and directed research on problems in audition connected with shell shock. For this work he was awarded an O.B.E. in 1943. It was a great grief to Burton when, after the end of the War, the Government decided to relinquish all the work at 'R.E.L.' and to sell parts of the establishment; he had hoped that a portion of it would be maintained as a factory for the manufacture of scientific apparatus for use in Canada.

On McLennan's retirement from Toronto in 1932, Burton became director of the Physical Laboratory, and soon after that developed with A. Pitt and others the study of valve circuits, leading in one instance to the Burton–Pitt electrical method for the determination of the water content of grains and soils. The low-temperature work (initiated by McLennan) on helium and the superconductivity of metals was carried on by Burton and others. The study of the viscosity of liquid helium I and II, with the discovery of the very low viscosity of liquid helium II, opened up a new field which he, with the help of Wilhelm and Misener, vigorously prosecuted. Also, with the help of Grayson-Smith and others, he carried on the work of superconductivity and in 1934 published a small book on the subject.

Elected to the fellowship of the Royal Society of Canada in 1913, he became president of the Mathematics, Physics and Chemistry Section in 1934–35 and was awarded the J. M. Tory Medal in 1947. He was also president in 1931–32 of the Royal Canadian Institute, a Toronto society which gives public lectures on scientific subjects adapted for the general public. As a member of the National Research Council of Canada for many years, he gave much of his time and energy to the furtherance of scientific work in Canada and for providing means for young Canadians to stay at home and develop their own country rather than emigrate to the United States.

During the war years, Burton encouraged Prebus and Hillier to build an electron microscope. This was based on an existing European design and was probably the first electron microscope set up on the American side of the Atlantic. Burton gave Hillier and his successors all the backing he could, so that the Toronto School of Electron Microscopy has been in the forefront of this work, and many of the men who have been through it have secured important posts in the United States.

The physics building of the University of Toronto was sorely overtaxed for space during the war years, and as soon as labour was available Burton persuaded the board of governors to build a new wing to the building, which increased the total space by about thirty per cent. The new wing was named by the governors the "Burton Wing", and Burton was enabled to see it unofficially opened in May 1948. In this new wing there are special suites for research work on low-temperature problems, radio-work, and especially for electron microscopy. The Electron Microscope Society of America met here in September to honour the man who had done so much, but unfortunately he had passed away before he could receive their congratulations.

Dr. Burton was one of the most cheerful and kindly of men. Unfortunately, in later years his energy was undermined by diabetes and heart-shocks, and in his last year failing memory and eyesight robbed him of his lively good humour. He leaves an honoured name in Toronto and Canada generally. He is survived by his widow and one son and one daughter.

JOHN SATTERLY

Dr. Susan Isaacs, C.B.E.

SUSAN ISAACS died on October 12 at the age of sixty-three. Few can have had a greater influence in our time on the upbringing and education of children; indeed, the modern trend towards full recognition of the human aspect of nursery school and subsequent education owes much to her work.

Dr. Isaacs was the daughter of William Fairhurst, of Bolton, Lancashire, and of Miriam Sutherland. Educated at Bolton Secondary School and at the Universities of Manchester and Cambridge, she became a research student at Cambridge in the Psychological Laboratory in 1912, and then lecturer in psychology at Darlington Training College. In 1924 she was invited to become principal of the Malting House School at Cambridge. It was during the following three years that she gathered the comprehensive data of children's behaviour, thoughts and feelings which she presented brilliantly in her two books "Intellectual Growth in Young Children" (1930) and "Social Development in Young Children" (1933).

In 1933 she was made head of the new Department of Child Development of the University of London, at the Institute of Education. She held this post with outstanding success for ten years. In the course of that time a large number of experienced teachers and educationists were enriched by the wide and deep new knowledge which she was able to impart, and above all by her vivid sense of every child as a full, living personality, needing to be imaginatively realized and understood in his own right.

Dr. Isaacs turned to the new insight offered by Freudian psycho-analysis as soon as this work became generally known in England, and joined the British Psycho-Analytical Society in 1921. She was appointed a psychologist on the staff of the London Clinic of Psycho-Analysis in the year 1931. She remained on the staff of the Clinic until her death, and contributed signally in a great number of ways to the scientific work of the Society and to the practical work of the Institute. She was a valued member of the Training Committee and of the Council.

Dr. Isaacs was a clear writer as well as teacher and lecturer; her books and scientific papers are well known to students of psychology to-day. Her small handbook for mothers and teachers, "The Nursery Years", written in 1929, is known all over the world; it was awarded the Parents' Magazine Medal in the United States. "The Children We Teach" is another little book which is widely popular. One of the two books published just before her death is "Childhood and After", containing essays and clinical psychological studies which belong to the later period of her life [see review on p. 871]. A chapter in it called "Children in Institutions", originally a memorandum presented to the Home Office Care of Children Committee, known as the Curtis Committee, 1945, was probably the most important single document consulted by that Committee.

Dr. Isaacs' gifts were based on a combination of intellectual and emotional factors. Her passionate interest in the conditions, first, of young children's education, and, secondly, of their general upbringing in the home, arose out of her own experiences. Her mother's death when she was just six, terminating a fatal and incapacitating illness which started when Susan was barely four, led her to find in her first elementary school in a Lancashire town in the 1880's a refuge and solace from the tragedy at home, but also to become very quickly a rebel against its manifold constraints and inadequacies. This disappointed eagerness and keen sense of what 'school' might have been like, but in fact was not, remained in the background of her mind throughout her growth and did much to shape her later life-work.

It became clear to her at an early stage in her development that mere criticism and mere abandonment of existing methods could bring no constructive results. She quickly assimilated and adopted the most advanced educational ideas current at the time, and her immediate response to the new teaching of psycho-analysis showed that no conventional opposition or resistances could stand in the way of her unhesitating acceptance of anything that offered her wider horizons and deeper understanding. In the same way, at a later stage, when Melanie Klein's ideas were first put forward in Great Britain, she was among the earliest to sense the further sources of knowledge which were now opening up. She saw how these new ideas could be developed to the general benefit of every child's upbringing, and from that moment she pursued that knowledge, and applied it untiringly up to the very last.

Her outstanding intellectual characteristic was an extremely rapid and comprehensive grasp of the matter in view and an ability to classify and summarize it, to present it with remarkable clarity, and to discuss it from various angles. Her exceptional capacity for instantly translating her thoughts and impressions into verbal expression served as a powerful instrument for all her other gifts.

It was characteristic of Susan Isaacs that when she found that there was a great deal which she had not yet encompassed, especially in the work of Melanie Klein, she decided (although she was already a member of the British Psycho-Analytical Society) to start again as a trainee and to go through the whole course. Thus she developed further, undergoing a second long personal analysis, and greatly enriched her own work and the contribution which she was eventually able to make to general psycho-analytic research. In her last years she devoted herself almost entirely to actual analytic practice, and felt this to be the most satisfying of the various kinds of work she had done.

In her husband, Nathan Isaacs, she had a constant friend and supporter, and a constructive critic.

DR. FRANTIŠEK BĚHOUNEK, lecturer in radiology at the Charles University of Prague, died at the end of October at the age of fifty. He had been a pupil of Mme. Curie and had developed a method for measuring atmospheric radioactivity. In 1926 he accompanied General Nobile on his ill-fated polar expedition, and when the airship *Citta di Milano* came to grief they were rescued by the Russian ice-breaker *Krassin*. Běhounek, with Heyrovský, wrote the standard Czech text-book of radioactivity.

NEWS and VIEWS

Science in the U.S.S.R.

In his presidential address to the Royal Society, delivered on November 30 (see p. 872), Sir Robert Robinson refers to the restrictions which have been placed on biological teaching and research in the U.S.S.R. Also simultaneously, his predecessor in the presidential chair of the Royal Society, Sir Henry Dale, has resigned his honorary membership of the Academy of Sciences of the U.S.S.R., because, as he says in a letter to the president of that Academy, "I believe that I should do a dis-service even to my scientific colleagues in the U.S.S.R. if I were to retain an association in which I might appear to condone the actions by which your Academy, under whatever compulsion, is now responsible for such a terrible injury to the freedom and the integrity of Science". In his announcement of his resignation, Sir Henry recalls that his election took place while he was president of the Royal Society, and that it was widely welcomed among British scientific men "as the symbol of a community of purpose between the scientists of our two nations . . . in defending, as we believed, the freedom of Science, as of all man's proper activities, from the threat of an aggressive tyranny". He points out that in the same year, 1942, N. I. Vavilov was elected a foreign member of the Royal Society in recognition of his contribution, by research in the U.S.S.R., to advances in genetics. But Vavilov had fallen into disfavour, and even now the Royal Society does not know whether he was alive at the time of his election to foreign membership. "More recent events, of which full reports have come to hand, have made it clear what has happened. The late N. I. Vavilov had been replaced by T. D. Lysenko, the advocate of a doctrine of evolution which, in effect, denies all the progress made by research in that field since Lamarck's speculations appeared early in the nineteenth century. Though Darwin's work is still formally acknowledged in the U.S.S.R., his essential discovery is now to be rejected there. The whole great fabric of exact knowledge, still growing at the hands of those who have followed Mendel, Bateson and Morgan, is to be repudiated and denounced; and the last few, who were still contributing to it in the U.S.S.R., have now been deprived of position and opportunity. This is not the result of an honest and open conflict of scientific opinions; Lysenko's own claim and statements make it clear that his dogma has been established and enforced by the Central Committee of the Communist Party, as conforming to the political philosophy of Marx and Lenin. . . . It remains to be seen whether such compliance with dogma is to be exacted in other departments of Science. So far as we know only that of the genetics encouraged by Lenin is now prohibited as alien to his political philosophy."

Dr. H. J. Muller, the distinguished American geneticist, has also resigned his honorary membership of the Academy of Sciences of the U.S.S.R.

Royal Society: Officers for 1949

At the anniversary meeting of the Royal Society on November 30, the following were elected as officers and council for the ensuing year: *President*, Sir Robert Robinson; *Treasurer*, Sir Thomas Merton; *Secretaries*, Sir Edward Salisbury and Prof. D. Brunt; *Foreign Secretary*, Prof. E. D. Adrian; *Other Members of Council*, Prof. J. D. Bernal, Prof. G. R. Cameron, Sir James Chadwick, Prof. S. Chapman, Prof. H. Davenport, Sir Frank Engledow, Prof. W. E. Garner, Prof. A. C. Hardy, Dr. C. H. Kellaway, Prof. G. F. Marrian, Sir William Stanier, Dr. H. G. Thornton, Prof. C. E. Tilley, Dr. A. E. Trueman, Prof. S. Zuckerman.

British Association: Newcastle Meeting, 1949

Next year the British Association for the Advancement of Science will meet in Newcastle-upon-Tyne (August 31–September 7). The Council has completed appointments to the various offices in the Association; these include: *President*, Sir John Russell; *General Treasurer*, M. G. Bennett; *General Secretaries*, Dr. Edward Hindle and Sir Richard Southwell; *Presidents of Sections*, Sir Harold Spencer Jones (Physics and Mathematics); Sir Alfred Egerton (Chemistry); Prof. W. J. Pugh (Geology); Prof. A. C. Hardy (Zoology); Prof. L. Dudley Stamp (Geography); Sir Alexander Gray (Economics); Sir Arthur Fleming (Engineering); Mr. M. C. Burkitt (Anthropology and Archæology); Prof. R. A. Peters (Physiology); Prof. Godfrey H. Thomson (Psychology); Prof. Lily Newton (Botany); Sir Fred Clarke (Education); Prof. N. M. Comber (Agriculture). The chairman of the Local Executive Committee is Lord Eustace Percy. The Lord Mayor of Newcastle has issued an appeal for a local fund of £4,000, and more than two hundred local volunteers are already making preparations for what is expected to be one of the largest meetings in the history of the British Association.

Unesco: New Director General

At the Third General Conference of Unesco now being held in Beirut, M. Jaime Torres Bodet, Mexican Foreign Minister, has been elected director general in succession to Dr. Julian Huxley, who has held office since the inception of Unesco two years ago. M. Bodet, who is forty-six years of age, was head of the library department of the Mexican Ministry of Education during 1922–24. From 1924 until 1928, he was professor of French literature in the University of Mexico. In 1929 he entered the Foreign Service and successively held positions in Mexican legations in Spain, Holland and France. During 1936–37 he was director of the Diplomatic Department of the Ministry of Foreign Affairs and the following two years he spent as chargé d'affaires in Brussels. From 1940 until 1943 he was Under-Secretary for Foreign Affairs, after which he was appointed Minister of Education. In this capacity he conducted a campaign against illiteracy, founded circulating libraries, organised a system of rural education, and devoted his whole time to the orientation and administration of education in Mexico.

Bicentenary of Berthollet

Claude Louis Berthollet, the associate of Lavoisier and himself a distinguished chemist, was not a native of France but was born at Talloires, near Annecy, in Savoy, on December 9, 1748. He was educated at Chambéry and at Turin. After taking his doctor's degree at the latter place he became physician to Philip, Duke of Orleans, in which capacity he made a name for himself as a chemical discoverer. In 1781 he was made a member of the Academy of Sciences of Paris and afterwards became director of the Government dye works. His discovery of the composition of ammonia was made in 1785 and that of the bleaching power of chlorine in 1786. With Lavoisier, Fourcroy and Guyton de Morveau he compiled the "Methode de Nomenclature Chimique" in 1787. He was one of the first to become a convert to the views of Lavoisier. The Revolution, while it brought him into danger, also called forth his organising powers, and it was largely due to his efforts that the saltpetre supply of France was maintained at a critical time. With Monge and Clouet he did much to improve and extend the manufacture of steel. In the reorganisation of the Academy and the inauguration of the Institute in 1795 Berthollet took an active part. Napoleon appointed him and Monge as heads of a Commission to select from the spoils of Italy the choicest works of art, and Berthollet was one of the group of French men of science who accompanied him to Egypt. In 1803 he published his well-known "Essai de statique chimique". Four years later he founded the famous Société d'Arcueil, comprising as members Laplace, Biot, Gay Lussac, Thenard and one or two others. After the suicide in distressing circumstances of Berthollet's son, the Society was broken up and from that time Berthollet lived in retirement. He was a senator, a grand officer of the Legion of Honour, and under the empire was created a count. He died at Arcueil after a long and painful illness on November 6, 1822. His character was amiable, frank and sincere. Though he enjoyed a great reputation in his time, he was modest and unostentatious and his honesty and courage were sufficient to impress even Robespierre. His eulogy was pronounced before the Academy of Sciences by Cuvier.

Radioactive 'Tracers' for Germany

A CONTRACT for the supply of radioactive tracers to approved research institutes in the Bizone of Germany has recently been placed with the Atomic Energy Research Establishment, Harwell, by the Joint Export–Import Agency, following the decision of the Isotope Allocation Committee of the Ministry of Supply in January last that radioactive 'tracers' produced in the Harwell Gleep could be made available for research work in Germany. The decision of the Isotope Allocation Committee was communicated to the authority responsible for the control of research in the British Zone, who immediately informed the U.S. Research Control Group. Together they approached the board of the import agency, supported by their respective public health advisers: and with the minimum of delay the Board authorized the import of radioactive tracers from Harwell into the Bizone.

Research institutes in the Bizone thus gain access to a range of radioactive tracers, the indigenous production of which is denied to Germany under Control Council Law No. 25 for the Control of Research. Their allocation within the Bizone is the responsibility of a small German committee, competent to decide where proper use will be made of the small total supply of 'tracers' at present available from Harwell to Germany. In order to assist the Committee in its task, a team of experts from Harwell visited Germany during October and demonstrated the latest ancillary equipment. Thus everything possible has been done to ensure that the maximum use shall be made of the limited quantities of radioactive 'tracers' which can be spared by the Atomic Energy Research Establishment at Harwell for export to the Bizone.

Research Council of Alberta

THE twenty-eighth annual report of the Research Council of Alberta (King's Printer: Edmonton) summarizes the work of the Council for 1947. All investigations in progress in 1946 were continued and a new project involving a survey of road surface conditions existing at selected places on the main highways of the Province, both where there was evidence of deterioration of the pavement and where the road appeared to be standing up satisfactorily in service, was commenced. The Council has continued to take a close interest in the bituminous sand separation plant being erected at Bitumount on the Athabaska River, and further laboratory work has shown that the loss of oil in the hot separation process is not due to filming on to particle surfaces but to the flecks below a critical size being enmeshed among the particles and afterwards, on redispersion of the tailings, settling with the clay, increase of clay content in the bituminous sand decreasing the oil recovery. Work on the applicability of water-flooding to the bituminous sands has continued, as well as on the systematic examination of Alberta coals and on the carbonization of low-grade sub-bituminous coals in the pilot plant low-temperature retort designed on the principle of a vertical shaft carbonizer. Investigations on the preparation of Alberta coals for the market and on some aspects of the chemical constitution of coal have been commenced. The Gasoline and Oil Testing Laboratory has widened its scope and now includes the examination of aviation, jet, Diesel and other fuel oils, petrol, lubricating oils, hydraulic fluids and solvents. Geological work included investigations of coal, clays, sand, water and miscellaneous mineral investigations, the major project being a survey along Evans-Thomas, Ribbon and Pigeon Creeks to determine coal measures in that area. Under the natural gas project for the conversion of carbon monoxide and hydrogen, from natural gas and oxygen, into a product resembling crude oil, the influence of operating conditions, catalyst structure and composition on the yields of liquid hydrocarbons was further studied, and a modified Emmett apparatus used to measure the surface areas of various catalysts. A market survey of poplar products was conducted, and the soil survey programme was continued in co-operation with the Dominion Department of Agriculture and the University Department of Soils. Tests were also made on the utilization of quartz sand and of straw.

Field Archæology in Great Britain

A NEW report, the "Survey and Policy of Field Research in the Archæology of Great Britain. 1: The Prehistoric and early Historic Ages to the Seventh Century A.D.", has recently been published by the Council for British Archæology, Institute of Archæology in the University of London (1948; price 5s.). The object of this publication is to consider briefly—in only 120 pages—the present state and future desirable direction of British field research. A number of archæologists have epitomized, without references, their present ideas about the periods under review and have pointed out where further work should be undertaken to settle doubtful questions and to fill in gaps. The idea of giving a present starting point and of suggesting where investigators should concentrate their efforts in the future is excellent. But it is not easy of execution. A volume issued under the auspices of the Council for British Archæology might be considered as indeed authoritative, yet the reader should remember that some of the statements made are really matters of opinion of the writers concerned and not universally agreed upon. For example, a number of investigators cannot agree with the statement at the top of page 21, and will affirm on the contrary that the industries in the top gravels of the 100-ft. terrace below London are indeed quite late and do belong to the same series as those from East Anglia mentioned at the bottom of page 20. Again, in such a short epitome is it not perhaps a pity to have introduced a totally new nomenclature for the glaciations which has not yet been to any extent accepted? The considerable cave excavations of Upper Palæolithic industries are dismissed in about three sentences, which is scarcely sufficient. The Neolithic Age is allowed three pages. Those who have studied the period will know the subject-matter already, while those who are less instructed will find the discussion far too condensed. But such a work lends itself to criticisms on almost every page, and yet undoubtedly it has a definite value. It covers a far wider range in time than most archæological works dealing with Great Britain, and in spite of criticisms of details, it does give a bird's-eye view of what is known of the period under review. The pin-pointing of what is required to be discovered by future investigators is also very useful.

Agricultural and Horticultural Research Station, Long Ashton

The annual report of the Agricultural and Horticultural Research Station, Long Ashton, for 1947 has now been published (price 10*s*.). The problems of the cider industry naturally play a prominent part in the work of the Station, and a list of suitable varieties for planting has been drawn up. Sweet and bitter-sweet sorts are specially advised, since many orchards at present contain too high a proportion of sharp varieties. Studies on the chemical composition of different ciders have been started and already fresh lines for further research work are indicated, which may well lead to results of practical importance. Another group of papers deals with the black currant crop. New varieties are described, and management and manurial treatment discussed. The nitrogen requirement of this crop is particularly high, and composts and stable manure alone have proved inadequate. Both fruit and vegetable crops are included in the investigations on plant nutrition. New methods have been developed for studying molybdenum deficiency in sand culture, while in the soil acidity investigations, some account is given of how the specific effects of aluminium toxicity, manganese toxicity, and calcium deficiency in various crops may be distinguished. As regards plant pests, a fluorine compound, *bis*-(β-fluoroethoxymethane), has been found to exert remarkable insecticidal properties, when watered on the soil, on beans and cauliflowers. Although compounds of this type cannot be used in commercial horticulture in view of their extremely poisonous nature, the discovery is of importance, for by it, light may be thrown on the process of translocation within the plant tissues.

Local Government

The problem of the definition of local government areas for one purpose or another is a very complex one. The needs of local administration have long outgrown the existing framework, and for every aspect of local government the boundaries need to be redrawn. In a paper in the *Geographical Journal* (111, 4–6) entitled "The Boundaries of Local Government Areas", Mr. E. W. Gilbert discusses some of the problems involved, especially as the geographer sees them, with reference to the "Local Government Boundary Commission Report" for the year 1946. A valuable feature of his paper is the series of twenty maps of England and Wales showing boundaries of areas that have been used or suggested for the different purposes, including gas and coal boards, electricity, railways, hospitals, post office, weather forecasts, and so forth. The divergence of views is obvious from these maps. Provinces or areas, each with a regional consciousness, do occur; there is no question of that; but the difficulty lies in their definitions. Even as regards towns the problem is not easy since town boundaries are arbitrary and do not coincide with the urban areas. Again, it is essential that the confines of an administrative region should embrace an area of which all parts are easily accessible in terms of time and expense. This feature has much to do with the growth of regional consciousness.

"Silva of North America"

"Silva of North America", the authoritative description of the trees which grow naturally in North America exclusive of Mexico, by Prof. C. S. Sargent, long out of print, has now been reprinted by Peter Smith, 321 Fifth Avenue, New York, 16, in a limited edition, complete with all the illustrations, in fourteen volumes (bound in seven) at 200 dollars net. Permission to reprint these books was granted to Peter Smith by Dr. E. D. Merrill, director of the Arnold Arboretum.

Announcements

Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, has been appointed principal and vice-chancellor of the University of Edinburgh. It has also been announced that Sir Edward has been awarded the Valdemar Poulsen Gold Medal of the Danish Academy of Technical Sciences, "for outstanding contributions to radio technics and particularly for remarkable achievement in research on the ionosphere". The award was instituted in commemoration of the work of Dr. V. Poulsen, the inventor of the Poulsen arc and a pioneer of radio-telephony, who received the first medal on the occasion of his seventieth birthday on November 23, 1939.

Mr. Roger Duncalfe has been elected chairman of the General Council of the British Standards Institution in succession to the late Sir Clifford Paterson.

The Council of Scientific and Industrial Research, India, has established an Indian Scientific Liaison Office in London, and Dr. S. Bhagavantam, who was professor of physics in the Andhra University, Waltair (India), has been appointed chief scientific liaison officer. This Office is with the Scientific Liaison Offices of the other Dominions, at Africa House, Kingsway, London, W.C.2.

The price of Richardson's "Veterinary Protozoology" reviewed in *Nature* of November 13, p. 756, is given as 10*s*. net. We are informed by the publishers, Messrs. Oliver and Boyd, Ltd., that the correct price is 18*s*. net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Heterochromatic Fabry – Perot Fringe System Applicable to the Interferometry of Absorption Spectra

PARTIALLY successful attempts to apply the high resolving power of Fabry – Perot étalons to the study of astronomical absorption spectra have been made by Burns[1], Shane[2] and others. None of the arrangements hitherto employed has been successful in securing complete independence of the resolution from the slit-pattern distortion of the spectrograph, an effect which is always present in the high-dispersion spectrographs which these methods require for the primary dispersion.

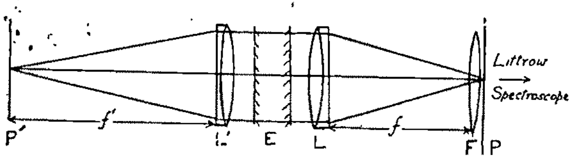

Fig. 1. Optical arrangement for the production of heterochromatic Fabry – Perot fringes

I have experimented with a new optical arrangement, which is depicted in Fig. 1. The Oxford solar spectrograph, a Littrow prismatic instrument with a dispersion of 1½ A./mm. and resolving power, not exceeding 10^6 at 5890 A., produced a spectrum of the solar centre in the plane *P*. Behind this plane was placed a second collimating lens *L* and a second camera lens *L'*. This system formed a second spectrum in the plane *P'*. The field lens *F* was introduced in the plane of the first spectrum *P* to obviate vignetting effects. When a small étalon was introduced into the parallel beam between *L* and *L'*, the second spectrum was broken up into a system of concentric circular interference fringes.

These figures resemble, superficially, normal Fabry – Perot fringes, but differ from them in three essential respects.

(1) The new fringe system is heterochromatic, being constructed of fringes of equal chromatic order. The large wave-length range over which the fringe system extends will be seen from the accompanying photograph (Fig. 2) of the *D* region.

(2) The centre of the pattern does not coincide with the axis of the étalon, but is displaced by an angle $f(d\lambda/dx)/\lambda$, where λ is the wave-length, f the focal-length of the second collimator, and $d\lambda/dx$ the dispersion at *P*. In view of the high dispersion of the Oxford instrument, and the short focal length (25 cm.) of the second collimator, this angle amounted to a few degrees only, a fortunate fact, to which the recognition of the fringe system was largely due. When the spectral region is altered by changing the setting of the minimum deviation link-work of the main spectrograph, the centre of the pattern becomes alternately bright and dark, and gradually shifts in relation to the étalon axis, in consequence of the varying prismatic dispersion.

(3) The intensity distribution within the fringes is a Fabry – Perot analysis of the instrumental slit pattern. Consequently a necessary condition for the production of the fringes is that the primary monochromatization produced by the main spectrograph shall correspond to a wave-length range smaller than the range of the étalon.

As a consequence of the third property of the fringes, the effect of widening the slit is to produce a pattern of much broadened fringes with an approximately square-topped intensity distribution. Within the fringes of this broadened system the solar absorption lines appear, broken up into short sections of Fabry – Perot ring systems of the normal monochromatic type, concentric with the axis of the étalon. The resolution of these absorption lines is completely independent of the instrumental slit pattern, and is entirely determined by the resolution of the étalon and plate-grain effects. The possibility of obtaining full resolving power with a wide slit, in contrast to Shane's method, allows a reduction of exposure time of the order of 100. Thus for the first time it becomes possible to make use of the high resolving power of really heavily silvered étalons.

The accompanying photograph of the *D* region was taken with a slit-width of 0·2 mm., étalon spacer 2·5 mm., reflectivity greater than 0·9. The exposure time was 13 min. Some idea of the actual improvement in resolving power will be given by comparing the interference photograph with the normal spectrum, taken with slit-width 0·025 mm. It will be seen that the line 5884, which is at the very limit of resolution in the normal spectrum, is very clearly split into two components in the interference photograph. This line appears single in Minnaert's photometric atlas, and is quoted in the Revised Rowland Catalogue as an iron line with a water-vapour companion too close for accurate measurement. The resolving power so far attained is provisionally estimated as about 400,000, and it is believed that the present limit is set by plate grain, owing to the somewhat short focal-length camera (50 cm.) thus far employed.

It is obvious that the method will be of wide applicability to problems of solar wave-length measurement, and to the photometry of absorption line contours. Plates for wave-length determination

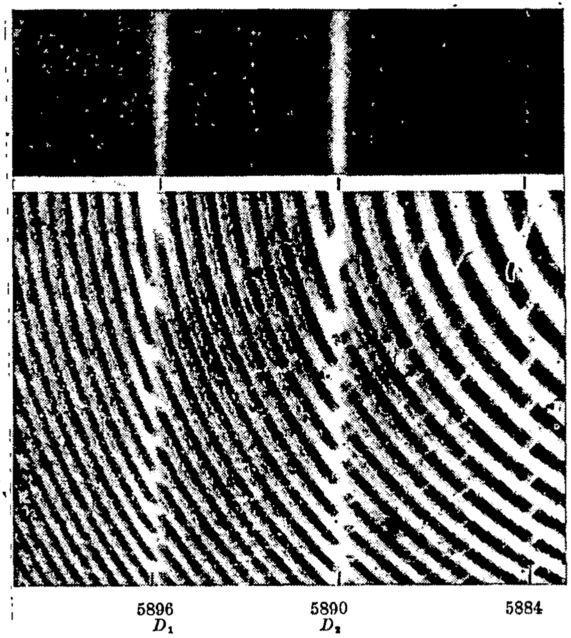

Fig. 2. Direct and interference photographs of the *D*-region of the solar spectrum (negative prints)

in the *D* region and for contour measurements of broad and narrow solar absorption lines in the region of the line Ca 4227 are now in process of measurement. A full account of the new fringe systems, and of these applications, will shortly be communicated to the Royal Astronomical Society.

P. J. Treanor, *S.J.*

University Observatory,
Oxford.
Oct. 1.

[1] Burns, K., and Meggers, W. F., *Pub. Allegheny Obs.*, 6, 105 (1927).

[2] Shane, C. D., *Lick Obs. Bull.*, 19, 119 (1941).

Short-Period Changes in the *F* Region of the Ionosphere

Radio observations designed to detect horizontal movements in the ionospheric regions and to investigate the relation of these to previously observed changes occurring above a single observing point have been in progress for some months in the vicinity of Sydney, New South Wales. The present system uses three transmitters (T_1, T_2, T_3) placed at the apexes of a right-angled triangle with its shorter sides approximately north–south and east–west and of length 13 miles and 27 miles respectively (Fig. 1). The transmitters are operated on the same frequency and with the same repetition frequency, and are so phased, by either mains synchronization or pulse triggering technique, that the three pulses are spaced about 50 km. apart on a normal type of time base such as is used for ionospheric observations. It is thus possible to record the three sets of echoes simultaneously on a single film. Standard 35-mm. film is used, moved continuously with a film speed of ¾ inch per minute. Observations can be taken at one or more of three points, two being at the most widely spaced transmitting sites (R_1 and R_3), and a third at a point approximately midway between these (R_4).

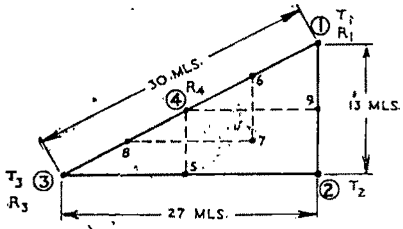

Fig. 1

Assuming that a reflexion point is vertically above a point on the ground midway between transmitter and receiver, we have eight possible points for checking uniformity of motion.

During seven months of operation (November 1947–May 1948), it has been observed very frequently that several types of clearly defined changes which occur in echoes from the *F* region show a time difference of occurrence at the spaced points.

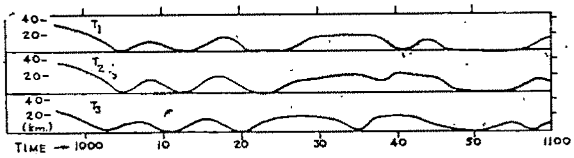

Fig. 3. Comparison of 'splits' observed at point R_3

Fig. 2 shows a particularly clear example of one type recorded at R_3. In this case the traces are produced by applying the signal to the intensifier electrode only of the cathode ray tube. The uniform lines are height marks spaced 100 km. apart. The top trace is the *F* region echo from transmitter T_3. The time base and height marker are initiated by this transmitter, so that the changes in virtual height are real.

The transmitters T_2 and T_1 are synchronized with T_3 through the 50-cycle power supply grid. Their traces (at R_3), therefore, show different amounts of phase fluctuation relative to T_3 and to the height marker, and their apparent changes in height may not be real. Corrections can be made if a ground ray is also visible on the screen; but this requires a closer scale with some loss of resolution. The transmitters T_1 and T_3 are interrupted for a few seconds at intervals of one minute (except every tenth minute on R_1), to provide time marks on the records.

It will be observed that there is a sudden disturbance on each trace in the form of a temporary splitting of the echo lasting about one minute (not easily seen in the reproduction). It occurs first on T_3, three minutes later on T_2 and a further minute later on T_1. An almost identical pattern was recorded four minutes later at R_1, which eliminates any possibility of the time differences being due to slight differences in frequency or to the small differences in the angles of incidence. The deduced direction of horizontal motion in this case is 60° east of north, and the velocity in this direction 3·9 miles per min.

Another common type of variation is shown in Fig. 3, which is a condensed plot of the amount of 'split' (difference in virtual heights of ordinary and extraordinary rays) for the three echoes as observed at R_3 over a period of one hour on the following day. It will be observed that quasi-periodic variations appear in almost the same form on all three traces, but with time differences which are of the same order as in Fig. 2.

Fig. 4 is a plot for the following hour of the virtual heights of the two components as observed at vertical incidence at R_3 and R_1. Here it will be seen that the two magneto-ionic components at each point (as shown by the full line and the dotted line) go through a very similar sequence of changes, but there is a time lag between the dotted and full-line curves. It will be noticed, however, that the time of travel from R_3 to R_1 is the same for both components. The time difference in this case is about seven minutes, as we are observing the full distance R_3 to R_1 and not the half-distance as in Figs. 2 and 3.

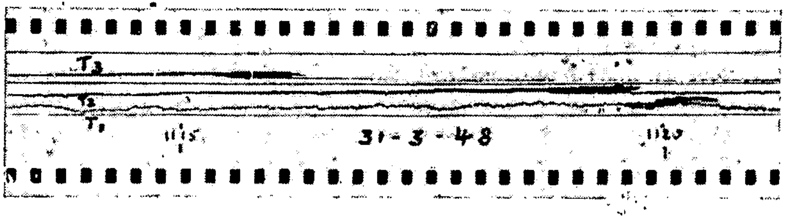

Fig. 2. *F* region echoes from spaced transmitters observed at R_3

We thus appear to have definite evidence of some form of horizontal progression in the *F* region. The great majority of cases analysed so far have given horizontal directions between 30° and 60° east of north, and deduced velocities between 3 and 5 miles

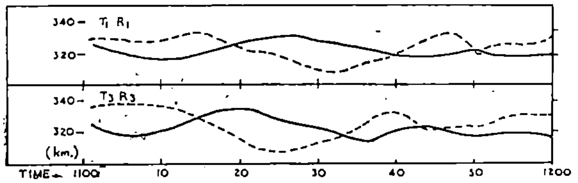

Fig. 4. Changes in virtual heights at points 1 and 3 (30 miles apart)

per minute. The observations have been made between 9 a.m. and 5 p.m. local time on a frequency of 5·8 Mc./s.

Changes in virtual height of the type shown in Figs. 3 and 4 appear most likely to be produced by changes in the ionization gradient. The effects observed might be due to either a horizontal drift in the atmosphere, with superimposed local variations in ionization gradient, or to progression of a wave motion of such a nature as to cause changes in ion concentration (for example, a pressure wave). Present evidence seems to favour the second alternative.

The time difference in the occurrence of the changes in the two rays in Fig. 4 suggests that there may be also a vertical component in the progression. This is supported by some $h'f$ observations which have been made at R_4 during occurrences similar to those of Fig. 4. They show a progression of such changes along the $h'f$ curve for the F region from the higher to the lower frequencies, corresponding to a progression from a greater to a lesser height.

Further observations are in progress to extend and clarify the information already obtained. The results will be reported more fully elsewhere.

This work has been carried out as part of the programme of the Radio Research Board of the Commonwealth Council for Scientific and Industrial Research, and is published with the consent of the Council. I wish to acknowledge the invaluable help of the staff of the Sydney Section of the Radio Research Board in carrying out the observations and to express appreciation of the keen interest of Sir John Madsen, chairman of the Board, which has made this work possible.

G. H. MUNRO

Electrical Engineering Department,
University of Sydney. June 22.

Evidence of Horizontal Motion in Region F_2 Ionization

DURING the winter periods of 1942 and 1943, a series of relative field-strength measurements were made at the Radio Research Station, Slough, on signals from the German short-wave sender Zeesen, situated 990 km. east of Slough[1]. Subject to the assumption that local time variations corresponded with longitude variations in the ionosphere, it was observed that the time of the initial appearance of the oblique ray signal at sunrise agreed closely with the value to be expected from calculations based on normal incidence ionospheric observations at Slough[2]. These sharp sunrise variations in the ionosphere occurred at Slough some thirty minutes later than at the mid-point of the oblique trajectory; this corresponds closely to the local time difference between Slough and this mid-point. It was noted, however, that in addition to these regular sunrise ionospheric changes of large magnitude, there were small irregularities in the F_2 layer occurring near the mid-point of the oblique trajectory, which were repeated overhead at Slough some 60–75 minutes later.

It is interesting to speculate on the reason for the repetition of small changes in region F_2 at two sites 500 km. apart along a line of latitude with a delay of one hour or more. It seems possible that the explanation lies in a rapid east–west motion of or within region F_2 ionization. An examination of many records indicates an average value of about 70 minutes for the delay time, requiring a velocity of 430 km./hr. in a direction east to west at the level of the F_2 layer at the time of such observations.

W. J. G. BEYNON

Department of Physics,
University College of Swansea.
Oct. 20.

[1] Beynon, W. J. G., *Proc. Phys. Soc.*, **59**, 521 (1947).

[2] Appleton, E. V., and Beynon, W. J. G., *Proc. Phys. Soc.*, **52**, 518 (1940); **59**, 58 (1947).

Latitude Effect of Penetrating Cosmic Ray Showers

IT has been shown by Broadbent and Jánossy[1] that penetrating cosmic ray showers are of two types: (*a*) local penetrating showers; (*b*) extensive penetrating showers. Local penetrating showers are supposed to be produced by primary nucleons, and they give rise to a transition effect which is proportional to mass. Extensive penetrating showers appear to be parts of extensive air showers. They show a strong transition effect in lead but almost none in paraffin.

From theoretical considerations, Jánossy[2] has suggested that local penetrating showers are produced mainly by nucleons that are latitude-sensitive. It is therefore expected that the transition effect of local penetrating showers might show a marked latitude effect.

In order to test this prediction, we have set up a penetrating-shower recorder situated at geomagnetic latitude 4° S. at sea-level in Colombo. This recorder is illustrated in Fig. 1 and is identical with that used by Broadbent and Jánossy[1] in Manchester. It consists of three trays of eight counters each, arranged as shown. Each tray covers an area of 1,000 cm.^{2}. The trays are separated by 15 cm. of lead absorbers, and in addition the middle and the bottom trays are shielded at the sides and ends by about 50 cm. of lead. The top tray is divided into three independent groups of counters, while the middle and the bottom trays are each divided into two groups as shown. Sevenfold coincidences (designated P) consisting of the simultaneous discharge of at least one counter of each group were recorded. These coincidences are due to the occurrence of showers of at least two particles capable of penetrating 30 cm. of lead absorber.

In order to select the local penetrating showers, a fourth tray of unshielded counters (not shown in the

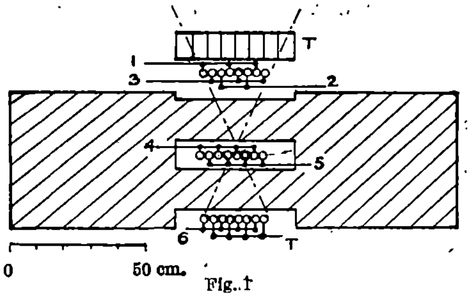

Fig. 1

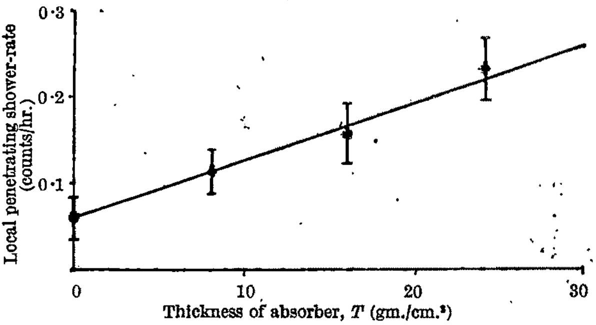

Fig. 2

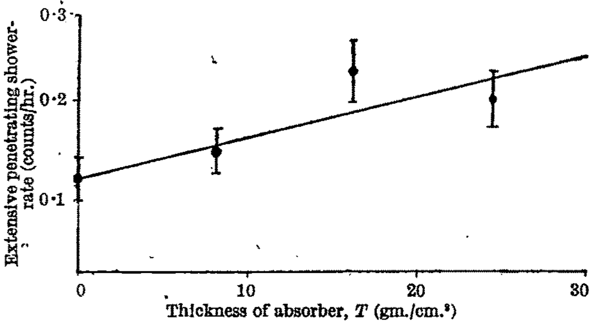

Fig. 3

figure) forming a single group of effective area 2,500 cm.^{2} was placed near the top tray. Eight-fold coincidences between *P* and at least one of the counters of the fourth tray were also recorded. These coincidences are due to extensive penetrating showers. Anticoincidences, that is, *P* coincidences not accompanied by the discharge of any of the counters of the fourth tray, are then due to the local penetrating showers.

We have in the first instance measured the transition effect in paraffin. Various thicknesses of absorber 48 cm. × 48 cm. were placed close above the top tray in the position *T* (Fig. 1). Our results are given in Fig. 2, the deviations shown being standard deviations. From a comparison of the results for Manchester and Colombo, we obtain the following values for the transition effect of local penetrating showers :

	Shower-rate for $T=0$ (coincid./hr.)	Initial slope of transition curve	Estimated max. shower-rate (coincid./hr.)
Manchester	$0{\cdot}051 \pm 0{\cdot}008$	$5{\cdot}7 \times 10^{-3}$	0·30
Colombo	$0{\cdot}060 \pm 0{\cdot}019$	$6{\cdot}7 \times 10^{-3}$	0·35

It is seen that the transition effect in Colombo is of the same order as that in Manchester. Hence there appears to be no observable latitude effect of penetrating showers. We have also measured the transition effect of extensive showers and found an indication of an effect in paraffin. The actual increase observed is from $0{\cdot}107 \pm 0{\cdot}026$ coincidences/hour without paraffin to $0{\cdot}208 \pm 0{\cdot}035$ coincidences/hour under 24·3 gm./cm.^{2} of paraffin. The effect is shown in Fig. 3.

It is hoped to publish elsewhere a detailed account of our work on completion.

V. Appapillai
A. W. Mailvaganam

University of Ceylon,
Colombo.

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[1] Broadbent and Jánossy, *Proc. Roy. Soc.*, A, **190**, 497 (1947).

[2] Jánossy, *Proc. Roy. Soc.*, A, **183**, 190 (1944).

Origin of Cosmic Rays

It is important to decide whether or not the main sources of the cosmic ray particles are external to our galaxy. An external source seems, at first sight, to be established by the observed isotropy of the cosmic rays incident on the earth. But it has been claimed by a number of authors that this isotropy is simply a consequence of a magnetic field assumed to exist in interstellar space. The basis for this claim is that a *single* particle of energy η and charge e is deflected through an appreciable angle after travelling a distance d across a magnetic field of intensity H, provided

$$H \sim \eta/ed.$$

For η equal to 10^{10} eV., e equal to the electronic charge ($4{\cdot}77 \times 10^{-10}$ E.S.U.), and d equal to the radius of the galaxy ($\sim 3 \times 10^{22}$ cm.), the necessary value of H is about 10^{-15} gauss. This value may be compared with the average interstellar field of about 10^{-20} gauss that would result if (i) every star possessed a magnetic moment equal to the commonly quoted magnetic moment for the sun ($\sim 1{\cdot}5 \times 10^{34}$ C.G.S.); (ii) the stellar magnetic dipoles were all aligned parallel to each other.

Although, even with these favourable assumptions, the interstellar magnetic field is still too small to be of consequence in this connexion (by a factor $\sim 10^5$), it has nevertheless been argued (*a*) that the magnetic moment of the sun may be exceptionally small, (*b*) that the connexion between angular momentum and magnetic moment suggested by Blackett[1] leads to an interstellar magnetic field $\sim 10^{-10}$ gauss. In view of these possibilities it is desirable to consider the matter afresh.

We find that the effects of a magnetic field as high as 10^{-10} gauss are still negligible. A fallacy underlies the usual type of argument, because the question cannot be decided through investigating the behaviour of an isolated particle. It has been shown that the motions of the cosmic ray particles are not appreciably disturbed by the field, provided

$$H^2 \leqslant 4\pi W,$$

where W is the energy density of the rays. Using the observed value $W \sim 10^{-13}$ ergs per cm.^{3}, this gives $H \leqslant 10^{-6}$ gauss, which is satisfied by a large margin even if Blackett's views are accepted.

The physical basis of the above inequality is easily understood. When this inequality is satisfied then, whatever the electromagnetic processes taking place within the particle distribution, the momentum density of a uniform beam of particles of energy density W is large compared with the average momentum density of the electromagnetic field. Our conclusion follows from the conservation of momentum, as applied to an assembly of particles moving in an electromagnetic field.

We see, therefore, that the main source of the cosmic rays must be external to the galaxy. An important consequence is that the source must be adequate to give an energy density $\sim 10^{-13}$ ergs per cm.^{3} not only in interstellar space but also in *inter-nebular* space. One of us[2] has discussed elsewhere the implications of this conclusion.

J. W. Dungey

Magdalene College, Cambridge.

F. Hoyle

St. John's College, Cambridge.

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[1] Blackett, P. M. S., *Nature*, **159**, 658 (1947).

[2] Hoyle, F., *Mon. Not. Roy. Ast. Soc.*, **106**, 384 (1946).

Effect of Hydrogen Atoms on Intensities of X-Ray Reflexions

In calculating the intensities of X-ray reflexions (diffractions) from crystals, it is customary to disregard contributions that may be due to hydrogen atoms. Their single electrons will tend to merge with the distributions about other atoms to which they are chemically bound, and the relatively small disturbance of the symmetry about these other atoms can usually be safely neglected.

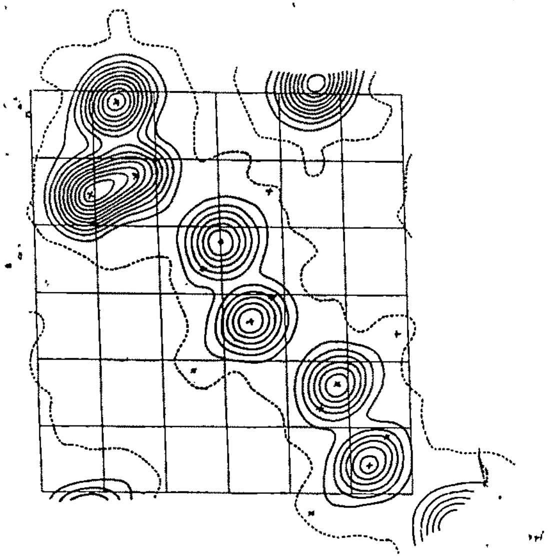

Fig. 1. Portion of sebacic acid structure. Contour scale, one electron per line

However, in discussing the results of some quantitative X-ray studies of aromatic hydrocarbons, especially coronene, $C_{24}H_{12}$, attention has been directed to certain small bulges on the electron density maps which appear close to every carbon atom to which a hydrogen atom should be attached[1,2]. Although these features are clearly visible, the total effect is too small to have much influence on the intensity calculations. If we regard the scattering power of the various atoms in a molecule as simply proportional to their atomic numbers, then the hydrogen atoms in the coronene molecule will represent only 7·7 per cent of the total scattering power. In pyrene, $C_{16}H_{10}$, the figure will be 9·4 per cent and in anthracene, $C_{14}H_{10}$, 10·6 per cent.

For aliphatic molecules, the total effect of the hydrogen atoms will be much greater. Thus, in methane the hydrogen electrons represent 40 per cent of the total, and in very long n-hydrocarbon molecules, C_nH_{2n+2}, about 25 per cent. We have recently been engaged on the detailed analysis of several aliphatic structures, and we find that it is necessary to take account of the hydrogen atoms in order to obtain reasonable agreement in the intensity calculations, particularly for the low-angle reflexions.

In sebacic acid, $C_{10}H_{18}O_4$, the hydrogen electrons account for 16·4 per cent of the total, and in hexamethylene diamine, $C_6H_{16}N_2$, 24·2 per cent. A detailed analysis of the crystalline structure of each of these compounds has now been completed, and the atomic positions have been determined accurately by the Fourier series method. The effect of neglecting the hydrogen contribution in calculating the structure factors for some of the low-angle reflexions is shown by the following figures:

Sebacic acid, $C_{10}H_{18}O_4$

hkl	sin θ λ = 1·54	*F* meas.	*F* calc. C, O and H	*F* calc. C, O only
001	0·071	33·5	34·5	47·5
002	0·141	11·0	12·5	17·0
$20\bar{1}$	0·171	11·5	11·5	4·0
$20\bar{2}$	0·154	3·0	4·0	0
$20\bar{3}$	0·168	13·5	14·0	15·5
$20\bar{4}$	0·206	23·5	24·5	28·5
$40\bar{6}$	0·335	59·0	54·5	48·0
$1\bar{1}\bar{1}$	0·189	8·5	8·0	5·0

Hexamethylene diamine, $C_6H_{16}N_2$

hkl	sin θ λ = 1·54	*F* meas.	*F* calc. C, N and H	*F* calc. C, N only
008	0·316	31·8	31·3	24·0
0010	0·395	14·5	13·2	10·0
0012	0·474	12·5	10·2	7·8
108	0·334	32·9	32·2	17·8
020	0·267	29·1	29·0	26·6
025	0·335	22·5	25·1	16·5
026	0·360	12·8	11·3	6·6
046	0·588	6·1	6·9	3·3

In each case the hydrogen atom is assumed to lie at 1·09 A. from the carbon atom in the direction required by a tetrahedral distribution of the valency bonds. The atomic f-curve for hydrogen has been given the same general shape as the empirical f-curve for carbon[3], but with a more rapid fall-off at large angles. It is similar to Hartree's curve[4] but with a large temperature correction.

The electron density maps for these two molecules show the presence of the hydrogen atoms very clearly.

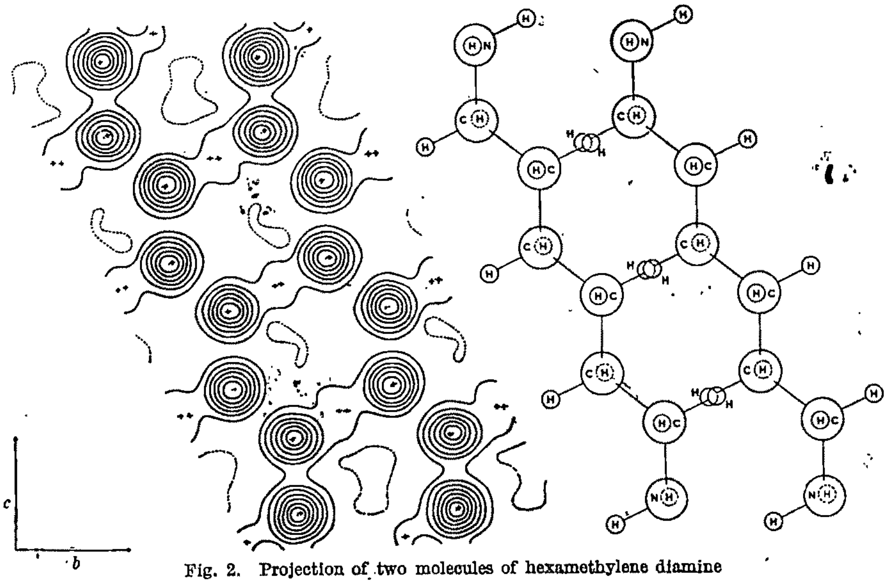

Fig. 2. Projection of two molecules of hexamethylene diamine

Four of the CH_2 groups in the sebacic acid chain are reproduced in a two-dimensional projection (Fig. 1), and the calculated positions of the hydrogen atoms are marked with small crosses.

In the hexamethylene diamine structure the crystalline arrangement of the molecules is particularly favourable for showing the hydrogen atoms in projection.

The molecules shown in Fig. 2 lie at different depths in the unit cell, but in projection the effect is to cause the hydrogen atoms of neighbouring molecules to overlap, with a consequent doubling of the projected electron density.

We are indebted to Messrs. Imperial Chemical Industries, Ltd., for materials and grants in aid of this work.

J. D. Morrison
W. P. Binnie
J. Monteath Robertson

Chemistry Department,
University of Glasgow.
June 29.

[1] Robertson, J. M., *J. Chem. Soc.*, 249, 256 (1945).

[2] Robertson, J. M., and White, J. G., *J. Chem. Soc.*, 607 (1945).

[3] Robertson, J. M., *Proc. Roy. Soc.*, A, **150**, 106, 110 (1935).

[4] "International Tables for the Determination of Crystal Structures", 2, 571 (1935).

A Proposed New Form of Dielectric-loaded Wave-Guide for Linear Electron Accelerators

It has frequently been suggested that a linear accelerator could be constructed using a wave-guide consisting of a circular metal tube lined with an insulating tube of dielectric, and several writers have recently published theoretical investigations of this type of wave-guide, as, for example, Frankel[1]. The performance of a linear accelerator using such a wave-guide is ultimately limited by the power losses which occur in the metal tube and in the dielectric itself, and calculations show that the performance compares unfavourably with other forms of accelerator, such as corrugated wave-guides[2]. However, some recent theoretical investigations show that the performance should be greatly improved by using a different form of dielectric loading, and that certain practical advantages should also ensue.

It has been shown that the losses in the metal tube can be decreased by using an anisotropic dielectric with a smaller dielectric constant in the direction of the wave-guide axis than in the transverse directions. These properties may be simulated by using a stack of isotropic dielectric laminæ in planes perpendicular to the wave-guide axis, with suitable small spaces separating the laminæ from each other. Since it is necessary to have a central hole for the passage of electrons, each lamina will be shaped like an engineer's washer, and the whole will resemble a corrugated wave-guide in which the corrugations are made of dielectric. The thickness of the laminæ and their spacing should be small compared with the wave-length in the guide in order to simulate a homogeneous material. Laminating the dielectric reduces the power losses in the dielectric itself, in addition to reducing the losses in the metal through its simulated anisotropic properties, and the total losses are found to compare favourably with those in a corrugated wave-guide.

The following table gives a few computed examples for this type of anisotropic loading:

ε	Q	ε_p	a (metres)	b (metres)	L_0 (metres)	η (ohm/metre)
—	—	—	0·025	0·096	11	27×10^6
100	2,000	30	0·02	0·085	100	64×10^6
95	2,000	80	0·02	0·050	17	19×10^6
16	5,000	12	0·02	0·063	100	22×10^6
16	5,000	12	0·01	0·058	100	29×10^6

where ε is dielectric constant of solid (unlaminated) loading material; ε_p is effective dielectric constant in the radial direction; a is radius of central hole; b is internal radius of metal tube; L_0 is length of wave-guide with an attenuation of 1·25 nepers; η, the 'efficiency' or figure of merit, is $(0{\cdot}407)\, E^2/\alpha W$; E is accelerating field; α is attenuation constant; W is energy flux in the wave-guide; $Q = \omega\varepsilon/\sigma$ for the solid dielectric. All the examples are for a wave-length of 0·25 metres. The first row relates to a corrugated wave-guide with five corrugations per wave-length and twice theoretical copper losses. The remainder are for dielectric loading, in which the Q factor shown has been taken as about half that claimed for certain ceramic materials.

The dielectric system seems to have certain practical advantages compared with a corrugated wave-guide. The dielectric washers can be made from ground ceramic material, which is relatively inexpensive; and if the spacing between washers is adjustable there should be no need to maintain the very accurate dimensions which are required in the case of corrugated guide. The outside diameter of the dielectric guide is also smaller, which should again reduce the cost of an accelerator. Finally, the design of the dielectric guide is more flexible in that widely different characteristics can be chosen. There is, of course, a number of practical difficulties which may arise; but it is not anticipated that any of these will be very serious.

It is proposed to start some experimental work at the Telecommunications Research Establishment upon dielectric loaded guides to study their practical properties.

This work was carried out as part of the programme of the Electronics Group of the Atomic Energy Research Establishment at the Telecommunications Research Establishment, Malvern, and acknowledgment is made to Sir John Cockcroft for permission to publish the results.

R. B. R.-Shersby-Harvie

Atomic Energy Research Establishment,
Harwell.

[1] Frankel, S., *J. App. Phys.*, **18**, 650 (1947).

[2] Fry, D. W., *et al.*, *Nature*, **160**, 351 (1947).

Surface Effects with Single Crystal Wires of Cadmium

The letter of A. H. Cottrell and D. F. Gibbons, published in *Nature* of September 25, describes certain experiments which go to show that the phenomenon named 'thermal hardening' by Orowan[1,2], and recently investigated by C. L. Smith[3], is due to contamination by gaseous reaction. Experiments which we have been carrying out for some time on single crystal wires of cadmium have led us to the same conclusion. The surface of our *HS* cadmium wires, 1 mm. in diameter, was cleaned with great care, and single crystals were made by the method of Andrade and Roscoe[4], the wires being held in loosely fitting 'Pyrex' tubes which had been baked out at 400° C. and evacuated to a pressure of about 10^{-4} mm. mercury. Thus every precaution was taken against initial surface contamination.

Three pieces were cut from a single wire, of which one was kept as control, one for further heating *in vacuo* and one for heating in air. With no preliminary strain and heating for half an hour at 200° C. both in air and *vacuo*, no appreciable effect was obtained; while with heating for about 20 hours at 200° C. in air pronounced 'thermal hardening' appeared. If, however, one end of the wire, to the extent of a few millimetres, was momentarily immersed in a solution of cadmium nitrate and afterwards dried, so that strictly local contamination was produced, a heating for half an hour in air at 200° C. produced the hardening phenomenon. This leads us to the conclusion that the formation of the surface film, which would appear to be, in any event, the first stage in the process that leads to hardening, is very much facilitated by local contamination. We cannot say at this stage whether the local contamination be oxide, nitrate or other salt. The fact that the phenomenon is so dependent upon a slight *local* surface impurity of this kind no doubt explains the irregular results that have been obtained. We reserve further observations on the nature of the phenomenon for subsequent publication.

We take this opportunity of describing very briefly certain other experiments which we have been carrying out on the effect of surface conditions on mechanical properties of single crystals of cadmium. We have found, following extensive experiments on surface conditions, that, if a single crystal with a clean surface is loaded so that it flows very slowly (at a rate of about 1 per cent per hour), the surrounding of the wire with commercial cadmium plating solution (which contains potassium cyanide, cadmium potassium cyanide, sodium carbonate and sodium hydroxide) leads to an immediate increase of rate of flow, which may be anything up to twenty-fold. The fact that the effect is immediate seems to indicate that diffusion from the surface is not concerned. With a solution of cadmium sulphate an increase of rate of from two- to four-fold is obtained, both with unstrained crystal wires and with pre-strain of up to 30 per cent. Cadmium chloride solution produces a similar effect. With a solution of cadmium nitrate, however, an immediate increase is followed by a complete cessation of flow, the wire being brought to a state of such hardening that nearly double the initial stress is needed to start flow again. Preliminary experiments with zinc nitrate indicate immediate hardening. Similar results have been obtained with single crystal wires of commercial cadmium (impurity quoted by the suppliers as about 1 in 10^5, as against better than 5 in 10^6 for *HS* cadmium) surrounded by plating solution, whereas with polycrystalline wires of commercial cadmium no effect was obtained. At present we attribute the increase of rate to the action of the cadmium ions and the hardening to the formation of a surface film, probably of oxide. The work is continuing.

E. N. da C. Andrade
R. F. Y. Randall
Department of Physics, University College,
London, W.C.1. Oct. 7.

Strength of Metals

It has been shown previously that progressive deformation of an annealed metal breaks down the grains into smaller units, or crystallites, which have a minimum size characteristic of the metal[1,2]. The lower limiting size for metals so far examined lies in the range 10^{-4} to 10^{-6} cm. A precise determination of this size has become of importance, because it appears to coincide with the maximum strength developed during deformation of the metal[3].

Measurements can be made by the X-ray diffraction method, which utilizes the relation between broadening of the X-ray lines and the size of the reflecting units. Hitherto this method has been complicated by the extra broadening which occurs if the reflecting elements are in a different state of internal strain[4]. We have used the method but reduced the difficulty by two devices. First, we have confined the X-ray measurements to one direction in the metal at one time, thereby taking advantage of a recent observation that, in a systematically deformed metal, elements of the same orientation are in a similar state of strain. Secondly, we have been able to obtain X-ray back-reflexion photographs from the heavily deformed metals with much shorter wave-lengths than previously have been considered practicable, and, in this way, to distinguish the broadening due to small crystallite size, which is proportional to the wave-length, from that due to internal strains, which is independent of the wave-length.

The measurements have been made in the first instance on the body-centred cubic metals, iron, tantalum, molybdenum and tungsten, which respond particularly well to the above procedure. Thus, after deformation, these metals give very broad X-ray lines when photographed with a wave-length of the usual order, 1·5–2 A., but very much sharper lines when photographed with a wave-length of 0·5–0·7 A. The effect of small crystallite size can be shown, therefore, to be the predominant factor, and the size itself then calculated from the broadening without ambiguity.

Next, the values thus obtained have been related to the maximum tensile strength of the metals, on the general hypothesis that a metastable condition is reached when the overall elastic strain of the crystallite is equal to one interatomic spacing. The fractional strain is then of the order of d/L, where d is the atomic spacing and L the linear crystallite size; and the corresponding stress is this quantity multiplied by the appropriate elastic modulus. The maximum stress will arise when L has the minimum value given by the measured lower limiting size.

A detailed treatment, based on comparison of the energy of a crystallite before and after deformation by slip, has been given by Sir Lawrence Bragg, who obtains for the critical stress, kGd/L, where G is the shear modulus and k a constant of the order of unity[5]. This he identifies with the initial yield stress.

Much depends on the interpretation placed on the yield strength. A full discussion together with the experimental derivation of the minimum crystallite size will be given elsewhere. It is desired here, however, to record the values of the crystallite size and point out a close agreement between the quantity Gd/L and the maximum tensile strengths of the metals under consideration.

The values are given in the accompanying table. The figure taken for G for the metals iron, molybdenum and tungsten is the shear modulus in the

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[2] Orowan, E., *Proc. Phys. Soc.*, **52**, 14 (1940).

[3] Smith, C. L., *Nature*, **160**, 466 (1947).

[4] Andrade, E. N. da C., and Roscoe, R., *Proc. Phys. Soc.*, **49**, 152 (1937).

	L (cm.)	*d* (cm.)	*G* (tons/sq. in.)	*S* (calc.)	*S* (obs.)
Fe	$3 \cdot 0 \times 10^{-6}$	$2 \cdot 48 \times 10^{-8}$	$3 \cdot 9 \times 10^{3}$	32 tons/sq. in.	30 tons/sq. in.
Ta	2·4	2·85	4	47	58
Mo	4·2	2·72	8·6	56	75
W	2·9	2·74	10	95	110

slip direction [111]. This figure is not available for tantalum, and for this metal the modulus measured on the bulk metal has been used. The value of d is the atomic spacing in the slip direction. The value L for the crystallite size is the minimum reached after progressive deformation, and thus refers to the fully strain-hardened condition. Exploratory measurements of L made some years ago by W. A. Wood were purposely confined to cold-worked metals in a partially recovered condition, and therefore gave somewhat larger values. The present values for L are the ones required for comparison with the maximum strength. The table includes observed values of true tensile strengths (S obs.). The value for the iron was determined directly; the remainder were taken from published data. Unfortunately, the figures usually published are nominal strengths calculated on the initial cross-section of the test specimen, or, for the rarer metals, strengths measured on hard-drawn wires, which often are in a state of high internal strain. The values given in the table, however, suffice to indicate that the calculated strengths S (calc.) $= Gd/L$ are definitely of the right order.

W. A. Wood
W. A. Rachinger

Baillieu Laboratory,
University of Melbourne.
June 23.

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Production of Extremely Thin Metal Films by Evaporation on to Liquid Surfaces

In two articles in *Nature* of March 15, 1947, a method is given for making very thin metal films, 10–20 A. or more in material thickness. On the surface of a film of cellulose nitrate, etc., there is evaporated a small amount of, for example, beryllium or aluminium. Then the basic film is dissolved away by amyl-acetate or other appropriate solvent, the metal being left free. Such films of beryllium or aluminium are especially useful as supporting membranes for electron microscopical studies. As a rule these metal films have no visible structure. It may, however, happen that a faint structure appears even if the film is very transparent in the electron microscope. This structure effect may depend upon the fact that all the cellulose molecules are not nitrated to the same degree, some of them being insoluble in amyl acetate. Other explanations may be that a molecular layer of the cellulose nitrate adheres very closely to the metal surface and does not go into solution, or that some of the very active metal atoms have penetrated into the cellulose molecules. I have now found that the structure effect mentioned above does not exist when using acrylates instead of cellulose nitrate, collodion, etc., as the basic film. The solvent then used is ethyl acetate. The metal films made are almost invisible in the electron microscope when made 20 A. in thickness, and the photographic contrast effect of the object particles is increased compared with that obtained with ordinary supporting membranes, which is of the greatest importance when studying molecules or other minute particles.

I have recently devised another method for making thin metal films, which is simpler, since no dissolving process is needed for the basic film: *the metal film is made by evaporation in a vacuum of a small amount of beryllium or aluminium on to a liquid surface.* From the physical point of view it may seem impossible to get any metal layer in this way. It works nicely, however, and very thin films of beryllium and of aluminium can be made. I have been using several liquids, but chiefly glycerol. The liquid used must have a high boiling point and low vapour pressure at room temperature; for example, glycerol, boiling point 290° C. and vapour pressure less than 10^{-4} mm. mercury.

The procedure for making metal films on a glycerol surface is as follows. A piece of glass, about 3 cm. × 3 cm., is covered with a thin layer of glycerol ($\frac{1}{2}$ mm. or less in thickness) and put into the vacuum chamber. The glycerol ought not to have more than the smallest possible content of water, otherwise it will boil in vacuum. After a little while, when water which may have been absorbed in the glycerol has disappeared, a small amount of metal (beryllium or aluminium) is evaporated. The glass slope is next put into a container into which distilled water is introduced. The glycerol is dissolved and the film will immediately float off; it lies on the water surface, holding together well. The film is washed by using a container, where the water can be changed without disturbing the film. The film is transferred to a plane grid of copper, platinum or other convenient metal, the holes measuring about 0·1 mm. in diameter, and is allowed to dry. In this way it is easy to get pieces 3 cm. × 3 cm. or more, and whenever a specimen film is needed, a little piece can be cut off this ready-made film.

It is possible to make membranes of beryllium, aluminium, etc., with a material thickness of only 10–20 A., lying on grids where 80 per cent of the area is covered with only the thin metal film. Such thin films are of great interest also from the physical point of view, especially in investigations on the scattering effect of electrons penetrating thin metal films, and the contrast effect in the electron optical picture. One of the greatest advantages of this new method compared with the old method of making metal films for electron microscopical use is the possibility of laying a metal film directly on an organic substance without using amyl acetate or other liquids which affect organic substances.

I have also evaporated metals on to oil surfaces (vacuum oil); but in this case I did not obtain metal films; but there seemed to be rather big metal crystals after dissolving away the oil. According to the atomic structure of the liquids used, it may be expected that the active metal atoms are more likely to penetrate into the oil surface layer than into an ordinary liquid.

In another experiment I have evaporated aluminium metal in a vacuum on to a mercury surface. It is well known to chemists that mercury and aluminium react readily, when put into contact, growing salt-like trees at reaction points. The very unexpected thing is that this did not take place when I evaporated aluminium on to a mercury surface in vacuum. It may depend upon the fact that the evaporated aluminium atoms cannot penetrate into mercury—possibly the surface tension will not let them penetrate, on account of crystalline structure of the liquid in the surface or in the mass itself.

When beryllium is being used, great care must be taken, due to the fact that beryllium dust has been found to be very poisonous.

The investigations described above were carried out at the Nobel Institute for Physics in Stockholm.

NILS HAST

Royal Institute of Technology,
Stockholm.
Sept. 23.

'Knock' in Internal Combustion Engines

THERE is evidence that the phenomenon of 'knock' in spark-ignition engines is connected with the production of peroxides in the last part of the fuel–air mixture to be burnt. Thus we have found that of all the intermediate products of combustion which have been identified in the gases sampled from the engine, the peroxides are the only ones which possess an appreciable pro-'knock' effect. Egerton *et al.*[1] have shown that peroxides, probably alkyl hydroperoxides, are present in the pre-combustion processes, and Stern and Polliak[2] have identified hydrogen peroxide in samples taken from an engine cylinder. This work has now been extended to enable quantitative determinations to be made of the total peroxide content of gas samples. At the same time, we have determined the aldehyde content.

An electromagnetically operated valve has been developed which permits samples to be abstracted from an engine cylinder over a narrow crank period. This is used on a Ricardo E6 variable compression engine and positioned so that gas is sampled from the 'knocking' zone. At an engine speed of 1,500 r.p.m. and a valve opening period of 3° crank, a flow-rate of 200 c.c./min. of expanded gas is obtained when sampling at about the time of maximum cylinder pressure.

Secondly, we have developed a method for the determination of the total organic + hydrogen peroxide content of the sampled gases. The major difficulty is the presence of nitrogen dioxide and olefins, which obviously complicate any such determination. Our method, which is basically that of iodine liberation from potassium iodide, is as follows. The nitrogen dioxide is removed by passing the sampled gas through a trap containing an aqueous solution of sulphamic acid. This retains the peroxides in solution and at the same time destroys the nitrous acid formed from the nitrogen dioxide which otherwise would reduce the peroxides. The olefins are removed by bromine under conditions designed to minimize the loss of peroxide by interaction with bromine. Ferrous sulphate is used as a catalyst in the reaction with potassium iodide.

Thirdly, we have used essentially the bisulphite method of Lea[3] to determine the total aldehyde content.

Peroxide curves obtained using technical *iso*-octane as fuel are shown in Fig. 1. At the lower compression ratios, the engine was free from 'knock', while at a compression ratio of 9·9, 'knock' of a fairly heavy intensity occurred. On all these curves a rise in pre-flame peroxide concentration takes place prior to 'top dead centre', followed by a much higher peak value just before the flame. With increase of compression ratio there is an earlier rise in peroxide concentration and a much higher peak value. Surveying the large number of these curves which we have obtained there appear to be indications of a slight discontinuity just after 'top dead centre', suggesting that the curves are two-stage in nature.

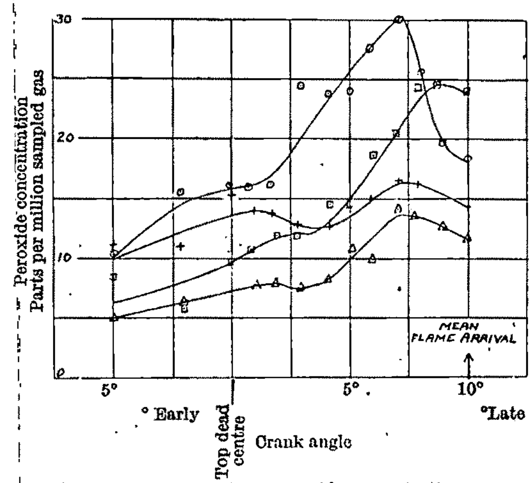

Fig. 1. Pre-flame peroxide concentration

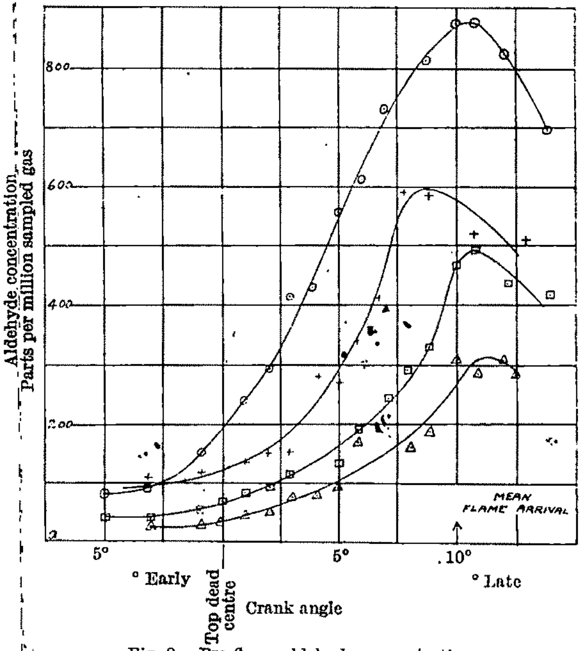

Fig. 2. Pre-flame aldehyde concentration

	Compression ratio	Fuel
△ — △ —	7·0	Octanes
□ — □ —	8·0	Octanes
⊙ — ⊙ —	9·9	Octanes 'knocking'
+ — + —	9·9	Octanes + 3 c.c. T.E.L./I.G.

The effect of the addition of tetraethyl lead to suppress 'knock' is to lower the concentration of peroxides, as compared with the curve on the unleaded fuel at the same compression ratio. The effect appears to be greater after 'top dead centre' than before, thus tending to confirm the two-stage nature of the curves.

The aldehyde curves (Fig. 2) show a smooth rise up to the time of flame arrival, achieving a peak concentration some thirty times greater than the peak peroxide value. The effect of increasing compression ratio on the aldehyde concentration parallels the effect on the peroxide curve. Tetraethyl lead uniformly decreases the aldehyde concentration at all points.

As regards the nature of the aldehydes produced, repeated tests with dimedone gave only the formaldehyde derivative.

This work has been carried out at the Ricardo Laboratory on behalf of the Shell Petroleum Co.

R. W. Wheeler
D. Downs
Ricardo and Co., Eng. (1927), Ltd.,
Bridge Works,
Shoreham-by-Sea.

A. D. Walsh
Laboratory of Physical Chemistry,
Cambridge.
July 2.

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Infectious Chlorosis of Bananas in the Cameroons

During recent years, there has been a considerable extension of the cultivation of the Gros Michel banana in the British Cameroons. Vascular wilt disease (*Fusarium oxysporum cubense*) and *Cercospora* leaf-spot disease (*Cercospora musæ* Zimm), which are both present there, are already well known to the planting community. Here I wish to direct attention to a virus disease which I observed during a recent visit. This disease, which has been described as 'infectious chlorosis' or 'heart rot' by Magee[1] and Morwood[2], has been recorded in New South Wales by these observers[3] and in Guadeloupe and Haiti by myself[4,5].

In the Cameroons, infectious chlorosis has been observed in several plantations. The virus is known to be transmitted by the aphis *Pentalonia nigronervosa*[1]; this is also present. According to the Australian workers, this disease is potentially as destructive as the better-known bunchy-top disease, caused by a different virus but also transmitted by the banana aphis. In the Cameroons the evidence (so far as I was able to ascertain during a brief visit) is that infectious chlorosis is at present of occasional occurrence but is capable of spreading under the local environmental conditions. Accordingly, Magee's warning of the possible destructiveness of this disease should be given due heed by all concerned with this valuable industry.

The symptoms include a characteristic chlorosis of the leaf (linear spots from midrib to margin), the development of localized, internal regions of necrosis in the leaf sheaths of the trunk, rotting of the heart leaves and the death of the plant before the onset of fruiting[3].

C. W. Wardlaw
Department of Cryptogamic Botany,
University of Manchester.
Oct. 11.

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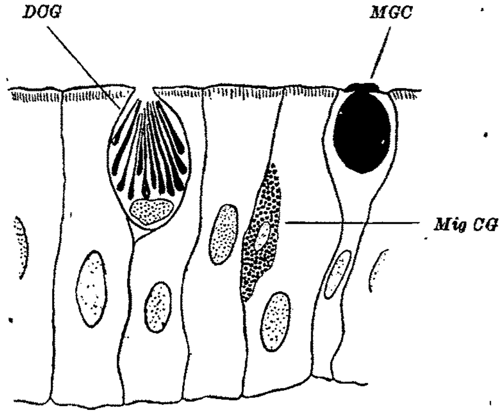
Coarse Granulocytes in Epithelial Tissues of Teleost Fishes

In the course of an investigation of blood-cell formation in teleost fishes, a peculiar formation has been seen in the intestinal mucosa and gill epithelium. Apparently the coarse granulocytes commonly found in these tissues migrate towards the surface and the granules elongate, appearing like long narrow clubs with pointed ends converging towards the epithelial surface. This regular characteristic pattern of arrangement was first noted by Duthie[1] in the mesenteries of teleost fishes of the families Labridæ and Triglidæ. I have seen it in the intestinal mucosa and gill epithelium of *Ctenolabrus rupestris* (Labridæ) and *Trigla cuculus* (Triglidæ), and also in the same sites in trout and roach. In trout and roach I have observed similar formations in the walls of kidney tubules and in the peritoneal coat of many internal organs.



Intestinal mucosa of trout. Fixed Zenker-formol. Stained Giemsa
DCG = Discharging coarse granulocyte; *MGC* = mucous goblet cell; *Mig CG* = migrating coarse granulocyte

Careful examination of dogfish, frog and mammalian material has not revealed a single example of such a condition. The appearance suggests a discharge of a fluid substance from the interior of the granules. These modified granules may be regarded as vesicles, containing a fluid which is discharged at the epithelial surfaces detailed above, the 'wall' of the vesicle remaining for a time in the cell body.

W. T. Catton
Physiology Department,
Medical School,
King's College,
Newcastle-upon-Tyne 2.

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[1] Duthie, E. S., *J. Anat.*, **73**, 396 (1939).

Burrowing of the Lugworm

In his recent letter in *Nature*[1], Wells gives an interesting account of the movements and action of the proboscis of the lugworm and of the part that it plays in burrowing. He considers that its movements alone are sufficient to account for this activity, which is chiefly due to the diverging teeth of the buccal mass scraping away soil particles in the line of advance. He appears to consider that the physical properties of the soil are of no direct importance to burrowing, which he likens to that of a "digging rabbit".

But it appears to us that the mode of action of the proboscis described by Wells is in no way at variance with our thesis, namely, that the thixotropic properties of the soil must be taken into account to explain satisfactorily the burrowing of the lugworm, and probably that of other animals living in a similar habitat. The exact movements of the proboscis, interesting though they are in themselves, are but a means of softening the soil in the line of advance. That a mere scraping away of sand particles is insufficient to account for the burrowing of the creature is shown by the results of other experiments (in the press). These indicate that the thixotropic state of the muddy sand which we studied is dependent upon the water content, and if this is reduced below a certain value (about 25 per cent by weight of water in the whole mass) the ability of the sand to become fluid on agitation is so diminished that lugworms cannot burrow into it. Yet, if we understand Wells' argument correctly, there should be nothing to prevent lugworms from burrowing even into perfectly dry sand. This they cannot do, nor, in fact, into sand which is not fully saturated with water.

Another aspect which is accounted for by the thixotropic behaviour of the sand is the construction by the worm of a *permanent* L-shaped burrow, as described fully by Wells[2]. This permanence could be accounted for by the rapid setting of the sand, as soon as the movements making the burrow have ceased. Again, it can be assumed that the downward-moving column of sand filling the headshaft is produced by movements which are effectively similar to those by which the burrow was made in the first place.

GARTH CHAPMAN
G. E. NEWELL

Department of Zoology,
Queen Mary College,
London, E.1.
Nov. 1.

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[1] Wells, *Nature*, 162, 652 (1948).

[2] Wells, *J. Mar. Biol. Assoc. U.K.*, 26, 170 (1945).

The Cellulose of Marine Algæ

THE term 'algic cellulose' was applied by Stanford[1] to an insoluble residue obtained from seaweeds after the removal of algin, and many workers have assumed that this material is identical with the cellulose of land plants. Although denied by some[2], this view has been supported by Kylin[3] on the evidence of the colour reaction with iodine and sulphuric acid, and by Russell-Wells[4], who also demonstrated the solubility of the material in cuprammonium hydroxide and prepared an acetate.

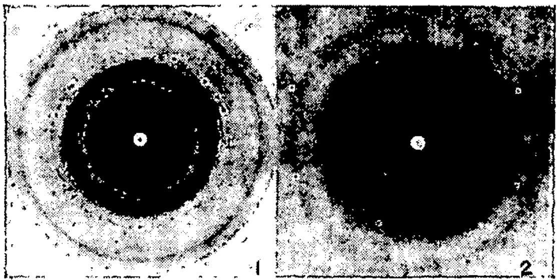
Dillon and O'Tuama[5] obtained a sugar by hydrolysis from which they prepared glucosazone and showed also that 'algic cellulose' was not a mannan. It was also converted into a viscose and into chloroform-soluble acetyl and methyl derivatives.

From these qualitative tests, therefore, the possibility exists that 'algic cellulose' is similar to cotton cellulose; but no evidence is available to show either that the substance is built up entirely from glucose residues, or that the fundamental 1,4-β-linkages are present. The problem has now been reinvestigated under the auspices of the Scottish Seaweed Research Association.

Algal celluloses have been prepared from *Laminaria Cloustoni*, *L. digitata* and *Fucus vesiculosus* by a method based on the A.O.A.C. (Washington) crude fibre determination[6]. The products gave the characteristic blue colour with iodine–zinc chloride, and dissolved readily in Schweizer's reagent. Fluidity measurements[7] gave a value of *c.* 40 poises^{-1} and indicated considerable degradation in comparison with cotton cellulose (*c.* 2 poises^{-1}); a control experiment showed that this high fluidity was due mainly to the rather vigorous treatment used in the isolation, since the fluidity of cotton cellulose rose from *c.* 2 to 28 poises^{-1} when treated similarly.

Hydrolysis to glucose (yield 80 per cent of the theoretical, cf. 88 per cent from cotton cellulose) was carried out by the method of Monier-Williams[8], the sugar being estimated both polarimetrically and by Somogyi's[9] method before and after treatment with yeast[10]. No other reducing sugars could be detected, and this was confirmed by the paper chromatogram. Glucosazone was isolated in the usual way.

The algal cellulose was converted into cellobiose octa-acetate[11] (yield, 31 per cent); m.p. 224°, not depressed on admixture with an authentic specimen, $[\alpha]^{20°}_{D}$ + 40° (in chloroform). This is strong presumptive evidence that 1,4-β-linkages are present, and further confirmation was obtained by periodate oxidation. The course of this reaction was the same as that followed by cotton cellulose, 1·02 mol. of sodium periodate being consumed per $C_6H_{10}O_5$ unit (constant after seven days). The possibility of the existence of 1,3- and 1,6-linkages is thus negatived, since in the former case none, and in the latter two, molecules of $NaIO_4/C_6H_{10}O_5$ would be required, apart from the requirements of the terminal groups.



X-ray diagrams of (1) algal cellulose from *L. Cloustoni*, (2) material regenerated from (1) after dissolution in cuprammonium hydroxide

Oxidation with potassium periodate[12] and titration of the formic acid released (fourteen days) gave a result corresponding to a chain of *c.* 160 glucose units. This is much less than the value reported for cotton cellulose, but is explained by degradation during isolation. This result also disposes of any possibility that significant numbers of glucose residues are united in the polysaccharide by 1,6-linkages.

Through the kindness of Prof. W. T. Astbury, the X-ray diagrams of an algal cellulose prepared from *Laminaria Cloustoni* (Fig. 1) and of the material regenerated from *A* after dissolution in cuprammonium hydroxide (Fig. 2) have been investigated. *A* shows the characteristic pattern of normal cellulose and *B* that of 'hydrate' cellulose.

This result, taken in conjunction with the chemical evidence outlined above, makes it certain that algal cellulose is fundamentally similar to the cellulose of land plants, although, as with the cellulose from different plants, it would be unwise at present to assume that all celluloses are identical in every respect.

E. G. V. PERCIVAL
ALAN G. ROSS

Chemistry Department,
King's Buildings,
University, Edinburgh 9.
July 1.

[1] Stanford, *J. Soc. Chem. Ind.*, **4**, 518 (1885).
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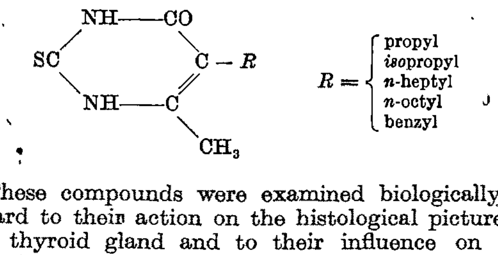
Effect of 5-Alkyl (Benzyl) Derivatives of 2-Thio-4-Methyl-Uracil on the Thyroid Gland and the Bone Marrow in Rabbits

H. Cullumbine and M. Simpson[1] have reported the results of their investigations on the activity of several derivatives of thymine (5-methyl-uracil) having an antithyroid property and a stimulating action on the bone marrow. These researches were based on the assumption that if thymine, according to Spiess, Jacobson and Williams, possesses a therapeutic value in the treatment of pernicious anæmia, its thio-derivatives should have a similar property with the simultaneous antithyroid activity. It is known that one of the greatest disadvantages of antithyroid drugs now being used is their toxic effect on the functioning of the bone marrow. The quantitative changes of reticulocytes and leucocytes in normal and splenectomized rabbits after a parenteral treatment with the compounds being tested were the basis of Cullumbine and Simpson's investigations.

The thiouracil derivatives synthesized by me in the Biological Institute of the University of Kraków possessed various hydrocarbon radicals (*R*) in position 5 beside the methyl grouping in position 4.



These compounds were examined biologically in regard to their action on the histological picture of the thyroid gland and to their influence on the functioning of the bone marrow. The criterion of the latter in my work was the number of white blood cells in 1 mm.^{3}. The animals used were white rabbits about eight weeks old. All the compounds tested were given by mouth in equal dosages, once daily and for equal periods, to facilitate the comparison of the results obtained. The animals were treated in three groups: group (I), 9 days with 50 mgm. a day; group (II), 9 days with 50 mgm. a day and the following 5 days with 100 mgm. a day; group (III), 9 days with 50 mgm. a day and the following 9 days with 150 mgm. a day. In this way the following compounds were tested biologically: 2-thio-4-methyl-uracil; 2-thio-4-methyl-5-propyl-uracil; 2-thio-4-methyl-5-*n*-heptyl-uracil; 2-thio-4-methyl-5-*n*-octyl-uracil; 2-thio-4-methyl-5-*iso*propyl-uracil; and 2-thio-4-methyl-5-benzyl-uracil.

The first compound (May and Baker, Ltd.), at present widely used in the treatment of all forms of thyroid hyperfunction, was used as a standard preparation for comparison purposes. The results are given in the accompanying table.

Name of compound	Average percentage change in white blood cell count	Histological activity
2-Thio-4-methyl-5-propyl-uracil	−30	+++
2-Thio-4-methyl-5-*n*-heptyl-uracil	+64	no effect
2-Thio-4-methyl-5-*n*-octyl-uracil	+66	no effect
2-Thio-4-methyl-5-*iso*propyl-uracil	+52	+
2-Thio-4-methyl-5-benzyl-uracil	+15	+
2-Thio-4-methyl-uracil	−28	++++

Comparing the results, it is clear that the greater the number of carbon atoms in the *n*-radical linked with position 5, and consequently the larger the molecular weight of the whole compound, the weaker its antithyroid activity and the greater the stimulating effect on the bone marrow. The decrease of the antithyroid activity in this group of derivatives is, I think, connected with the increase of the molecular weight of the compounds, and consequently with decrease of the percentage of sulphur in the molecule.

In the second group of compounds tested there is an interesting difference between the 2-thio-4-methyl-5-propyl-uracil and 2-thio-4-methyl-5-*iso*propyl-uracil. The former exerts a marked influence on the function of the thyroid gland and an inhibiting one on the bone marrow, whereas the latter with its small effect on the thyroid gland brings about a rise of the white blood cells count of about 52 per cent.

Of the aromatic derivatives of 2-thio-4-methyl-uracil only the benzyl compound was tested; it was found to be ineffective as regards both the thyroid and the bone marrow.

These results show that the pharmacological action of these compounds depends not only on the number of the carbon atoms but also on the configuration of the radical linked with position 5. Further derivatives of this type are being prepared and tested.

ARTHUR JURAND

Institute of Biology and Embryology,
University of Kraków.

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Role of Gastric Urease

IN a previous communication[1], we were able to confirm that urease is present in the gastric mucosa and, to some extent, in the duodenal mucosa. It was pointed out that the amount of the ferment present in the whole stomach of an animal is sufficient to release enough ammonia from urea to neutralize large amounts of hydrochloric acid.

We suggested previously that urease might be concerned with the protection of the superficial gastric mucosa and the neutralization of hydrochloric acid, a view of its possible purpose which has also been advanced in the past by Luck[2], Linderstrøm-Lang and Ohlsen[3] and others. No direct experiments on this point were ever apparently made. If the concentrations of the substrate, urea, were changed, presumably there might be more ammonia formed. In a series of normal student subjects we have compared the response of the stomach to histamine stimulation when given either without or with urea administered orally. The results are summarized in the accompanying table. It should be emphasized that all the urea solution was removed as the first post-histamine specimen was being removed, and, of course, that in the non-urea series a control solution was administered at zero time.

Mean maximum secretory response of 14 normal human stomachs to histamine acid phosphate (0·1 mgm./10 kgm.) without and with 15 gm. urea given at time of injection

Hydrochloric acid (m. eq.)				Ammonia-nitrogen (m. eq.)				
Non-urea		Urea		Non-urea		Urea		Blood urea change (mgm. per cent)
Fasting	After histamine	Fasting	After histamine	Fasting	After histamine	Fasting	After histamine	-
5	60	6	27	9·36	9·80	7·99	36·54	29 → 41

These results are qualitatively similar in a limited series of gruel test meals or insulin test meals. The invariable result is a reduction of hydrochloric acid only variable in degree. It might be noted that even at the height of ammonia release into the stomach, the degree of neutralization observed could not always be explained on the basis of intra-gastric ammonia alone. The maximum increase in blood urea in these cases falls almost within the range noted after a meal (cf. Conway, O'Connor and O'Donovan[4]). We are, as yet, not clear how the precise effect of the urea rise is brought about, though the neutralization view is most favoured. There is a possibility that the increased urea inhibits the oxyntic cells. Against this there is the observation that the histamine volume response does not appear to change, suggesting the effect is eventually increased neutralization rather than diminished formation.

A calculation can be made as to the amount of urea which would be required to neutralize an average amount of acid secreted in the stomach. Urease releases 2 mol. of ammonia from 1 mol. of urea. At *p*H 6, 80 per cent of the ammonia nitrogen released from urea by urease will be dissociated from any HCO_3 compound; at *p*H 5 about 95 per cent will be dissociated. 300 mgm. urea would be required to neutralize 100 ml. $N/10$ hydrochloric acid. It is known that there may, at least in extreme circumstances, be quite a large urea A/V difference in the stomach (cf. Vladesco *et al.*[5], who were only concerned with the problem of urea excretion in uræmia). No figures are as yet available for animals with a more normal blood urea, nor are there any reliable data on the blood flow in the stomach. Hanke[6] states that 60 ml. of gastric blood flow is required for the production of 1·1 ml. of gastric juice. If the same flow exists during the time required to neutralize this same acid (assuming it to be $N/10$) an A/V difference of 5·5 mgm. per cent urea would be required. Obviously the addition of urea would facilitate this effect, though how it is controlled we do not know.

We have no evidence as to the fate of any ammonia retained inside the gastric mucosal wall, but have not been able to detect any urea-forming system. The use of urea in the study and treatment of the peptic ulcer has been initiated and the results to date are most promising.

One of us (O. F.) wishes to acknowledge the receipt of grants from the Medical Research Council of Eire. We would also wish to acknowledge our indebtedness to Prof. E. J. Conway for many helpful discussions.

OLIVER FITZGERALD
PHILIP MURPHY

Department of Physiology,
University College, Dublin,
and
St. Vincent's Hospital, Dublin.

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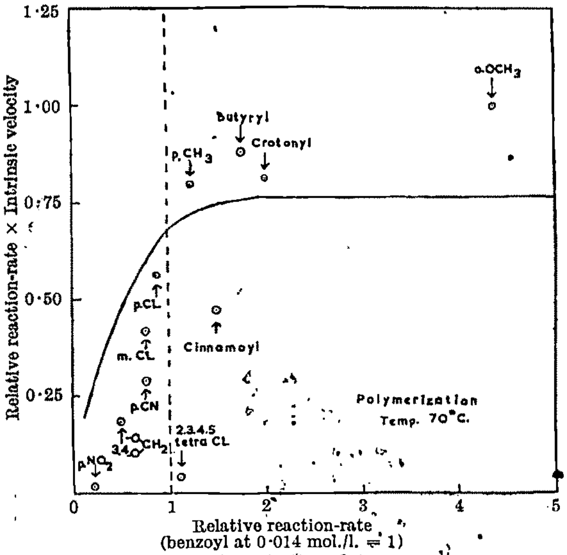
Radical Reactivity in the Initiation Reaction of the Polymerization of Styrene

FREE radicals are known to have widely varying activities, as shown by the studies on the reactions of peroxides with various organic compounds by Kharasch[1] and by studies on copolymerization by Mayo *et al.*[2]. It is possible from a study of the catalysed polymerization of vinyl compounds to obtain information on the activity of the radicals initiating the polymerization. Results are here given on the polymerization of styrene using various types of peroxide catalyst. As an empirical and arbitrary measure of the activity of the catalyst, the product of the rate of polymerization and intrinsic viscosity of the polymer has been taken. (The detailed justification for holding this to be a measure of the catalyst activity will be given on another occasion.)

In the accompanying graph are shown the results obtained with a few diacyl peroxides. The product of $-\frac{dM}{dt} \cdot (\eta)$ is plotted against $-\frac{dM}{dt}$ (the velocities of reaction are taken relative to that of benzoyl peroxide at 0·014 mol./l. concentration; the other peroxides examined are at the same concentration).



Bulk polymerization of styrene

The continuous line shows the value of $-\frac{dM}{dt}\cdot(\eta)$ for benzoyl peroxide over a wide range of concentrations. This has been included as it shows that with 'good' catalysts and fairly high catalyst concentrations the activity is independent of changes of catalyst concentration. This point is important since all peroxides decompose at different rates; hence the comparison has been made at equal rates of polymerization. The fall in the curve at lower concentrations is probably due to the more noticeable effect of transfer reactions. (As at this stage the results are purely comparative, it is not considered necessary to use the power relationship which has been established between (η) and the molecular weight; the constancy of the product of the reaction-rate and intrinsic viscosity over a wide range is fortuitous.)

The activity, according to this point of view, is shown by the values of the ordinates for the various catalysts relative to the standard catalyst, benzoyl peroxide. The position on the abscissa is of less importance, though in some cases it gives an indication of the rate of decomposition of the catalyst. The results shown, which are mainly obtained from substituted benzoyl peroxides, support the view that electron-attracting substituents give radicals of low activity, particularly when this is supplemented by the mesomeric effect. On the other hand, electron-repelling groups increase the activity of the radical.

In the case of alkoxy benzoyl peroxides, the mesomeric effect outweighs and reverses the inductive effect, consequently the activity of the radical is high. (This result is supported by U.S.P. 2,419,347, claiming high catalytic activity for *o*-alkoxy benzoyl peroxides.) However, di(3-4-methylene dioxybenzoyl) peroxide has a low activity, suggesting that the observed effect is purely inductive. Halogens have similar activities with the same orientation: the two results shown for di-*p*- and -*m*-chlorobenzoyl peroxides are in the expected positions. (Many of the results are in a similar order to those found for the dissociation constants of the substituted benzoic acids. In addition, an 'ortho' effect is shown by all ortho-substituted benzoyl peroxides.) Alkyl groups, as would be expected, increase the activity; but there is little difference between the effects of different alkyl groups. A result for an aliphatic acyl peroxide is given, and, as would be expected, this shows high activity. The introduction of a double bond (dicrotonyl peroxide) increases the rate of reaction, possibly by an increase in the rate of decomposition, and causes a slight fall in activity. Replacement of the methyl in this peroxide by phenyl, however, in dicinnamoyl peroxide, stabilizes the radical, which is consequently of lower activity.

These results seem to indicate that an important characteristic of a free radical is the availability of the free electron for reaction with the π-electrons of the double bond.

This work forms a part of a larger investigation which will be given in detail elsewhere.

W. COOPER

Chemical Research Division,
Dunlop Rubber Co., Ltd.,
Fort Dunlop, Erdington,
Birmingham. Aug. 12.

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Transformation of Frequency Distributions

FREQUENCY distributions of numbers of eggs, insects, spores, or other biological entities are descriptive of discrete variation, and can never be represented *exactly* by a normal distribution or by any other distribution of a continuous variate. Nevertheless, when the number of observations and the range of variation is large, such distributions may often be *adequately* represented by a continuous distribution. Experience has shown that transformation of discrete counts to a scale of $\sqrt{n}$, log n, or log $(n + 1)$ may considerably assist the representation by a normal distribution.

The device of plotting the cumulative distribution in probit units against a proposed square root or logarithmic scale of counts, as suggested by Gaddum[1], is useful as a rapid test of whether or not the right normalizing transformation has been found: if the distribution is effectively normal on the transformed scale, the probits will be linearly related to the counts. Spiller[2] has recently commented on this procedure. He has stated that statistical analysis in terms of this linear regression seems preferable to argument from the parent distribution, but that methods of calculating regressions and variance do not appear to be available.

In all uses of probit methods, however, the parent distribution must be kept in mind. The standard methods of calculation associated with probit analysis[3] have been devised for data in which the cumulative distribution is estimated directly from the observations, and they are clearly not appropriate here. The regression equation for a diagram such as that drawn by Spiller is, in fact, a line which attains a probit value of 5·0 at the mean value of the sample (on the transformed scale), and which has a slope equal to the reciprocal of the standard deviation of the sample; an application of statistical theory to the problem of estimating this line would show that the parameters of the line were to be obtained from that mean and standard deviation. As Gaddum has stated, "The best estimates of the mean and standard deviation will be obtained by applying the ordinary methods directly to the transformed observations".

Some idea of the values of the parameters may be formed by measurement of the diagram. For example, Spiller's line *B* has a value of about 0·70 for log $(n + 1)$ at a probit of 5·0, and an increase of unity in log $(n + 1)$ corresponds to a probit increase of about 1·9. Hence the distribution of log $(n + 1)$ may be regarded as approximately normal, with mean 0·70 and standard deviation 0·53 ($= 1/1{\cdot}9$); these compare with values, calculated from Spiller's table, of 0·774 for the mean and 0·487 for the standard deviation. The size of the standard deviation relative to the mean suggests that agreement with a normal distribution cannot be very close (though it may be good enough for comparisons between samples to be made with the aid of normal distribution theory), and comparison of the frequency polygon with the calculated distribution would confirm this. The probit diagram may indeed be deceptive for data of this kind, since considerable deviations from normality are not always apparent by inspection of it.

D. J. FINNEY

Lectureship in the Design and Analysis of
Scientific Experiment,
University of Oxford. Oct. 6.

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THE INTERNATIONAL ASTRONOMICAL UNION

AT the seventh General Assembly of the International Astronomical Union which was held at Zurich during the week beginning on August 11, more than three hundred astronomers from thirty countries met (in many cases for the first time for ten years) to discuss their past results, their current problems and their future plans. The machinery of international collaboration, kept going during the War by the good offices of astronomers in neutral countries, had been overhauled at a meeting of the Union's Executive Committee at Copenhagen in the spring of 1946; and it was largely because of the spadework put in by that committee, then and since, that the full Assembly could get on with its business so expeditiously at Zurich. The Federal Institute of Technology was kindly made available to delegates throughout the week. The hundred sessions held by the forty commissions into which the Union is subdivided put no severe tax on the accommodation available, and the many mixed commission meetings, colloquia and informal lectures, though they were well attended, could always find an auditorium of ample size. It was evident that behind the smooth functioning of the local arrangements, which included (as well as the formal business) a full programme of social events and sightseeing trips for delegates and their guests, lay a tremendous amount of hard work by a most efficient organising committee, headed by Prof. Waldmeier, director of the Zurich Observatory.

After an inaugural general assembly at which warm welcomes were accorded the delegates by the civic authorities and by the Swiss National Committee of Astronomy, and were responded to by the president of the Union, Sir Harold Spencer Jones, the members devoted a short session to administrative business. The financial load on the Union has been considerably eased by a decision of Unesco to support many bodies, such as the Bureau International de l'Heure and the International Latitude Service, the world-wide scope and general scientific value of which deserve such support. The Union in its turn eased the financial burden on its less wealthy adherent countries by altering the system of paying dues. Instead of paying, as now, on a *per capita* basis, countries will in future be classified (on their own proposal, ratified by the Executive Committee) into eight categories, each paying different subscriptions. By this modification countries with large populations, such as India or China, will be relieved of the necessity of paying dues out of proportion to the extent to which astronomy has developed within their borders.

The next five working days were devoted to purely scientific matters. Discussion varied, as always, from prepared contributions to a symposium attended, perhaps, by a hundred delegates, to fierce wrangles around a table on some obscure technical point between the only three people in the world aware of its import. At the commission meetings themselves, the business was partly organisational and partly scientific, the proportion varying with the subject-matter of the commission. At one end of the building a handful of delegates might be revising the code for astronomical telegrams or the list of standard astronomical notations, while at the other a no less earnest group would be discussing the constitution of interstellar matter, or the emission spectrum of the night sky.

In the commissions concerned with positional astronomy, modern methods for improving meridian work were discussed. The Russians have successfully experimented on photo-electric recording of transits of the brighter stars, while the Washington transit circle is now fitted with cameras which record all readings photographically so as to reduce fatigue in the observers and eliminate erroneous logging of the results. New instruments are being designed, some of them (notably those at Greenwich) based on new principles chosen so as to eliminate many of the most troublesome errors that beset meridian work. Photographic astrometry proceeds apace with wide-angle lenses and now with Schmidt cameras, and the application of punched-card methods to repetitive computation is being followed by the development of automatic plate-measuring devices which feed measured co-ordinates direct to the mechanical computers. Inconsistencies recently found in the adopted system of the fundamental astronomical constants are to be attacked by a research team in the United States, and authors are urged not to make *ad hoc* alterations pending the report of this team.

The solar commissions were faced with tremendous advances in our knowledge since the previous meeting, at Stockholm in 1938. Solar-terrestrial relationships, if little better understood, are now reduced to some sort of order since the importance of solar flares and active coronal regions became clear; the coronal spectrum is no longer a mystery, even if the corona still is; and on the instrumental side astronomers now have the help of prominence cinematography, the Lyot polarization filter, and the V2 rocket for exploring the sun's ultra-violet spectrum. But with these advances have come new problems; and much time was taken up in discussing solar radio noise, corpuscular emission from solar flares, and chromospheric structure. Nor have all the long-standing problems been cleared up, as was shown when two of the liveliest controversies of the week developed around the supposed variations in the solar constant and the magnitude of the sun's magnetic field. There was a powerful appeal for further direct observations to confirm the Smithsonian measurements of the solar constant when reports of indirect checks (via the brightness of the moon and of Uranus) revealed conflicting results. As for the sun's magnetic field, so much recent work has been based on the classical results at Mt. Wilson that there was something of a sensation when it was announced that both Mt. Wilson and Hamburg Observatories had recently failed to detect the field with apparatus that had apparently confirmed its presence only a year or two ago. Whether this failure is due to a real change in the magnitude of the field or to an under-estimate of the size of the accidental errors of observation did not emerge; but a suggestion that the matter might be settled by measuring the polarization of the sun's radio emission from its north or south hemisphere during an eclipse was seized on as a hopeful way out of the quandary.

In the field of research on nebulæ, observers and cosmologists met on common ground. Recent spectrophotometric work has shown that the more distant nebulæ are redder than can be accounted for by the red-shift in their spectra, that is, the colour indices of the nebulæ increase with distance. This is conceivably an evolutionary effect: for if, as is currently believed, the red supergiant stars in the nebulæ exhaust their internal store of nuclei available for energy generation more rapidly than other stars, the distant nebulæ, which we see in their youth, will indeed be redder than the older ones in our neighbourhood, from which the red giants have faded. But whatever the explanation, this reddening must seriously affect those nebular counts to limiting magnitudes on which depend our present observational tests of various world-models. An interesting but inconclusive discussion took place on whether the classification sequence of the external galaxies is also an evolutionary sequence; and if it is, whether the sense of evolution is not towards rather than away from the elliptical forms. The cosmologists present carried the observers with them in an appeal to present observational results in a form which would facilitate rather than preclude a comparison of the different theories of world structure; in particular, to refrain from applying dubious 'corrections' for cosmological effects which are based on a particular model and therefore exclude others from proper consideration.

In a crowded symposium on infra-red spectrophotometry, recent results obtained with photoconductive lead sulphide cells were presented. Perhaps the most spectacular are: the identification of the infra-red spectra of the Martian polar caps and of the rings of Saturn with reflexion spectra from hoar-frost deposited on solid carbon dioxide; the suggestion that the green areas on Mars are due not to vegetation but to lichens devoid of chlorophyll; and the discovery of methane high in the earth's atmosphere from telluric bands at 3·4 μ and 1·6 μ in the solar spectrum.

Other well-attended meetings considered the spectral sequence and its anomalies (perhaps the most important paper here was a Russian one showing that a variety of observational data could be explained if interstellar matter is concentrated into small discrete clouds about 10 parsecs in diameter), the outer layers of the sun, and current progress with the 200-in. telescope. It seems that after a little preliminary trouble with the mirror supports, all goes well with the latter. The figure is approaching perfection, which the opticians define as "correct to 1/10 wave", and the light-grasp is up to expectations.

Animated discussions took place when the commission on international observatories met. Sharp cleavages of opinion emerged on the relative value of the various proposals which had been made, all designed to show that astronomy at least can override political boundaries. It was finally decided to proceed with all the immediately practicable parts of the schemes, including plans for establishing an international telescope in the southern hemisphere, an international astronomical laboratory in Europe (including a library and optical shops and a computing centre), and an international travel fund for facilitating exchange of astronomers.

The meeting reached its climax with a conference on the cosmic abundances of the elements. Since the 1938 meeting a measure of agreement has been reached on the nuclear reactions controlling energy generation in the stars, and interest now centres on the allied problem of elemental abundances. As a result of the present conference, it is now clear that no significant differences of abundance exist between the sun, the main-sequence stars and even the planetary nebulæ and interstellar matter, and that the proportions of the elements found in the earth's crust and in meteorites differ from the cosmic proportions only in physically explicable ways. The high-luminosity stars, however, lie on a mass-luminosity curve appropriate to a much higher mean molecular weight than the sun's; and it seems likely that, as was expected from their high rate of radiation, these giants have already burned up a considerable part of their hydrogen content. While discrepancies do undoubtedly exist in certain celestial bodies, it would be fair to say that the observed abundances do fit present conceptions reasonably well. The next move is to explain how the present abundances arose, and some steps have already been taken in this direction.

At the concluding general assembly some general resolutions were passed, the lists of members and of commissions were revised and new officers were elected. The incoming president is Prof. B. Lindblad, of Stockholm; the new general secretary is Prof. B. Strömgren, of Copenhagen. No decision has yet been reached on whether to hold the next meeting, in 1951, at Leningrad or Pasadena. With a final vote of thanks to its Swiss hosts for making possible a most successful meeting, the seventh General Assembly of the Union was declared closed on August 18.

VITAMIN C IN POTATOES

By Dr. FRANK WOKES
Ovaltine Research Laboratories, King's Langley, Herts
AND
GORDON NUNN
Oakley Training College, Cheltenham, Glos.

THE vitamin C content of potatoes is known to diminish steadily during the autumn and winter, so that their contribution towards the national requirements of this vitamin is considerably diminished. The average content of vitamin C in *raw* potatoes, as found by different workers, has been summarized by Lampitt, Baker and Parkinson[1] and is indicated by the shaded area in Fig. 1. The

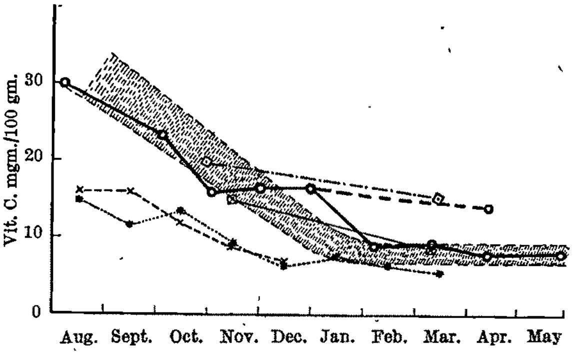

Fig. 1. Seasonal changes in vitamin C content of potatoes. The shaded portion represents average content in raw potatoes in different seasons as summarized by Lampitt, Baker and Parkinson. Results on raw potatoes stored in clamps indicated thus:

Lampitt, Baker and Parkinson (1945), □———□
Baker, Parkinson and Lampitt (1946), ◇—·—·—◇
Wokes and Nunn (1948), potatoes in clamp, ○———○
Potatoes removed from clamp to dry room, ○— — —○

Results on cooked potatoes indicated thus:

Olliver (1943), ×– – – –×
Thompson (1944), •············•

vitamin C content of *cooked* potatoes, as found by different workers[2,3], is indicated in the same figure by dotted lines, and will be seen to be less than that of the raw potatoes but to show a similar decline in the latter part of the year. Certain workers[4] have found that in raw potatoes stored in clamps the vitamin C content does not always fall so steeply as would be expected from the average figures. No convincing evidence has been forthcoming to show that this was due to temperature changes. The question how to diminish, and if possible prevent, this loss of vitamin C is therefore not yet satisfactorily answered.

In the course of some storage experiments on potatoes which we have been carrying out recently, we have made some observations which may perhaps be of interest. The potatoes we used (Kerr's Pink) were grown in Cheltenham and stored in an experimental clamp, samples being withdrawn at regular intervals for testing. Results obtained on these potatoes are indicated in Fig. 1 and show that, after the usual drop in the autumn, the average vitamin C content became steady in three batches taken during November and December, but fell again in January, February and March. These results are based on duplicate assays on more than a hundred separate potatoes, enough being taken to ensure that the alterations in the slope of the curve at the end of October and at the end of December were highly significant.

When looking for a possible cause for the unexpected stability of the vitamin experienced by ourselves, and occasionally by other workers[4], we first considered the storage temperature. Daily records of the maximum and minimum temperature in the storage clamp did not provide the explanation we were seeking. Moreover, in some of our potatoes stored in the refrigerator we experienced a greater loss of vitamin than in others of the same variety of potatoes stored at higher temperatures (see table). Taken in conjunction with the findings of previous workers, who detected no difference in the rate of loss at different storage temperatures from 3° to 31° C., our results seem to show that storage temperature *per se* is not a decisive factor.

Effect of storage conditions on rate of loss of vitamin C in potatoes

Storage conditions	% Loss	No. of weeks	% Loss per week
Closed containers			
at 4–5° C.	14·1*	10	1·4
at 27° C.	20*	7	2·9
Open to air			
(L) at 30° C.	41	9	4·6
at 4–5° C.	75†	20	3·8
(L) at room temperature (20° C.) in dark	32	6	5·0
	26	9	2·9
(L) at 31° C. in dark	23·5	5	4·9
	23·5	9	2·6

This table includes results obtained by Lampitt and his colleagues (marked L).
*Indicates less significant (p = 0·1–0·2).
† Indicates highly significant (p = 0·01).

We next considered the effect of atmospheric moisture. Our potatoes, like those of Lampitt and his colleagues, also stored in the refrigerator and referred to in the table, were exposed to air and therefore to a higher relative humidity than the potatoes stored at higher temperatures. It seemed to us feasible that the absorption of moisture from a more humid atmosphere might increase the tendency to form sprouts and thus use up some of the vitamin C in the potato. Rainfall records for the area in which our experimental clamp was situated showed that there was, in fact, very little rain during the period November–December, when the vitamin C content of the potatoes remained constant, but much more rain in January and February, when the vitamin C content fell. As a further test of this hypothesis, we examined in April some of the potatoes which had been taken for seed purposes from the clamp at the beginning of January and since stored in a dry shed. The vitamin C content of these potatoes was significantly higher than in similar potatoes stored in the clamp during this period; for example, 13·9 ± 0·4 as compared with 7·7 ± 0·4 mgm./100 gm. When these seed potatoes were stored in the same humid atmosphere as the main stock for a few days, they began to sprout and their vitamin C content fell to 8·1 ± 0·9 mgm./100 gm. (the second figure given above is the standard deviation of the mean).

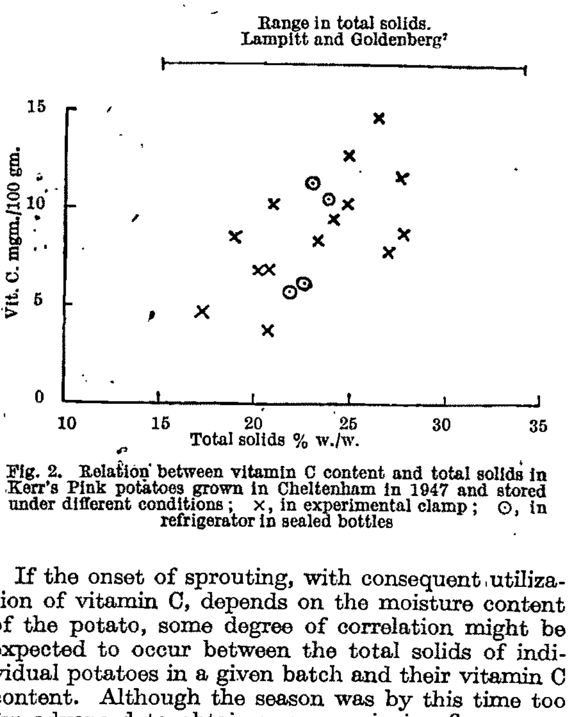

Fig. 2. Relation between vitamin C content and total solids in Kerr's Pink potatoes grown in Cheltenham in 1947 and stored under different conditions; ×, in experimental clamp; ⊙, in refrigerator in sealed bottles

If the onset of sprouting, with consequent utilization of vitamin C, depends on the moisture content of the potato, some degree of correlation might be expected to occur between the total solids of individual potatoes in a given batch and their vitamin C content. Although the season was by this time too far advanced to obtain very convincing figures, we attempted to investigate this question, and think that our data, summarized in Fig. 2, at least suggest the possibility of such a correlation. We hope that publication of these preliminary findings may stimulate other workers to study this problem, the solution of which should benefit the diet of the nation.

We are indebted to Misses Finnegan, Morphet and Raynor and to Mr. D. B. Kingston for assistance, and to Glaxo Laboratories, Ltd., for the loan of a Waring blender used in preparing some of the extracts.

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ORIGIN OF LANGUAGE

By Prof. ALEXANDER JÓHANNESSON
University of Iceland

IN articles in *Nature*[1], I have set out the conclusion that a great part of human speech originated in the speaking organs' unconscious imitation of the gestures of the human body, especially the hands. The three articles dealt only with Ide. and Hebrew (as representative of the Semitic group). I have continued my researches and this time chosen the sounds *l* and *r*, which I have systematically investigated in Ide., Hebrew, Archaic Chinese, Polynesian, Sumerian and partially in Greenlandic.

	Ide.	Hebrew	Arch. Chin.	Polynes.	Sumerian
Examples with l:					
1. Sound	*lêu-* (Ags., *léop*, 'song')	*lw-n*, 'to mutter'	*liw-ər*, 'eulogy'	*leo*, 'the voice, speech'	*lu-ga*, 'to scold'
2. Light, colour	*leuq* (Lat., lux)	*lw-ḥ*, 'to shine'	*luk*, 'to look carefully' (*liuk*, 'green')	*roherohe*, 'a torch' (in P. *r* and *l* interchange)	*luǵ*, *laǵ*, 'light'.
3. Water	*leiqu-*, 'wet' (Lat., liquor)	*lḥ-ḥ*, 'be wet'	*lia*, 'thin wine'; *log*, 'rain water'	*rewa*, 'melt, become liquid'	*li-*, 'fat'; *lù*, 'muddle, disturb the water'.
4. To break, scratch, etc.	*lem*, 'to break' (Old-Bulg. *loml'ja*, 'to break')	*lm-d*, 'to stab'	*lâp*, 'to break'	*rami*, 'to squeeze'	*laǵ*, 'to strike'.
Examples with r:					
1. Sound	*rās-*, 'to sound' (Old-Ind. *rás-ati*, 'cries, sounds'	*rz-h*, 'to cry'	the hard '*r*' does not exist	*rāra*, 'to roar'.	
2. Light, colour	*reg*, 'to colour' (Gr., *ῥεζω*)	*rah*, 'to see'		*ra*, 'the sun'	*ra*, 'shining'.
3. Water	*reg-*, 'wet rain' (Lat., *rigare*)	*rh-t : rahat*, 'water-pipe'		*rire*, 'deep water'	*ri*, 'to flow'?
4. To break, scratch, etc.	*reis-*, 'damage' (Old-Ind. *riṣyati*, 'damages')	*rs̱-s̱*, 'to smash'		*raku*, 'to scratch'	*ri*, 'to throw down'.

In all these 'unrelated' languages the sounds *l* and *r* show a double origin: (1) that of a Nature sound (especially where *l* and *r* form the beginning of a syllable, or in the connexion vowel + *l* or *r*, but sometimes also in the combination consonant + vowel + *l* or *r*), and (2) that of a different (gestural) sound (mostly in the connexion consonant + vowel + *l* or *r*, but even vowel + *l* or *r*) as spontaneous imitations of the speaking organs to express the idea of the form or shape of things in Nature or to designate a movement.

The investigation shows that the most remarkable meanings of roots with the Nature sounds *l* and *r* (marked as l' and r' to distinguish them from l^2 and r^2, which mainly are a means of designating the shape or form or a movement, cf. above) are: (1) sound; (2) light, colour; (3) water; (4) to break, scratch, etc.

	Ide.	Hebrew	Arch. Chin.	Polynes.	Sumerian	Greenl.
Round, vaulted, curved, twisted, etc.	*k̂el-*, 'to enclose, cover' (Lat., color)	*kl-l*, 'to bend, encompass'	*kl-io*, 'round basket'	see under *r*	*gal* (*ga-al*) 'big'	*qal-eq*, '*ribbon*'
	k̂er-, 'string, to plait'	*kr-r*, 'be round, turn'	*k'iər*, 'bow down (the head) to the ground'	*kara*, 'an old man' (bent by age, cf. Gr. *γερων*)	*gar*, 'to encompass'; *gůr*, 'to bow'	*qar-ajak*, 'bay, encircled by rocks'
To move, to rise above, to grow, to lift, etc.	*tel-*, 'to lift' (Lat., *tollo*)	*dl-g*, 'to jump'	*lia*, 'depart from'; *tiər*, 'push away'	*tere*, 'to move swiftly'	*zal*, 'to extend' *sir*, 'be long, to remove'	
	reiq-, 'to arise' (Germ. *riegel*)	*rg-š*, 'turbulent movement'				

All these four subdivisions are closely related. It is an accepted theory that an impression on either the ear or the eye may give the same phonetical release (*Schall- und Lichtempfindung* in German handbooks)—presumably because they were originally symbolized by somewhat similar gestures. Thus Ide. *ghel*, 'to cry', and *ĝhel*, 'to shine', are related. No. 3 means water dripping, etc. No. 4, with the meaning 'to smash, to tear, to scratch', etc., shows that in those roots the *l* and *r* represent a hard sound (as also in some cases of Nos. 1 and 2).

More interesting is it to see how the 'unrelated' languages imitate the shape or form of things or movements. In the combination consonant + vowel + *l* or *r*, or vowel + *l* or *r*, we see how the idea of 'round, vaulted, curved, twisted', etc., or the idea of 'to rise above, to grow, to lift, to move', etc., came into existence by the speaking organs' spontaneous imitation of a curved form or movement.

The importance of comparing the roots in different languages may be seen by tabulating the number of Ide. and Hebrew roots with *r* according to their various meanings:

	No. in Ide.	No. in Hebrew
Sound	46	19
Colour	32	10
Water	19	14
To break, scratch	91	70
Round, vaulted, curved	103	26
To move, rise above	97	83
Total	388	222

To this may be added some other roots, especially with the meaning 'to cut' (Ide., 8 roots; Hebrew, 17) or 'to devour' or to be 'relaxed'.

As the roots with *l* have a similar extension to those with *r* we see that, in Ide. languages, the sounds *l* and *r* in the roots of approximately one word in three have more or less determined the meaning (the Ide. roots number 2200), and that in more than 50 per cent (200 out of 388 for the sound *r*) all words containing in the roots the sounds *l* or *r* are of gestural origin. This fact might encourage philologists to scrutinize systematically all combinations of sound-groups in the roots as the most important means of solving the problem how man learned to speak.

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[1] *Nature*, 153, 171 (1944); 154, 466 (1944); 157, 847 (1946).

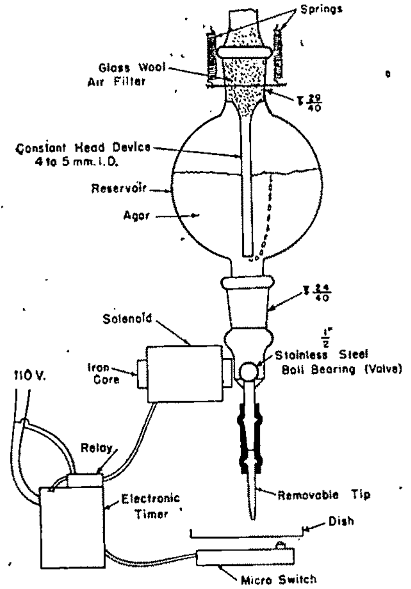
AN AUTOMATIC AGAR DISPENSER

By W. H. SCHMIDT[*], M. D. REEVES[†], FRANCIS J. CASTLE and R. G. BENEDICT

Fermentation Division, Northern Regional Research Laboratory[‡], Peoria, Ill.

IN many laboratories various types of semi-solid culture media are routinely dispensed in Petri dishes for use in the study of micro-organisms.

The automatic agar dispenser described in this article was originally designed for rapid and reasonably accurate transfer of melted agar to plates for subsequent use in the assay of penicillin. A notice of this was published some time ago[1]. Because of the interest shown in the apparatus by visitors from other laboratories, it appears desirable to publish a more complete description which will be more widely available. A drawing of the apparatus is reproduced herewith.



Assembly of agar dispenser

In principle, the device is simple. It consists of a constant-head reservoir which empties through a modified solenoid valve connected with an electronic timer. The only part of the apparatus considered difficult to make is the glass seat for the ball valve. This seat should be flattened so that no leakage can occur when the stainless steel ball is in its normal position. When the micro switch is pressed, the solenoid must not lift the ball but roll it to one side. Any timer, either mechanical or electronic, which makes or breaks a circuit may be used, the accuracy of the device depending upon the accuracy of the timer. The size of the glass reservoir for holding the agar depends on the quantities to be dispensed. For routine plate-pouring (20 ml. per plate), we use a vessel with a total capacity of 2 litres. For dispensing smaller amounts of agar, such as those required for flooding assay plates (4 ml. per plate), a 500-ml. receptacle is used. A delivery tip with a much smaller opening is attached to this vessel.

Sterilization of the reservoir and valve in our Laboratory is effected by passing steam in at the top and permitting it to escape to a drain by raising the ball valve with a straightened paper clip inserted through a small opening in the rubber tubing. The constant-head device and delivery tip are sterilized separately in an Arnold steamer. Autoclave sterilization may be substituted when steam is not available on the laboratory table. To guard against the possibility of pressure developing in the reservoir during steam sterilization on the table, two steel springs, attached at the top of the standard taper (29/40) male joint, are clipped to loops at each end of a wire ring, shown at the top of the reservoir. Should the ball valve accidentally close during sterilization, slight steam pressure pushes the top male joint up to prevent breakage of the reservoir. In assembling the apparatus, we close this top joint with only moderate pressure and do not employ any lubricant. The lower joint standard taper (24/40) connecting the bottom of the reservoir with the glass assembly containing the ball valve is greased with a temperature-resistant chemically inert lubricant.

Data on accuracy of delivery are shown in the accompanying table. A 2 per cent agar medium was melted and cooled to 48° C. before transfer to the glass reservoir. The timer was set to deliver 20 ml. agar (ball valve opened and closed in 1·5 sec.).

Accuracy of delivery of automatic agar dispenser
Weight in grams of 20 ml. samples, reading down from left to right

20·91*	20·60	20·54	20·40
20·80	20·72	20·65	20·32
21·08	20·62	20·28	20·27
20·76	20·32	20·74	20·30 (last sample)
20·64	20·71	20·41	
20·82	20·71	20·35	* First sample

Average weight of all samples delivered was 20·63 gm. Extreme variations from the mean value were +0·45 gm. and −0·36 gm.

One operator is able to handle thirty plates within 2–3 minutes. The dispenser is much simpler and faster than agar delivery by pipette, and more accurate than pouring plates from tubes containing measured amounts of the materials.

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[*] Now associated with Schenley Laboratories, Lawrenceburg, Indiana.

[†] Now with the Department of Chemistry, John Brown University, Siloam Springs, Arkansas.

[‡] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U.S. Department of Agriculture.

[1] Schmidt, W. H., *Bull. Health Organ., League of Nations*, 12, 259 (1945–46).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 6

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Dr. A. D. Buchanan-Smith: "Inheritance of Milking Capacity in Dairy Cattle".

UNIVERSITY OF LONDON (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. C. de Duve: "The Control of Carbohydrate Metabolism".*

(Further lectures on Thursday, December 9, and Monday, December 13.)

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. K. L. Little: "Education for International Understanding—Africa".*

SOCIETY OF CHEMICAL INDUSTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. H. Seligman: "Application of Radio-active Elements in Industry".

ROYAL INSTITUTE OF CHEMISTRY (at Norwood Technical Institute, Knight's Hill, London, S.E.27), at 7 p.m.—Dr. A. Albert: "Drug Action, Ions and Neutral Molecules".

Tuesday, December 7

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX, NORTHERN BRANCH (at the North of England Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 10 a.m.—Conference on "The Value of Organised Information Service to Industry, Commerce and Education".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. W. B. Douglas: "Maternity in Britain—the Results of a Social Survey".*

Institution of Electrical Engineers (joint meeting of the Measurements and Supply Sections, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Papers.

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. E. F. Edson: "Radiation Hazards and their Control".

Sir Halley Stewart Trust Lecture (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Prof. D. W. Brogan: "The Atomic Age—America as Atlas".*

Wednesday, December 8

Physical Society, Colour Group (in the Large Physics Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Air Vice-Marshal Donald Bennett: "Order in the British Air".

Illuminating Engineering Society (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6 p.m.—Reports and Discussion on the 1948 Meeting of the International Commission on Illumination.

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.30 p.m.—Mr. Longworth: "Functional and Performance Characteristics of Automatic Temperature Control".

Thursday, December 9

Physical Society (at the Laboratories of the Metropolitan-Vickers Electrical Co., Trafford Park, Manchester), at 9.45 a.m.—Scientific Papers.

Linnean Society of London (joint meeting with the Royal Entomological Society, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Bearing of the Parasite-Host Relationship in Taxonomy" (to be opened by Mr. G. H. E. Hopkins, Dr. J. Ramsbottom and Dr. O. W. Richards).

Royal Society of Medicine (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "Colour Vision in Industry" (to be opened by Prof. W. J. B. Riddell, Prof. H. Hartridge, F.R.S., Dr. W. D. Wright and Dr. Leslie Norman).

Chemical Society (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. C. K. Ingold, F.R.S.: "Aromatic Nitration".

Textile Institute, Midlands Section (joint meeting with the Coventry Textile Institute, at St. George's Hall, Nuneaton), at 6.45 p.m.—Mr. A. Y. Stirrat: "Increasing Production in the Textile Industry by Training and Production Study".

Royal Photographic Society, Scientific and Technical Group (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Dr. R. H. Herz: "The Action of X-Rays and Electrons on the Photographic Emulsion".

Society of Chemical Industry, Fine Chemicals Group (joint meeting with the Agriculture Group, at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 7 p.m.—Dr. W. A. Sexton: "The Chemistry of Plant Growth Regulators".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

Society of Chemical Industry, Microbiological Panel of the Food Group (joint meeting with the Nottingham Section of the S.C.I., at the Nottingham Gas Show Rooms, Nottingham), at 7.15 p.m.—Mr. F. C. Bawden: "Some Properties of Plant Viruses".

Chemical Society, Edinburgh Section (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, in the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. D. W. Kent-Jones: "Bread and its Influence on History".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. G. Crowden: "A Survey of Physiological Studies of Mental and Physical Work in Hot and Humid Environments".

Friday, December 10

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mechanical Engineers, Applied Mechanics Group (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—General Review of "Fluid Flow through Granular Beds" (Discussion based on papers by Dr. H. E. Rose and Dr. A. M. A. Rizk).

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. T. W. F. Brown: "British Marine Gas Turbines" (Parsons Memorial Lecture).

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Brigadier R. A. Bagnold, F.R.S.: "Model Scale Experiments on Waves and Beaches".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "The Emission of Light in Chemical Reactions".

Saturday, December 11

British Psychological Society (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Prof. G. Humphrey: "Some Problems in the Modern Theory of Learning".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mr. Percy Edwards: "British Wild Birds and their Voices" (Pictures and Voices).*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Lecturer in Physics at the Ministry of Supply School of Electronics—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs., quoting 5/138/JFA (December 11).

Lecturer (Grade IIc) in Chemistry—The Secretary, The University, Edmund Street, Birmingham 3 (December 11).

Deputy Laboratory Steward for the Department of Organic Chemistry—The Registrar, The University, Liverpool (December 11).

Electronic Physicists and Electronic Engineers (in the Senior Scientific Officer, Scientific Officer, Experimental Officer and Assistant Experimental Officer grades) in Ministry of Supply research and development establishments mainly in Hampshire, Worcestershire and Kent—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.161/48A (December 11).

Laboratory Steward to take charge of the maintenance of Physics and Chemistry Laboratories—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (December 11).

Senior Scientific Officers, Scientific Officers, Experimental Officers, Assistant Experimental Officers and Scientific Assistants in the Air Ministry Soil Testing Laboratory under the Directorate General of Works in London or the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.487/48 (December 13).

Deputy Survey Officer at the Coal Survey Laboratory, Cardiff—The National Coal Board, Establishment (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting TT/103 (December 13).

Teacher of Chemistry for matriculation and intermediate science classes—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (December 13).

Assistant Lecturer in Philosophy—The Registrar, The University, Leeds 2 (December 13).

Assistant Warden for duty at Juniper Hall Field Centre, near Dorking—The Director, Council for the Promotion of Field Studies, 10 Exhibition Road, London, S.W.7 (December 14).

Crombie-Ross Chair of Mental Health—The Secretary, The University, Aberdeen (December 15).

Lecturer in Mechanical Engineering, a Lecturer in Civil Engineering, a Lecturer in Electrical Engineering, and a Lecturer in Automobile Engineering, at the Technical Institute, Yaba, near Lagos—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1 (December 18).

Candidates for two posts in the Directorate of Scientific Control to carry out operational research—The National Coal Board, Establishment (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting TT/110 (December 20).

Deputy City Bacteriologist—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2, endorsed 'Deputy City Bacteriologist' (December 20).

Keeper of Art, a Keeper of Antiquities, a Keeper of Geology, a Schools Service Organiser, and an Assistant Keeper of Art—The Director, Museum and Art Gallery, New Walk, Leicester (December 29).

Chemists, Chemical Engineers and Fuel Technologists at the Dominion Laboratory, Wellington—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (December 30).

Candidates (Experimental Officer and Assistant Experimental Officer grades) for indexing and abstracting literature and official reports and supplying research workers with information—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.381/48A (December 30).

Professor of Botany—The Secretary and Registrar, University College of North Wales, Bangor (December 31).

New Zealand Research Fellowship—Research Applications British Federation of University Women, 17a King's Road, London, S.W.3 (January 1).

Economic Botanist in the Department of Agriculture, Fiji—The Director-General of Recruitment, Colonial Office, Sanctuary Buildings, London, S.W.1.

Candidate with a special interest in and general knowledge of the Rhynchota to undertake determinations and possibly later a certain amount of systematic revisionary work in that order of insects—The Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7.

Departmental Demonstrator in Physical Anthropology—The Professor, Department of Human Anatomy, The University, Oxford.

Lecturer in Horticulture at the Kent Farm Institute, Sittingbourne—The County Education Officer, Springfield, Maidstone.

Assistant Manager (Production), a Technical Records Officer, and a Works Engineer (Maintenance), in the Department of Atomic Energy at Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Department of Atomic Energy Risley, Warrington, Lancs.

Abstractors (male and female)—The Secretary, British Shipbuilding Research Association, 5 Chesterfield Gardens, London, W.1.

Experienced Metallurgist for the application of research results to industrial practice—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

Technician (Grade II) in the Department of Civil Engineering—The Secretary, University College, Gower Street, London, W.C.1, quoting 'Civil Engineering/1'.

Visiting Demonstrator in Bacteriology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Meteorologist for Directorate of Civil Aviation, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London S.W.1, quoting M.N.22047/3E.

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SOCIAL AND ECONOMIC RESEARCH IN GREAT BRITAIN

IN considering the provision made for research in Great Britain into social and economic questions, the Clapham Committee, reporting in July 1946, was satisfied that unless the existing arrangements and plans were upset in some future economy campaign, the provision for such research within the government machine was much more likely to be hampered by the lack of properly trained staff than by failure to realize the importance of the work to be done. Developments in the departments and in the central secretariat promised well for the future of research in this field. It was, however, highly desirable that the Government departments which collect and analyse material relevant to social and economic research should be in continuous contact with outside experts, who could keep them aware of the needs arising in the speculative branches of the field and who could assist in assessing the value and possible uses of material which is already being collected. Equally it was desirable that there should be continuous contact between the relevant divisions within the different departments, both to avoid overlapping and to ensure that the potential value for research purposes of the material available was exploited from every point of view.

The Clapham Committee accordingly recommended the establishment of an interdepartmental committee charged with the duty of bringing to the notice of departments the potential value for research purposes of the material which they collect, and suggesting new methods and areas of collection. The appointment of such a standing committee was announced by the Chancellor of the Exchequer on January 21, 1947, and in its first report now issued*, the Committee examines the availability, for academic research, of statistical data and other descriptive matter available in Government departments. Much of this material is already known to and used by academic research workers, and the departments themselves benefit considerably from the fundamental research or studies in methodology proceeding at the universities. The interdependence of the departments and the universities in the field of the social sciences is now clearly recognized.

The Interdepartmental Committee recognizes the value of the close personal contacts established during the War, when many members of university staffs were employed in Government departments, and it is convinced that there is no adequate substitute for them. Such contacts should not only be maintained but also multiplied; and the Committee regards it as one of its principal functions to stimulate all forms of collaboration, whether formal or informal, between the departments and research institutions. Personal contacts in themselves are not enough; but while the Committee's recommendation remains designed to supplement, not to supersede, the direct contacts now existing between individuals, it is not likely to sponsor expensive schemes which aim at theoretical completeness as regards the covering of information, rather than what is economically worth while in view of the effects of such personal contacts. The Committee acknowledges the assistance given in this part of its work by the memorandum submitted by the National Institute of Economic and Social Research as a result of the conference on research relations with Government departments, to which reference was made in some detail in the last annual report of that Institute (see *Nature*, July 31, 1948, p. 197).

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* Report of the Interdepartmental Committee on Social and Economic Research. (Cmd. 7537.) Pp. 16. (London: H.M. Stationery Office, 1948.) 4*d.* net.

Before tackling the wider and more general questions confronting it, however, the Committee thought it advisable to ensure so far as possible that any new schemes which departments might be projecting for collecting and tabulating social and economic material should at the outset make reasonable provision for research needs. Information obtained about the number and condition of the people, their health, their work and their needs is obviously capable of much fuller use when it is so handled at the outset that it can serve more than immediate administrative requirements. From the point of view of the individual citizen, quite apart from that of economy, there are obvious advantages in such co-operation; and it is encouraging to learn that not only is there wide interest in the work of the Committee and a general willingness to co-operate, but also that three of the major departments of State, the Ministry of Agriculture and Fisheries, the Ministry of Education and the Board of Trade have already asked for guidance on particular tabulation schemes.

In studying the material which Government departments collect and publish, the Committee decided to work in the first instance through sub-committees making a close study of one department or group of departments, and strengthened as needed by co-opting additional academic or other members with special knowledge of the particular field. In these surveys, the immediate objects are to find out what information is collected, the extent to which this information could be made available, and whether there are any fields of statistical or other information in which a change in present methods of collection or treatment might benefit departmental or other research workers. These surveys began with the Ministry of Labour and National Service, Prof. R. G. D. Allen being co-opted to the sub-committee concerned. A guide to the material available through this Ministry has already been published, but the sub-committee's report also led to a recommendation to the Ministry that some of the unpublished information already in the possession of the Ministry, such as information about working days lost through industrial disputes, wages and juvenile employment, should be assembled and published. Other information, it was suggested, should be published in greater detail or more frequently.

Man-power considerations may well preclude action on some of these recommendations at the present time; although if like recommendations emerge as the outcome of the work of the sub-committee at present studying the work of the Board of Trade, it might well be possible to implement them by transference and not by the engagement of further staff. Investigations along these lines should assist the research worker to find out what material is available in the departments, and it should be noted that the Committee considers that the publication of the Guide of Current Official Statistics should be resumed at the earliest possible date and not delayed for the incorporation of references to unpublished material which is also available.

Location, however, is only one aspect of the subject. The research worker also wants to be certain that the material he requires will not be destroyed before he can consult it. One of the main functions of the Public Records Office is to ensure that research material is not destroyed, and as the pamphlet on "The National Register of Archives", published in 1945, shows, the services of the Office to social and economic research in the preservation of documents are not limited to material in the possession of Government departments. The Committee, while appreciating the importance of the work of the Public Records Office in this field, suggests that it has been regarded too exclusively as a source of information about the past; certain proposals are accordingly made with the view of enabling the Record Office to offer a more positive contribution to those engaged in contemporary research. One such proposal, that the words "or useful for social and economic research" should be added to the paragraph inserted in every schedule governing the disposal of departmental records to ensure that they are examined by a competent officer before they are destroyed, has already been accepted.

The Interdepartmental Committee further proposes that the Public Record Office should issue a publication classifying all the documents preserved either at the Public Record Office itself or elsewhere under its jurisdiction. It suggests further that more might be done in framing the schedules which govern the preservation and destruction of records to make them more immediately intelligible to research workers. Attention is also directed to the special case of war-time collections of data in departments, and to the risk that these may not be sufficiently used for research purposes.

The scope of the Committee was limited to research work in Government departments, but it does not overlook the importance to social and economic research generally of avoiding the dispersal, loss or destruction of the records of industries now nationalized or being nationalized. This matter lies outside the terms of reference of the Committee, and is related to the question of the preservation of business records generally. Nevertheless, the Committee has brought the matter to the notice of the Office of the Lord President of the Council, and this report should do much to help the work of the British Records Association in this field. The suggestions in this report could find considerable application to business records also, as will be apparent to any reader of the paper by Dr. Chaloner on "Business Records as a Source of Economic History", read before the Northern Branch of Aslib last autumn and now available in the *Journal of Documentation*. That paper was specially concerned with the selective preservation of business records in libraries. Here the principles laid down by the Interdepartmental Committee regarding the confidential character of Government information have a close bearing, and some at least could be applied. If it is a recognized duty of Government departments towards the society of which they are the institutional agents to make available, at least for the purposes of scientific inquiry, as much as possible of the information which they possess, business firms can scarcely disclaim all such responsibility. Indeed, although much that passes for the history of particular firms or industries scarcely meets the criteria of R. E. Collingwood in "The Idea of History", at least the volume of such monographs is considerable enough to indicate that industry recognizes a responsibility of this character. In the opinion of the Committee, a *prima facie* case exists for publishing, or making otherwise accessible, all information of general social utility, unless there is good reason to the contrary; and such *obiter dicta* cannot well be limited to Government departments.

Whether this be universally applied or not, it is necessary to be clear as to what constitutes a good reason to the contrary. Government departments have first to observe faithfully statutory requirements, though opportunities might well be taken, in amending legislation, to modify obsolete requirements. The requirements of security and public policy have also to be met, in the Departments of State and in business or industry, though liberal interpretation of rules may well be called for; and in Government departments and in industry practical administration must not be hampered. Likewise, it is reasonable to insist that the cost of making the information available should not be out of proportion to the importance of the subject-matter; and whatever the source of the information, public interest demands that the obligation, whether statutory or otherwise, ensuring that individual persons, firms and other entities are not publicly identifiable, must be discharged.

That there will be some difficulties is not denied; but the Committee points out that such difficulties have been surmounted even in fields in which access to information of a personal or individual nature is essential. The general observance of such a code of rules in respect not only of information available in Government departments or commercial firms, but also information obtained by the departments for administrative purposes from trade unions, employers' federations and trade and professional associations, and the scheduling of such documents on similar lines might immensely enrich the field of research available for accredited research workers. It is a necessary and reasonable corollary to any such proposals that all persons concerned exercise particular care that the material is only used by such workers.

Besides the confidential material, there is much non-confidential information, particularly of a statistical nature, which could be made available for social and economic research. Copies of such unpublished documents might well be distributed to specialized libraries where outside research workers might consult them. The Committee, in fact, compiled such a list, including university libraries, research libraries within the universities and the libraries of other research bodies of standing and of learned societies. A number of departments have already indicated their willingness to co-operate, and the intention is to ascertain by experiment the documents which such libraries wish to receive, and then to see if regular distribution could be arranged.

The emphasis on this report is on finding ways in which the Departments of State could assist the outside research worker more effectively than they do now. There is the complementary question, which may well increase in importance, of the help which research workers can incidentally give the Departments of State. There are always academic research projects in progress which bear at least indirectly on Government problems, and in this connexion the Committee refers to the value of the Register of Research in the Social Sciences compiled by the National Institute of Social and Economic Research. The need is primarily for collaboration between the Departments of State and research workers; and this first report warrants the belief that the Standing Committee will provide a powerful stimulus to such co-operation, and even to the use for social and economic research of the much larger amount of material available in business records.

FORCES INSIDE THE ATOMIC NUCLEUS

Nuclear Forces

By Prof. L. Rosenfeld. (Monographs on Theoretical and Applied Physics, Vol. 1.) Pp. xix+181. (Amsterdam: North-Holland Publishing Co., 1948.) £1 4*s.* 5*d.*

THERE is a mass of experimental material in nuclear physics, much of which gives information about the forces acting between nuclear particles. The theory of nuclear forces, on the other hand, is still inadequate. Even the law of force between two nucleons is unknown, though meson theory suggests a form, but leaves numerous parameters to be settled by comparison with experiment. The research literature of nuclear physics is consequently chaotic, and the appearance of a book on the subject is to be welcomed. In his preface, Prof. L. Rosenfeld explains the reasons which led him to adopt a discursive approach to his subject at the expense of brevity and at the risk of losing the basically simple thread of the argument. The result has been a book which is not easy to read quickly by anybody who wants to discover the central ideas of the subject. The wealth of detail, which might well have been relegated to appendixes, will prove very valuable to research workers in the field, particularly to those entering it for the first time, but may well try the patience of the more general reader trying to learn something of this important branch of physics.

Only volume 1 has so far appeared, and it is a pity that a list of references and a provisional subject index could not have been prepared for it. The text abounds with references to a bibliography at the end of the book; but the reader who turns to the end of the present volume will find a disappointing blank. This is all the more unfortunate in connexion with the table of nuclear data and figures summarizing them, which are referred to in the text. It is to be hoped that the remaining volumes will soon become available, so that the student who wishes to read the original papers may know where to find them, and be able to consult what must be a very useful compilation of data.

The present volume, after an introductory survey of the whole field (Part 1), is confined to detailed consideration of two-nucleon systems, on the hypothesis that only central forces are effective. The first chapter of Part 1 deals with the elementary particles of physics and their properties. How difficult a task it is to write a book about a rapidly developing subject is demonstrated by the absence of any reference to the recent discovery by the Bristol physicists that there are at least two kinds of mesons in the cosmic rays, and that the mesons which occur at sea-level are not those which play a part in the nuclear forces. This discovery, though scarcely a year old, has called for revision of our ideas on the subject, which could not be included in this volume. The remainder of Part 1 is devoted to considerations of the simpler properties of nuclei, such as their binding energies, radii, etc., and the arguments pointing to the saturation property of nuclear forces.

In Part 2, one chapter is devoted to general considerations on the wave equations of the two-nucleon system, two chapters to detailed considerations of the proton–neutron system (that is, the deuteron and the scattering of neutrons by protons), one chapter to the proton–proton system and a final chapter to a comparison of the forces between like and unlike nucleons. These topics are treated with an encyclopædic thoroughness which will certainly make the book a standard work of reference for many years to come.

The book, though written in English, is printed in Holland. The printing is attractive and pleasantly free from misprints; but the formulæ are disfigured by symbols in strange types and a luxuriant growth of prefixes, affixes and suffixes. These latter also disfigure the text by having made it impossible for the printer to keep an even spacing between the lines; they could well have been omitted without loss of clarity. M. H. L. PRYCE

A SOUTH AMERICAN ANTHROPOLOGICAL SYMPOSIUM

Handbook of South American Indians

Edited by Julian H. Steward. (Smithsonian Institution: Bureau of American Ethnology, Bulletin 143.) Vol. 3: The Tropical Forest Tribes. Pp. xxvi+986 +126 plates. Vol. 4: The Circum-Caribbean Tribes. Pp. xx+609+98 plates. (Washington, D.C.: Government Printing Office, 1948.) n.p.

THE first two volumes of this work, dealing with the marginal tribes and the Andean civilizations, were introduced in *Nature*, Nov. 30, 1946, p. 769. Those now under review cover vast areas in eastern and northern South America, besides the West Indies and most of Central America south of Mexico. These regions were more sparsely covered by published information even than those dealt with in the first two volumes, so their preparation has involved a great deal of research, one result of which was to show that the arrangement of sub-areas planned for vol. 3 was largely artificial, though it was too late to alter it, and that much of the information on Colombia in vol. 2 might more properly have been included in vol. 4. The editor points out that the fragmentary nature of the information about many of the tribes treated in vol. 3 has resulted in prolixity rather than in brevity, since it has forced authors to let original accounts speak for themselves, retaining much detail which may be unimportant, and has prevented them from making reliable summaries of the basic features. This is not to say that these volumes are less valuable than their predecessors or any less necessary to students of South American archæology and ethnology; in fact, they represent, if anything, a greater advance on our previous knowledge about the areas they deal with.

In vol. 3 the emphasis is, naturally, on the modern Indians rather than on the archæology, about which there is little to say, although parts of eastern Bolivia and the Napo region of Ecuador, about which at least a little is known, seem to have escaped mention both here and in vol. 2. The Indians described are mainly in their original state, unlike those in the Andes in that they are little affected by culture contact. As a matter of convenience, the tribes of northern Colombia and of Venezuela north of the Orinoco are dealt with in vol. 4.

A general principle of great interest and importance, which is indicated by the survey of this area, is that the tropical forest type of culture spread upstream from a centre in the lower Amazon and the Guianas as far as its limit at the edge of the Andean zone, and it is considered that there was little cultural diffusion overland either from the Orinoco basin or the Andes. It is further suggested that the tropical forest culture came originally from the circum-Caribbean area, and the argument is carried further in vol. 4, where the idea of a circum-Caribbean culture, whence the forest culture is derived by degeneration, is developed. It is shown that, at the time of the conquest by the Spaniards, a number of tribes in that area had an elaborate culture, now vanished, which probably resembled that of the Formative Period in Mexico and the Andes, with a strong bias towards the latter. This implies that cultural flow in Central America was mainly from the south. Opportunity is taken to point out the weakness of the theories of origin of American civilizations which ascribe them to the areas least known at the time of enunciation, and to show how inherently improbable is the idea that the essentials of the higher civilizations could have come from the forests.

In contrast to vol. 3, there is a good deal to say in vol. 4 about archæology, and there are extremely useful summaries dealing with the Central American countries, Venezuela and the West Indies, by acknowledged experts such as Strong, Lothrop, Alfred Kidder II and Rouse. There is a large amount of information about the modern tribes, in spite of the fact that many of them are relatively degenerate survivals, as has already been implied. The area dealt with includes northern Colombia, but it is rather unexpected to find the Cayapa and Colorado of western Ecuador in this volume.

The extent of our debt to the Bureau of American Ethnology for this vast undertaking gradually becomes apparent as publication advances. In order that we may get the best out of it, an index is urgently needed, and it is to be hoped that one is planned for the final volume. G. H. S. BUSHNELL

TECHNICAL WRITING

The Presentation of Technical Information

Based on four Public Lectures given at University College, London. By Prof. Reginald O. Kapp. Pp. xi+147. (London: Constable and Co., Ltd., 1948.) 6*s.* net.

SINCE the lectures on which this book is based were delivered in April and May of 1947, the publication of Sir Ernest Gowers' "Plain Words" has stolen some of Prof. Kapp's thunder. There is some common ground in the two books, but Prof. Kapp is concerned with the presentation of technical information and deals with the choice and use of words only so far as they contribute to that purpose: whether or not technical terms, words are to be chosen deliberately so as to serve the technical ideal of fitness for the purpose. That is the ideal which is in Prof. Kapp's mind throughout, just as it dominated Prof. J. R. Nelson's "Writing the Technical Report", a second edition of which appeared last year. Prof. Kapp insists that the presentation of technical information demands the use of what he terms functional English—language in which words are chosen and sentences constructed so as to express the writer's meaning clearly and without ambiguity, and are as appropriate to his purpose as the units selected and used by the designer of an engineering construction. Functional English, he claims, presents facts and ideas simply and logically, but jargon is eschewed by him as firmly as by Sir Ernest Gowers or by Quiller-Couch in a lecture that few scientific writers appear to have discovered.

In his 150 pages, Prof. Kapp includes much that should help the technical or scientific writer to select the words most appropriate for his paper, report or book, and which will best assist the reader—or hearer, for Prof. Kapp is concerned with spoken as well as written exposition—to understand his meaning. Primarily, it is the postgraduate student to whom the book is addressed, but it should be equally welcomed by other students at an earlier stage, though Prof. Kapp provides no ready-made guide or model to be copied. The book is a challenge to real thinking about the task of presentation.

The expositor's first task before he even begins to select his material is to be quite clear in his own mind as to the purpose for which the information to be supplied is required and the reader or audience for whom it is intended. Unless we know the exact purpose to be served we cannot choose the appropriate tools for the task. No commoner error is made, however, in presentation than neglect to decide on that purpose or on the reader to be addressed. By apposite examples, Prof. Kapp illustrates a number of simple rules, observance of which will enable the scientific man to present the results of his investigations in much more readable and therefore effective form. Moreover, Prof. Kapp does this, too, by stimulating thought as well as by pertinent comments on prevalent use and abuse of words, and his book is admirably designed to meet a need voiced at the Royal Society Scientific Information Conference as well as in an ever-growing volume of books and papers.

Prof. Kapp's own book is original in its approach, and his treatment of the theme is clear, vigorous and searching. The book may justly be preferred to some of its more voluminous predecessors, but its merits can scarcely justify the virtual ignoring of all other publications on the subject; and some of his readers might well be grateful for references to other books or papers in which they could pursue their study of a subject Prof. Kapp illuminates but scarcely exhausts. He refers, indeed, but vaguely to a paper on the subject in the *Journal of the Institution of Electrical Engineers* since published by that Institution with others under the title "The Presentation of Engineering Evidence", and apart from the considerable number of books, some indeed of unequal value, concerned with the writing of reports or scientific papers, he gives his readers no indication of the existence of useful and entertaining literature on the handling of words themselves whether for technical or general purposes. R. BRIGHTMAN

INDEX KEWENSIS

Index Kewensis Plantarum Phanerogamarum

Supplementum Decimum: Nomina et Synonyma Omnium Generum et Specierum ab initio Anni 1936 usque ad finem Anni 1940 nonnulla etiam antea edita complectens. Ductu et consilio A. W. Hill (obiit 1941) et E. J. Salisbury. Pp. iii+251. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 84*s.* net.

FROM the time of its original appearance in 1893, the "Index Kewensis" has been one of the monumental works in the literature of systematic botany, and the publication of Supplements at regular intervals has always marked a notable stage in the records of plant taxonomy. The appearance of the tenth Supplement is no exception, and although on this occasion there has been inevitable delay in its production, it will none the less receive a warm welcome from botanists throughout the world. To the authorities at Kew every botanical institute must feel indebted for the continuation of an indispensable work of reference.

The present volume covers the five-year period 1936–40, and in its general plan it is similar to previous Supplements. Each page carries three columns, and generic names are arranged alphabetically, as also the specific names under each genus. Some idea of the immense amount of work involved in the preparation of an index of this kind may be obtained from the fact that each of its 251 pages deals with about 105 specific names. This gives an indication also of the contribution which has been made to the systematic study of Phanerogams in the period under review. Not only have large numbers of new species been described, but also numerous new genera have been established, notably in the families Cactaceæ, Compositæ, Gramineæ, and Rubiaceæ. The delimitation of genera in these and other families not infrequently presents considerable difficulty, and it is not surprising that some of the new generic names which appear in the Supplement are due to the elevation of previously recognized sub-genera.

As would be expected, the species which have been described as new to science are distributed among many genera; but the additions to certain of them, such as *Carex*, *Hieracium*, *Peperomia*, *Piper*, *Rubus*, *Quercus* and *Salix*, are conspicuous by their number. The pages of the Supplement as a whole, however, are testimony to the amount of systematic work which was achieved before the War brought botanical exploration temporarily to a standstill, and they give evidence of the substantial contribution which has been made to our knowledge of the world flora. Such an authoritative list of the names of plants, giving the author and place of publication of each, together with reference to synonymy and geographical distribution, is indispensable to all workers on the taxonomy of flowering plants.

An additional feature which distinguishes this from earlier Supplements is the insertion of an asterisk against those entries where an illustration accompanies the description of the new species. In this simple way the "Index Kewensis" will continue the function of the "Index Londonensis", a work which was brought to a conclusion in 1941.

J. R. MATTHEWS

ENCYCLOPÆDIA OF EYES

Tabulæ Biologicæ

Vol. 22: Oculus, Pars 1. Editores: K. Steindorff, F. P. Fischer, J. S. Friedenwald, Arnold Sorsby. Pp. viii + 408. (Amsterdam: Dr. W. Junk, 1947.) 70 fl.

ONE of the functions of science is to collect information and to classify it. Some of the information so collected may appear to any one person to be trivial or of little importance, but let that person remember that he is not the only oyster in the bed, and he will realize that the sand grains around him may become pearls for others. To one interested in the activities of the human eye there may seem to be little significance in measurements which relate the width of the ocellus of an ant to the breadth of its head; but to another, interested in the behaviour of ants, this information may be of far more value than statistics on the occurrence of blondes in Austria, or the relation between intra-ocular pressure and the thymus gland. The first part of "Oculus" contains collected numerical data on the structure and anatomy of eyes of all types, on the behaviour of the pupil and on vascular pressures in the eye; and the reader will find a wide diversity of subject-matter, including such topics as those mentioned above. The net is cast wide and the information collected is vast and various. Three further parts of the book are to follow, so that almost every aspect of the eye will be dealt with, each by a different author.

The task of collecting the data and preparing it for publication was largely undertaken or inspired by the late Kurt Steindorff, who clearly saw the advantages to be gained by collecting together as much information as possible in order to assist in elucidating the mysteries of vision. He might be described as the oculomotor nucleus.

In such a subject as vision, upon which the relevant literature is immense and still rapidly growing, it is easy to be critical on the grounds that such and such a table is not included in this volume; but since most of us who work on vision have experienced the mixed thrill and disappointment of finding that our much cherished ideas were either suggested or carried out in the last century, such criticism necessarily loses much of its force. Nevertheless, on such matters as the structure and distribution of the retinal constituents it is disappointing, for example, to find no references to the data collected by Polyak or Osterberg. There has clearly been some inevitable delay in the publication of the volume, and thus many of the more recently derived data are not included. Moreover, the index is to appear in a later volume and the bibliographies are arranged numerically, more or less in order of appearance in the text, and not alphabetically according to authors, so that it is difficult to be certain that one does not miss information through searching for it in the wrong place. Such difficulties will, of course, vanish when the whole work is published, and, when this occurs, ophthalmologists of all types will have an extremely valuable compendium of information.

E. N. WILLMER

VEGETABLE GROWING

Vegetable Growing

By Prof. James Sheldon Shoemaker. Pp. v+506. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 27s. net.

IT is unusual to find a North American book on any aspect of practical horticulture which is of much direct value in Great Britain. Prof. J. S. Shoemaker, perhaps because he is primarily a man of science, has produced a book which is an exception to the rule. The reason lies in the method of approach to the subject, which is more through the requirements of the crop than its detailed culture. While it is true that much of the discussion on varieties has little application in Britain, yet, because of the closer horticultural links of Canada with the home country, many more English varieties are included than one would find in a book from the United States.

Because of the prime importance of good seed in successful vegetable cultivation, the book starts with a discussion on seed production. This is undoubtedly a most valuable section, since few books on vegetables give more than cursory attention to the subject. The major part of the work is devoted to the specific crops, grouped according to use; for example, corn crops, root crops, salad crops, etc. The traditional procedure of giving preliminary chapters on soils, fertilizers and other considerations has been abandoned in favour of discussing these problems in relation to each crop, thus enabling direct application of research findings to be presented in their proper context. It is this treatment which lifts the book out of the general run of gardening manuals and raises it to scientific levels.

A surprising omission, however, in a book of this high standard is that of scientific names and botanical characteristics. The history of each vegetable is most admirably summarized, but to the serious student the interest and value would be greatly enhanced by reference to the botany of the crop. This is particularly true of the last chapter, on insect and disease control. Of what value to a student, especially in another country, is a reference to "early blight" and "late blight" of celery unless he knows that these are due to two different fungi, *Cercospora apii* and *Septoria apii*? Again, what is one to understand by "haywire", "calico" and "jelly-end rot" of potatoes? Even where the genus of an insect or a fungus is mentioned or clearly obvious, addition of the specific name would avoid confusion with other species possibly more common in another country. Perhaps in a second edition the author will bear in mind the needs of workers and students in Britain and elsewhere.

R. H. STOUGHTON

Cours de mécanique

Par Henri Beghin. Tome 1. Chapitres 1 à 3. Pp. ix+102. Chapitres 4 à 7. Pp. 103–201. Chapitres 8 à 11. Pp. 202–367. Chapitres 12 à 14. Pp. 368–488. Chapitres 15 à 18. Pp. 489–588+9. (Paris: Gauthier-Villars, 1948.) 1,800 francs.

IN order to avoid the current delays of printing, M. H. Beghin's book has been manifolded from typescript, a process which does not make for elegance; but the merits of the work are not thereby obscured. Based on lectures given at the École Polytechnique, the first volume deals with kinematics, with elementary statics, and with dynamics of a particle and of simple rigid bodies, going as far as Lagrange's, Appell's and Hamilton's equations. Vector methods are used when appropriate, but are not overdone.

A preface by General Brisac, commandant of the École Polytechnique, claims three points of M. Beghin's work for special praise—its simple presentation of principles, its systematic exposition of mechanics as an experimental science, and its sense of concreteness. The book shares with most other French treatises on rational mechanics a clear and logical view of dynamical principles and a power of simple yet precise exposition. But the contact with reality is a marked feature, and here M. Beghin's account is akin to the best of British text-books; and he is not above including some exercises for the student, though these are often of the type which we in Great Britain should expect to see as worked examples to illustrate the text. Fortunately, he despises the monotony of "A uniform rod of mass *m* and length 2*a*", and the majority of his examples are genuinely instructive. The long Chapter 7, "Exercices simples de mécanique terrestre", is full of good sound matter, clearly expressed, and of definite practical importance. Granted the French recognition of the value of pure science to the Fighting Services, it is easy to believe that M. Beghin's courses at the École Polytechnique were greatly appreciated.

The second volume is to deal with gyroscopic motion and with the mechanics of fluids and of elastic solids.

The Electrolytic Capacitor

By Alexander M. Georgiev. Pp. xii+191. (New York and Toronto: Murray Hill Books, Inc.; London: Crosby Lockwood and Son, Ltd., 1945.) 15*s*. net.

IN this age of electronics, we have ceased to marvel at the sight of incredibly complicated circuits being packed into ever smaller and smaller boxes. Few probably pause to consider the great part that has been played by the development of the electrolytic condenser in order to achieve these feats of space compression.

In Mr. A. M. Georgiev's book, all the aspects of electrolytic capacitors are considered, and running right throughout the book there is the comparison of the 'wet' with the 'dry' type of electrolytic condenser. The main theme is of a commercial and engineering nature, and a good deal of space has been devoted not only to the manufacturing processes but also to the details of the electrical equipment necessary for testing and fault-finding. On the other hand, the more academic aspect has not been overlooked, and a whole chapter (5) has been devoted to an outline of the many and various theories and hypotheses that have been advanced in an attempt to explain this curious dielectric surface of an aluminium anode, which is the starting-point of the whole subject.

There is much information to be obtained from this book, and in addition there is a very extensive bibliography, index, list of relevant patents and glossary (in which many of the terms are quite elementary). As such, this volume will be of much interest not only to qualified chemical engineers, but also to the scientific layman who is interested in the actual manufacture or use of electrolytic condensers.

Introduction to Wireless

By W. E. Pearce. Pp. viii + 247. (London: G. Bell and Sons, Ltd., 1948.) 7*s*. 6*d*. net.

THIS book is likely to appeal to the layman who is anxious to know something about how his wireless set works, and who may be expected to have forgotten all he ever knew about elementary electricity and magnetism. This may justify the inclusion of the material in Chapters 2–7. From Chapter 8 onwards the author does deal with radio; but the book is not strictly an "Introduction to Wireless" in the sense that it might form a suitable first-course text-book for serious students. The ground covered is too wide and the treatment too general and not sufficiently rigorous.

As a book for the general reader not concerned with becoming an expert, the book is well written and apparently free from very serious errors, although in places there is some confusion of thought, as on p. 99, for example, where the analogies between potential and kinetic energy on one hand and the energy in the electric and magnetic fields on the other seem to have become slightly mixed.

The author would have been better not to invite the reader to doubt his (the author's) capabilities by describing certain phenomena as "difficult to explain".

The book is well produced, and the text and diagrams are clear and readable. W. R.

Bird Haunts in Northern Britain

By G. K. Yeates. Pp. 175 + 119 plates. (London: Faber and Faber, Ltd., 1948.) 25*s*. net.

THERE is a special fascination and charm about the birds of the northern parts of the British Isles. The very names, 'whimbrel', 'black-throated diver', 'greenshank', and so on, seem to have a peculiar appeal. In this account of his experiences on the mainland of Scotland and in Shetland, Capt. Yeates conveys this fascination to the reader. He writes of birds and bird matters in a pleasant and informative manner, illustrating his text with many photographs. Bird photographers to-day are legion, and they vary much in skill; but Capt. Yeates is among the leaders in this branch of the photographer's art, and the 115 reproductions in black and white are good examples of his work, all being excellent, and many fine. In addition there are two reproductions in colour from 'Kodachrome' originals and two plates from paintings by Mr. G. E. Lodge. Colour photographs and paintings do not always bear comparison, the work of the brush generally winning from the artistic point of view; but in this case all the pictures are admirable, the 'Kodachrome' reproductions being accurate in colour rendering and at the same time soft and harmonious. As for Mr. George Lodge's pictures, it suffices to say that they are what we have long learnt to expect from this skilled painter of birds, fine colour effects being combined with great accuracy of plumage detail.

FRANCES PITT

GENETICS IN THE SOVIET UNION

By Prof. ERIC ASHBY
University of Manchester

SINCE last August there have been reports in the Press of a crisis among biologists in the U.S.S.R. The crisis culminated in a decree from the Præsidium of the Academy of Sciences, published on August 27. This decree dismisses a number of prominent biologists from their posts, closes two famous laboratories, and removes orthodox geneticists from committees and editorial boards of the Academy. The Press reports have not been complete or objective; and the only full accounts of the crisis have been in the Russian language. British biologists will be grateful, therefore, to the Commonwealth Bureau of Plant Breeding and Genetics, which has now brought out a summary[1] of the conference which led to the crisis, from articles in *Pravda* over the first three weeks of August. At the same time, an English version of Lysenko's speech at this conference has been published under the auspices of the Society for Cultural Relations with the Soviet Union[2]. These two documents, together with an essay published by the Bureau of Plant Breeding two years ago[3], and an illustrated account of Lysenko's experiments[4], provide the British reader with adequate data to interpret the recent decree of the Academy of Science.

The Lenin Academy of Agricultural Sciences, of which body Lysenko has been president for ten years, held a Conference during July 31–August 7 of this year. It was reported that several new members had been elected to the Academy, all 'Michurin-biologists'; Lysenko delivered a presidential address of some nineteen thousand words; and there was a long discussion in which many members took part. After Lysenko had spoken it was revealed that his address had been previously examined and approved by the Central Committee of the Communist Party.

Lysenko's address[2] follows familiar lines. It contains a re-statement of the antithesis between so-called Mendelism–Morganism and the new Soviet genetics based on Michurin. It denies the chromosome theory of heredity. It arraigns several Soviet biologists because their work is inconsistent with Marxist ideology and is sterile of practical results: M. M. Zavadovsky, because he admires Morgan; I. I. Schmalhausen, because his theory of stabilizing selection is "profoundly wrong ideologically" and has "a disarming effect upon practical activity"; A. R. Zhebrak, because his work on wheat polyploids has "produced literally nothing of practical value"; N. P. Dubinin, because the work on population genetics (upon the strength of which Dubinin was elected a corresponding member of the Academy of Sciences in 1947) is of no practical importance; and so on. Lysenko complains that the work of his school has been suppressed by the Academy, the Ministry of Agriculture, and the Ministry for Higher Education. He attacks the universities for using as their genetics text a book by the Americans Sinnott and Dunn. He explains that Michurin biologists will no longer be in a minority in the Agricultural Academy, "thanks to the interest taken in it by the Party, the Government, and Comrade Stalin personally". He then proceeds to give an outline (the clearest yet published in English) of his methods of "shattering" heredity by graft-hybridization and by partial vernalization. The mainstay of his evidence is still the experiments of Avakyan and Yastreb[5], which were discredited in 1944. The objective of Lysenko's attack on Mendelism is not so much its false ideology, but rather its impotence. By insisting on the stability of the germ plasm Mendelism "condemns practical workers to fruitless waiting". The inheritance of acquired characters is a doctrine necessary for the progress of Soviet agriculture.

Lysenko's speech was followed by a discussion which has been ably summarized by the Commonwealth Bureau[1], and which makes fascinating reading. There is a chorus of testimony to the efficacy of Lysenko's methods, a renewed insistence on utility as the test of a scientific theory, and a condemnation of Mendelian geneticists in the U.S.S.R., mainly on the grounds that they are wasting time. Dubinin's work, for example, is described by Yakuskin as a monstrous deviation from the tasks of a Soviet scientist, and by Mitin as "unpatriotic". The State Seed Committee is criticized for insisting that new varieties should be homozygous. The Academy is criticized because its three biological journals have refused to accept papers on Michurin biology, and the University is criticized for turning down some doctors' theses on Michurin biology.

These contributions to the discussion make it abundantly clear that before last August biologists in the U.S.S.R. were free to work and publish and teach orthodox genetics, and that the Academy of Sciences, and the Ministries of Agriculture and Higher Education, were putting some of their weight, at any rate, on the side of Mendel and Morgan. Nor, even last August, had the orthodox geneticists been silenced. Nemchinov, Zhebrak, Rapoport, Alikanyhan, Zhukovsky, Schmalhausen, all defended their views against Lysenko's attack, though some of them made declarations of a change of their views at the end of the session. Clearly there is now, for the first time, a 'party line' on questions of biology in the Soviet Union.

About three weeks after this Conference the Academy of Sciences of the U.S.S.R. met, and adopted the new party line on biology. As a consequence of this, the Biological Section of the Academy has had to be reorganised, and this is the purpose of the decree of August 26, which is translated in full by the Commonwealth Bureau of Plant Breeding and Genetics. The effect of the decree is to bring to a stop many lines of work which had earned the admiration of biologists all over the world: Dubinin's studies on population genetics; Schmalhausen's work on natural selection; the work of Zhebrak on colchicine-induced wheat polyploids, of Sacharov on buckwheat polyploids, of Navashin on chromosome structure; and the splendid genetics course built up by Serebrovsky in the University of Moscow, with its thorough training in biometry, will have to be scrapped. Michurin-genetics, which has hitherto been up against a 'non-co-operation policy' from the leaders of biology in the U.S.S.R., now has a clear field.

Many biologists outside the U.S.S.R. will react with indignation to these events; for science as a whole' is the poorer by the elimination of these admirable schools of genetical research in the U.S.S.R. Earlier crises in Soviet science have been so inadequately reported that it was difficult to form a sound judgment as to what had happened. On this occasion we have a good record of the facts.

[1] *Plant Breeding Abstracts*, **18**, No. 2,000. Commonwealth Bureau of Genetics and Plant Breeding (1948).

[2] Lysenko, T. D., "Soviet Biology: a Report to the Lenin Academy of Agricultural Science, Moscow, 1948". Birch Books, Ltd., London (1948).

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PARBOILING TREATMENT OF RICE

By Dr. J. J. C. HINTON

Research Association of British Flour-Millers,
Cereal Research Station, St. Albans

THE pre-milling treatment of paddy known as parboiling, involving treatment of the unhulled rice with hot water and steam, is established commercial practice, and for some time considerable attention has been paid to this and similar methods which aim at improving the nutritive value of rice; these latter include 'conversion' processes in which the steam is applied under pressure, sometimes preceded by a stage when the paddy is held under partial vacuum. Reviews of the subject have been prepared by the Economic Advisory Council, London[1], and the U.S. National Research Council, Washington[2]. These treatments result in a higher content of water-soluble nutritional factors, particularly those of the B group of vitamins, in the milled rice. It has been generally accepted that this is due to a redistribution of the nutrients within the grain, so that the endosperm is considerably enriched.

The distribution of vitamin B_1 within the rice grain is very similar to its distribution in wheat[3], and 45–50 per cent is found in the scutellum[4]. Furthermore, Nicholls has recently observed that, in contrast to untreated rice, in most samples of parboiled and converted rice the scutellum portion of the germ appears to remain in the grain after milling, and he has suggested that the explanation of the effect of pre-treatment may be found in this fact rather than in the re-distribution of nutrients[5]. The present article describes some experiments bearing on this interesting suggestion.

Parboiling and the Distribution of Vitamin B_1

Vitamin B_1 is readily assayed and may be taken as an index of the behaviour of the other soluble nutrients. An examination of the vitamin B_1 distribution was carried out on grain freshly treated on a laboratory scale. A conversion method of treatment, known as the Malek process, was used, small samples of paddy being heated in water at 75° C. for 4 hours, roughly dried on a cloth, and steamed at a pressure of 15 lb. per sq. in. for 15 min. 15–20 grains were dissected by first removing the embryo and scutellum. The end of the grain was then cut off, and the pericarp, aleurone layer and endosperm removed from the centre portion of the grain. The outermost layer, amounting to 15–20 per cent of the endosperm, is described as endosperm 1, and the remainder as endosperm 2. The vitamin B_1 content of these portions was determined by the microthiochrome method[6] and expressed on an air-dry basis of approximately 12 per cent water content. The results of several experiments are given in Table 1.

Table 1. Vitamin B_1 content (I.U. per gram) of parts of the rice grain untreated and converted by a parboiling process

Sample	Embryo	Scutellum	Pericarp-aleurone layer	Endosperm 1	Endosperm 2
1. Untreated grain	23	63	10·5	0·45	0·10
2. 4 hr. after parboiling	5·9	0·4	0·5	0·56	0·32
3. 4 hr. after parboiling			0·6	0·54	0·44
4. 72 hr. after parboiling	nil	nil	2·3	0·73	0·44
5. 12 days after parboiling	nil	nil	0·9	0·40	0·10
6. 4 hr. after parboiling	21·4	11·2	3·6	0·88	0·22
7. Heated to 75° C. for 4 hr., not steamed	24·4	30·7	6·2	0·80	0·20
8. 12 hr. after parboiling	3·2	2·1	0·65		
9. 23 days after parboiling	5·3	2·8	0·77		
10. 23 days after parboiling	6·4	3·8	0·71		

Excepting sample 5, all the samples show redistribution of vitamin B_1 in varying degree; the endosperm, particularly the outer endosperm, is enriched while the normally rich parts of the grain are impoverished. An analysis of the endosperm immediately in contact with the scutellum was also carried out, and the results are given in Table 2.

Table 2. Vitamin B_1 content of germ and adjoining endosperm in raw and parboiled rice

	Germ (scutellum and embryo)		Endosperm	
	Weight (mgm.)	B_1 (I.U. per gm.)	Weight (mgm.)	B_1 (I.U. per gm.)
1. Untreated	8·7	44	13·5	0·44
2. Parboiled	6·3	9·5	12·3	5·2
3. Parboiled	5·7	8·7	15·8	4·6

The figures reveal appreciable movement of the vitamin B_1 from the germ into the endosperm in the parboiled samples.

There are well-marked differences in the results of the tests shown in Table 1. Thus in numbers 4 and 5, no vitamin B_1 remains in the embryo or scutellum, and though there has been some re-distribution in 4, there is a total loss of about 75 per cent of the vitamin B_1, while there was no re-distribution in 5 and a total loss of 89 per cent. These samples were dissected some time after being treated; but the loss is not due solely to this storage period, as is shown by 9 and 10, which are sub-samples of 8 dissected 23 days later. Again, in sample 6, there has been little reduction in vitamin B_1 in the embryo and about 20 per cent of the original remains in the scutellum. Samples 2, 3, 8, 9 and 10 are between these two extremes of behaviour.

These differences were investigated further by examining the behaviour of dissected germ under the conditions of treatment of the paddy, and the conclusion was reached that they were probably due to the presence of a variable amount of water of condensation during the steaming stage. On the other hand, it seems likely that the presence of some free water during steaming is essential for effective re-distribution. The data obtained by examining the dissected germ portions (obtained from a sample of rice different from that of Table 1) are shown in Table 3 and will be discussed with those in Table 1.

Table 3. Vitamin B_1 in dissected rice germ subjected to various treatments

Sample of germ	Embryo (I.U. per gm.)	Scutellum (I.U. per gm.)
Control	31	45
1. Steamed in plugged tube. (Largely out of contact with steam)	21 20	20 21
2. Steamed on filter paper	16 13	20 21
3. Steamed on watch glass	1·5	2·0
Liquid in watch glass equivalent to	13·0	24·0

For the steaming treatment in the samples described in Table 1, small samples, 5–10 gm., of paddy were spread out on a clock-glass, filter-paper or an open beaker. When a clock-glass or beaker was used, considerable water of condensation was present; in tests 4 and 5 the grain swelled and burst, while in addition some liquid water remained on the clock glass in test 5. Samples 2, 3, 8 and 9 were spread on filter paper which would absorb most of the water of condensation; in these samples much less grain-swelling occurred and there was only slight opening of the hulls. It thus seems that heavy loss of vitamin B_1 from the germ is coincident with the presence of an excessive amount of water of condensation. The behaviour of the dissected germ in Table 3 supports this conclusion; steamed on filter paper, there is a reduction of about 50 per cent; steamed on a watch-glass, there is a reduction of about 95 per cent, but about 45 per cent was recovered from the condensate on the watch-glass, leaving an overall loss of about 50 per cent as before, which is probably due to thermal destruction of vitamin B_1.

Sample 6 of Table 1 was steamed in a flask plugged with cotton-wool; steam would reach the inside more slowly and condensation on and around the grain might be completely prevented. There was no obvious swelling and opening of the hulls, and the paddy was scarcely altered in appearance. There is very much greater retention of vitamin B_1 in the germ, the embryo showing almost its original value; while at the same time the re-distribution is less than 3 and 4, shown most markedly in the inner endosperm. The behaviour of the dissected germ (Table 3, sample 1) is broadly in agreement with this, the difference in behaviour of scutellum and embryo, however, being less marked.

In sample 7 steaming was omitted, and the vitamin B_1 is re-distributed to about the same degree as it is in 6, suggesting that the temperature of the steaming treatment alone has no effect on re-distribution.

These results suggest that re-distribution is determined mainly by the entry into the grain, as the starch gelatinizes, of a small amount of water condensed on its surface. The effect of the preliminary air exhaustion in, for example, one patented process known as the H.R. Conversion Process, may be to introduce water between the hull and the grain in addition to, or instead of, water of condensation. A great excess of water such as was present in some of the experimental tests led to almost total loss of vitamin B_1, while in the absence of sufficient water effective distribution did not take place.

It is to be noted that in these experiments the scutellum was more sensitive to the steaming treatment than the embryo, and that a considerable proportion of the vitamin B_1 of the germ and aleurone layer was not re-distributed but lost, at any rate as measured by the thiochrome method. In sample 4, about 75 per cent of the total vitamin B_1 was lost, and in samples 2, 6 and 9 about 50 per cent. Figures in the literature for rice prepared in a commercial conversion plant indicate a loss of about 20 per cent.

Parboiling and the Retention of Germ

(*a*) The residual germ, which was mainly scutellum, was dissected from the samples shown in Table 4 and the vitamin B_1 determined in the germ and grain. These samples had been parboiled and milled on normal commercial machines to produce the usual form of polished rice. The age of the four samples was unknown.

Table 4. Germ and vitamin B_1 contents of samples of milled rice

	Grain	Germ		
Sample	Vitamin B_1 content (I.U. per gm.)	Vitamin B_1 content (I.U. per gm.)	Proportion of the grain by weight	Percentage of total B_1 of grain
Parboiled No. 1	0·40	1·0	0·4 per cent	1·17
,, ,, 2	0·60	0·9	0·45 ,,	0·67
,, ,, 3	0·65	0·84	0·34 ,,	0·44
Raw	0·20	22·0	0·07 ,,	7·7

The three parboiled samples have a higher vitamin B_1 content and a much higher germ content than the raw sample. The B_1 content of the germ of the parboiled sample, however, is very low and contributes only about 1 per cent of the total vitamin B_1 of the grain. On the other hand, the small amount of germ left in the raw sample has a much greater vitamin B_1 content and contributes much more to the vitamin content of the grain.

(*b*) A second series consisting of samples taken at various stages of milling was examined. The treated samples had been prepared by a conversion process, and all the samples had been milled by normal commercial methods. There was very little difference between the vitamin B_1 content of the milled converted rice and milled raw rice, and the full data are therefore not presented in Table 5.

Table 5. Germ content and vitamin B_1 content of converted and raw rice

	Raw	Converted
Germ content of the milled rice	0·1 per cent	0·08 per cent
Per cent of grains containing some germ	6·0 ,,	90·0 ,,
Average germ content of grains which contain germ	1·71 ,,	0·09 ,,
	Vitamin B_1 content (I.U. per gm.)	
Hulled rice	1·38 per cent	0·48 per cent
Milled rice	0·43 ,,	0·49 ,,

The vitamin B_1 content of the milled raw rice is rather high, but is within the range reported in the literature; the B_1 content of the converted rice is low. No direct determinations were made on the germ; but the low vitamin B_1 content of the germ of the converted sample can be inferred from the low figure found for the converted hulled rice. The germ content in each of the milled samples is very low, the converted sample being lower than the raw sample. There is, however, an important point brought out in the figures. Only 6 per cent of the raw grains contained any germ, and those that did had an average germ content of 1·71 per cent. 90 per cent of the converted grains contained some germ, though the average germ content of each grain was only 0·09 per cent. Thus the germ content of the raw sample as a whole is due to a few grains which have completely missed the action of the milling machine, and contain almost the entire germ, while the great majority of the converted grains retain some germ, but this is much reduced in amount by heavy milling.

Another sample of converted rice from the same mill showed similar characteristics. 100 per cent of the grain contained some germ, but the germ content of the sample was only 0·05 per cent. Each of these samples appeared to have been heavily milled.

The suggestion that parboiling causes germ retention in milled rice is strongly supported by these results. A close examination of raw and freshly parboiled rice gives the reason. In cereal grains the scutellum is separated from the endosperm by a membrane formed by the walls of a layer of empty and crushed cells. In the rice samples so far examined, unlike wheat, for example, the endosperm in close contact with this membrane is loose and powdery, providing very poor adhesion. Normally, the skin layers and aleurone layer seal and hold the germ in the grain. The process of milling quickly removes the outer layers and the germ is then very readily dislodged; and this is what occurs in the samples of raw rice, the germ being lost not by rubbing down but by being knocked cleanly out of the grain.

Parboiling partially gelatinizes the endosperm, the powdery nature of the part in contact with the membrane is changed and adhesion is now extremely good so that the germ is not readily knocked out. There is also a slight toughening action on the germ itself, but this is not sufficient to prevent considerable loss if the grain is heavily milled.

Discussion and Conclusions

The large-scale processing of rice is not yet carried out in Great Britain. For this reason samples freshly prepared by commercial methods and otherwise of known history were not available for this work. Nevertheless, the experiments confirm that a parboiling or conversion treatment does lead to a re-distribution of vitamin B_1 in the grain, with the result that the endosperm is considerably enriched. Furthermore, there is an indication (sample 7 in Table 1) that simple steeping in hot water alone results in a measure of enrichment of the endosperm with vitamin B_1. However, it seems very probable that the maximum re-distribution is dependent upon water condensing, or being otherwise present, on the surface of the grain and entering into the gelatinizing endosperm. Under these conditions, vitamin B_1 is more or less rapidly lost from the germ.

The experiments also confirm the suggestion by Nicholls that there is a marked retention of the scutellum in milled parboiled rice as compared with milled raw rice, due largely to gelatinization of the endosperm immediately beneath the germ, which acts as a cementing layer so that the germ is not so readily knocked out or dislodged during the subsequent milling. It is not yet clear, however, how far this retention of germ is responsible for the higher vitamin B_1 content of rice milled after a parboiling treatment. This will depend upon the conditions of the treatment, that is, probably the amount of free water associated with the grain when gelatinization occurs. This in turn will largely determine the amount of vitamin B_1 retained in the germ. The fact, however, that the germ is not so readily dislodged from such grain does indicate the need for experiment on how far the type or severity of the milling process and the detailed conditions of pretreatment influence the quality of the final product. Clearly a high content of germ is desirable, apart from considerations of vitamin B_1 alone.

It would be of interest, for example, to study the effects of mild soaking in hot water (as in sample 7, Table 1) followed by light milling as an alternative to a boiling or steaming treatment followed by heavier milling, since this soaking had improved the adhesion of the germ by partially gelatinizing the endosperm beneath without seriously reducing its vitamin B_1 content.

I am indebted to Dr. Lucius Nicholls and Dr. C. W. Herd for the samples of rice.

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THE FIGURE OF THE EARTH*

By PROF. HAROLD JEFFREYS, F.R.S.

ANY departure of the earth's external gravitational field from symmetry affects several geophysical and astronomical phenomena, especially observed gravity, the form of the level surfaces, which are normal to the direction of gravity, and perturbations of the moon, of which two are secular and one has a period of a month. There is a formal theory connecting them, which amounts to saying that if Ψ is the geopotential, defined by

$$\Psi = U + \tfrac{1}{2}\omega^2 r^2 \cos^2\varphi',$$

where U is the gravitation potential, ω the rate of rotation, r the distance from the centre of mass, and φ' the geocentric latitude, then Ψ is a constant C over the ocean surface, and gravity is the inward normal component of the gradient of Ψ. If the ocean covered the whole surface, observations of gravity over it would suffice to determine its form and the complete external field. The problem is different from those in potential theory, where we are told the form of a surface and either the potential or its normal gradient over it, and we have to find the other. Here we are told a lot about both the potential and the normal gradient, and have to find the form of the surface. The problem was solved to the first order by Stokes and to the second by Helmert.

The chief complication, of course, is that Ψ is not constant over the outer surface; but this was dealt with by Stokes. The point is that if h is the measured height, $\Psi = C - gh + O(h^2)$; and the observations thus refer to a surface where Ψ is known (apart from an additive constant) but is not constant. But if we form $g_1 = g(1 + 2h/a)$ and take gravity equal to g_1

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* Substance of a paper at a Geophysical Discussion on October 22.

over a surface $\Psi = C$, the solution is practically identical with the correct one at points outside the earth and therefore gives the external field correctly. This is the free-air reduction. It plays such a fundamental part that we may say outright that there is no other way of allowing for variations of height above sea-level if we are to get the external field right. We cannot remove the effects of elevated matter on the field, and any process such as isostatic reduction that attempts to do so is simply a way of introducing systematic error.

When we try to use free-air values there is a difficulty, because in irregular country they vary irregularly and show a strong positive correlation with height. To represent a region properly, we want the mean free-air gravity over it, and therefore an estimate for the mean height of the region. Thus we have to take $g_1 = \alpha + \beta h$, find α, β by least squares, and use the solution to find $\alpha + \beta\bar{h}$, where $\bar{h}$ is the mean height of the region (*not* that of the stations, which have a way of being in valleys). I maintain that this is the only way of presenting gravity summaries that does not introduce systematic error or give a spurious appearance of accuracy. β is not the same in all regions; and over the ocean h must be replaced by the depth, and the solution must be adapted to mean depth. A reason often given for using isostatic anomalies* is that they are more regular than the free-air ones; but in most regions they are not appreciably more regular than the free-air ones with allowance for height, and the exceptions are precisely those where there is most risk of systematic error in using them.

When this method was applied to gravity, it was found convenient to classify the observations over 10° squares and get a mean value for the free-air anomaly for each. The means were found to show considerable irregularity, decidedly more than the apparent uncertainties will explain. Consequently it is useless to try to treat values for, say, 1° squares as subject to independent errors—there is a strong correlation of residuals at stations up to 10° apart and an appreciable one up to 30°. I speak of these as the τ_1 and τ_2 variations. Over and above the apparent uncertainty based on the departures for 1° squares from the mean, the 30° squares show a variation representable by a standard error τ_2 of about 15 mgal., and the 10° ones show one, with reference to the 30° means, of $\tau_1 = 21$ mgal. These should be right to about 2 mgal., and must be considered established. The values show no correspondence with mean heights of the squares, whereas any form of isostasy suggested would leave a positive correlation. The 'added mass' theory is, of course, worse; but we have reached a stage where further progress requires analysis of the residuals, and the isostatic theory gives us no help in understanding them. Isostasy must be regarded as a rough approximation for special regions where irregularity of height is extreme, and not even for all of them.

Even between adjacent 30° squares there is some correlation of the residuals. This could be due in part to errors of comparison of base stations. Assuming it genuine, I found four spherical harmonics in gravity of degrees two and three with longitude factors, and apparently significant amplitudes, besides small corrections to the mean and the main ellipticity term, but I should not like to be sure of them because some of the distant comparisons are under suspicion. The 10° and 30° variations, however, depend chiefly on comparisons with one base station common to each square and should be little affected by such errors.

The measurement of the radius and ellipticity of the earth by geodesy is essentially a matter of comparing the variations of latitude or longitude along an arc of measured length. As direction is measured by means of the plumb line, any irregularity of direction of gravity will be thrown into the latitudes and longitudes and produce errors in the results. In fact, it is known that residuals in surveys tend to maintain sign over considerable distances, and in some cases estimated uncertainties have been increased accordingly. But we now know a bit more; we still do not know the deflexions in detail, but we have a good idea of their average amount, because in a potential disturbance of high order the mean squares of the two transverse components are together nearly equal to that of the radial component, which we know from the irregularities of gravity. The uncertainty thus becomes calculable; the 10° and 30° variations together will produce an increase of the uncertainty of an estimate of the radius ranging from about 800 metres for a 10° arc to 280 metres for a 30° arc and 66 metres for a 100° arc. I had considerable difficulties in tracing the original determinations; but the outstanding result was that, with the apparent uncertainties found from the survey residuals, the results were plainly discrepant: $\chi^2 = 15\cdot3$ on 6 d.f.* But with an increase of uncertainty due to deflexions, χ^2 came down to 4·4 or 2·4 according as the low harmonics in gravity were allowed for or not. The solution then indicated that Hayford's radius was too large; the equatorial radius was 6378·117 ± 0·119 km. in both cases, Hayford's value being 6378·388 km.

The absolute value of gravity has been redetermined twice lately, at Teddington and Washington, and various cross-comparisons have indicated that the Potsdam determination of 981·274 ± 0·003 cm./sec.^{2} is 10–20 mgal. too high. It appears that the Potsdam workers had corrected for a systematic error that was not there. With a method of reduction that takes account of internal correlation of the errors, I get 981·2633 ± 0·0022. The three absolute measures, with three cross-comparisons, give

$$g_P = 981\cdot2606 \pm 0\cdot0010;\ g_T = 981\cdot1807 \pm 0\cdot0008;\ g_W = 980\cdot0831 \pm 0\cdot0009.$$

$\chi^2 = 6\cdot2$ on 3 d.f. This is slightly on the large side, but not large enough to afford reason against taking the experimental determinations at their face value. The principal British stations are strongly connected with Teddington by recent measures made by the Anglo-Iranian Oil Co. with a gravimeter. Apparently the solution requires all absolute determinations, which are mostly based on the Potsdam standard, to be reduced by about 13 mgal.

If the interior of the earth was in a hydrostatic state, the ellipticity could be found from the precessional constant with a standard error of about 0·08 in the denominator. No other method makes this less than about 1. The hypothesis is certainly false, but the existence of the 10° and 30° variations gives an indication of how far it is likely to be wrong; the effect is to increase the estimate of uncertainty to about 0·31 or 0·61 according as the low harmonics in gravity are rejected or accepted. In either case, contrary to what I had expected, it remains the most accurate single equation for the ellipticity.

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*An anomaly is the excess of gravity over that given by the international formula, which is an approximate formula that makes the surface $\Psi = C$ an exact spheroid of ellipticity 1/297·0.

* "d.f." means "degrees of freedom", which is number of estimates less number of parameters found from them. $\chi^2 = \Sigma(O - C)^2/s^2$, where s is the standard error of the estimate O.

The lunar parallax has been measured visually, and can also be calculated. Very crudely, $g = fE/a^2$, $n^2 = fE/r^3$; whence $an^2/g = a^3/r^3$. (f is the constant of gravitation; E is the mass of the earth; a is the radius; n is the moon's angular velocity; r is the moon's distance.) Several corrections are needed, and when they are made the result is the dynamic parallax. There has been a slight discrepancy between the visual and dynamical values, but as it was only about 1·4 times the standard error it does not, in any event, appear serious. Here again the possible deflexions of the vertical at Greenwich and the Cape must be taken into account. The final result is that all the data, survey (a and e), the main ellipticity term in gravity, the lunar parallax, and the estimate of the ellipticity from the precessional constant fall nicely into agreement with regard to the uncertainties, whether the longitude terms of low degree in gravity are accepted or not. All the discrepancies can be explained as due to the earth's having been treated as more symmetrical than it is.

The data for the moon's motion have been combined with those for the earth. Again no discrepancy was found; altogether $\chi^2 = 6{\cdot}3$ or $8{\cdot}7$ on 14 d.f. The final results in a compromise solution are

$$a = 6378{\cdot}099 \pm 0{\cdot}116 \text{ km.};\quad e^{-1} = 297{\cdot}10 \pm 0{\cdot}36.$$

$$g = g_0(1 + \beta \sin^2\varphi + \gamma \sin^2 2\varphi);$$

$$g_0 = 978{\cdot}0373(1 \pm 0{\cdot}0000024);\ \beta = 0{\cdot}0052891 \pm 0{\cdot}0000041;\ \gamma = -0{\cdot}0000059;$$

Lunar parallax = $3422{\cdot}419'' \pm 0{\cdot}024''$;
Mass of earth/mass of moon = $81{\cdot}278 \pm 0{\cdot}025$;
Processional constant = $0{\cdot}00327260 \pm 0{\cdot}00000069$.

Except for a and g_0, there is no serious change from accepted values, but the uncertainties are based on additional evidence and more satisfactorily determined.

OBITUARIES

Mr. Richard Elmhirst

RICHARD ELMHIRST died very suddenly on November 13 at Millport after forty-two years of service to the Scottish Marine Biological Association and within a few months of the date when he would have retired. He was the youngest son of the Rev. Robert Elmhirst, vicar of Brotherton, in Yorkshire, and was educated at St. George's School, Harrogate, and at Rossall School. There the bent of his mind was early displayed; he was twice natural history prizeman and was assistant curator of the School museum. In 1902 he proceeded to the Yorkshire College, which had become the University of Leeds before he left in 1905. He took no degree, maintaining throughout life an objection to degrees or appendages of any kind, but with his natural gifts fortified by study under that great teacher and zoologist, L. C. Miall.

Elmhirst had already had experience of museum work at Leeds and at Keighley when he went to Plymouth in January 1906 to undertake, for the Marine Biological Association, the preparation of a collection of marine exhibits for the exhibition held that year at Marseilles. He returned from France to take up an appointment in September as naturalist at Millport on the recommendation of E. J. Allen. It was at Millport that he was to do his life's work. On the resignation of the director, S. Pace, in 1907, he was appointed interim curator, promoted superintendent in 1908 and finally director in 1933. He served with distinction in the First World War as lieutenant, R.N.V.R., in the Dover Patrol.

From 1907 until 1922 Elmhirst was the sole member of the scientific staff at Millport. He had little to maintain him but his enthusiasm as a naturalist in the midst of a wonderful collecting area of sea and shore. Later he had the satisfaction of seeing the Station develop with a fine extension to the buildings in 1939, and even the setbacks of the Second World War made good by major increases in staff and equipment.

Richard Elmhirst was a born naturalist and a most lovable man; and because he was so interested in all living things, his fellow creatures as well as the inhabitants of the shores of the Great Cumbrae and of the waters of the Clyde Sea area, he was a fine teacher. He enjoyed the annual Easter classes where so many students had their introduction to marine biology. I myself must be one of many whose interests were permanently influenced by studying the seashore and its life under his guidance. It was the same with all visitors. He welcomed them with natural hospitality and would go to endless pains to secure the most unlikely of animals, and with a success that brought him as much pleasure as it did the recipient. The Millport laboratory has a tradition of popular teaching, and annually all manner of parties from natural history societies, colleges and schools came—and usually on Saturday afternoons—to be welcomed by him and given lectures and demonstrations or taken for expeditions on the shore. He was known throughout the west of Scotland as a willing and always interesting lecturer.

He never confined himself to any particular group of animals. He knew them all, and the plants as well. The very diversity of his interests was in one sense a drawback. There were so many fascinating things to observe and to investigate that when he had examined one thing he must proceed at once to another and then another. So his published papers, though far-reaching and all of real value, were never so full or so detailed as they would have been had he confined his interests more rigidly. But if he had done so he would never have acquired his amazing breadth of knowledge—and he would not have been Richard Elmhirst.

It was as a man that we remembered him when he was laid to rest on November 16 at Millport, with which his name will be associated so long as the marine station which he built up survives. Our heartfelt sympathy goes out to Mrs. Elmhirst and to his son.

C. M. YONGE

Dr. S. C. Bradford

THE death on November 13 of Dr. S. C. Bradford, following so closely on that of Prof. A. F. C. Pollard, suggests that the elder generation of those who built up the modern scientific information network is passing away, its contribution made.

Samuel Clement Bradford was born in London in 1878, and joined the staff of the South Kensington Museum in 1899, being in the library from 1901 onwards. He worked at this time in what is now the Victoria and Albert Museum. During 1911–14 he had charge of the chemistry collections in addition to his work in the library. During the First World War he was lent first to the National Physical Laboratory and then to the Chemical Warfare Department. He became chief librarian of the Science Library in 1925, with the rank of keeper from 1930. He married Cora Mabel Monnery, who survives him. He leaves no children.

It may well have been Bradford's experience of literature searches during the First World War which led to the activities for which he is remembered. At all events, he proceeded to develop the Science Museum Library as the nucleus of a great central information service, with a vast repository of cards classified by the Universal Decimal Classification. He became persistently active in propaganda for the decimal system, since the scheme would fall to the ground unless an international classification was widely adopted. The British Society for International Bibliography came into being largely through him. National and international meetings were held, culminating in the Oxford gathering of the International Federation for Documentation in 1938.

Meanwhile, one really successful development due to Bradford at South Kensington went on with no need of propaganda. This was the loan system, for after the First World War came the great development of research by industry and government, and this entailed a huge appetite for postal loans. This Dr. Bradford set himself energetically to satisfy. It is indeed ironical to think of the mechanized distributing centre planned from a room which in size and furnishings was one of the all too few survivals of a more spacious and humane conception of library work. It is as seated in this room that his friends will wish to think of him, the brown leather bindings behind the glass, the space bisected by a chemical bench. For Bradford was an active man of science as well as a bibliographer; colloids and the kinetic theory of liquids being among his subjects. Another of his activities will occur to many who met him: the choice rose so often to be seen in his buttonhole marked him for the very active fancier that he was. Music, also, had been an early interest. But basically he remained one of the older museum and library world, deeply concerned with the details of his profession.

Bradford's literary work included various official catalogues, including "Classification for Works on Pure and Applied Science", second edition, 1921; third edition, 1936; "Hand-list of Short Titles of Current Periodicals in the Science Library", fourth edition, 1926; fifth edition, 1938; "Romance of Roses"; "The Science of Rose Growing"; contributions to scientific and technical journals; papers on the kinetic theory of gases and liquids; the molecular theory of solution; colloid solutions; the formation and structure of jellies; the crystallization of gelatin; the Liesegang phenomenon; the classification and indexing of scientific literature; the principles of classification; the organisation of scientific bibliography; and library cataloguing. His final contribution in this last field was the book "Documentation", which appeared not long before his death.

H. T. PLEDGE

WE regret to announce the following deaths:

Dr. J. H. van der Bijl, F.R.S., chancellor of the University of Pretoria, on December 2, aged sixty-one.

Lieut. Oliver Burd, R.N., meteorologist, and Mr. Michael C. Green, general assistant, of the Falkland Islands Dependencies Survey, on November 8.

The Right Hon. J. H. Hofmeyr, chancellor of the University of the Witwatersrand, and president in 1928–29 of the South African Association for the Advancement of Science, aged fifty-four.

NEWS and VIEWS

Industrial Health Research Board

THE following have accepted the invitation of the Medical Research Council to serve as members of the Industrial Health Research Board during the next three years: Sir Frederic Bartlett, professor of experimental psychology, University of Cambridge (*chairman*); Sir Charles Bartlett, managing director, Vauxhall Motors, Ltd.; Prof. R. V. Christie, professor of medicine, University of London; C. R. Dale, Social Insurance Department, Trades Union Congress; Dr. A. N. Drury, director of the Lister Institute of Preventive Medicine; Sir Luke Fawcett, general secretary, Amalgamated Union of Building Trade Workers; Prof. T. Ferguson, professor of public health, University of Glasgow; Sir Claude Gibb, chairman and managing director, C. A. Parsons and Co., Ltd., Newcastle-on-Tyne; Prof. A. Bradford Hill, professor of medical statistics, University of London; Prof. Esther M. Killick, professor of physiology, University of London; Prof. R. E. Lane, Nuffield professor of occupational health, University of Manchester; Dr. A. Massey, chief medical officer, Ministry of National Insurance; Dr. E. R. A. Merewether, H.M. senior medical inspector of factories, Ministry of Labour and National Service; Dr. J. M. Rogan, Medical Research Council headquarters staff: Dr. Donald Stewart, chief medical officer, Austin Motor Co., Ltd.; Mrs. Joan M. Faulkner, Medical Research Council headquarters staff (*secretary*).

The Board is appointed by the Council to advise and assist the latter in that part of its research programme which relates to occupational health. The detailed consideration of research work is in the hands of scientific committees dealing with such subjects as occupational medicine, occupational physiology, occupational psychology, industrial pulmonary diseases, toxicology and statistics. These committees report directly to the Council for purposes of immediate action. The function of the Board itself is that of a reviewing body considering general policy with regard to research over the whole field.

Esperanto and Science

THE British Esperantist Scientific Association has been founded by a body of British scientific workers and technical experts who are interested in the use of Esperanto as an international medium for the discussion of scientific affairs. Before the War there existed an Internacia Scienca Asocio Esperantista; but this body, like so many others, disintegrated during the last ten years, and is only being reconstituted with some difficulty. 'BESA' (as the new Association is popularly called) is taking an active part in this work; meanwhile, however, it also aims at arousing an interest among British men of science in the potential value of Esperanto for the exchange of scientific information and at creating in Great Britain a nucleus of workers who are themselves adepts in the use of the language for scientific purposes. Several of its members are engaged in the compilation of technical vocabularies in various fields—an essential task inasmuch as (though Esperanto has been in use for general purposes for sixty years) there is as a result of the interruption of normal communications in recent times a considerable need for the standardization of many new technical terms which have come into use during this period. The Association has also made informal contacts with Unesco and other international organisations with regard to the whole question of international language. Since its inception in February 1947, the Association (which has an advisory panel of distinguished workers in various branches of science) has held a number of meetings at University College, London. Business proceedings are conducted in English, but technical papers are read and discussed in Esperanto. Membership of the Association is open to all who are interested in the application of Esperanto to science and technology, whether professionally occupied in these fields or not. The president is Dr. J. C. Flugel, of University College, London, and the honorary secretary, Mr. E. D. Durrant, of 15 Beaufort Road, Reigate, Surrey.

Vitamin D Assay

ALTHOUGH specification for the assay of vitamin D_2 by the chick method exists (London: British Standards Institution: B.S.S.911) there is none pertaining to assay on rats, the test animals used in many different laboratories. The Society of Public Analysts and Other Analytical Chemists, and the Society of Chemical Industry therefore set up a joint committee to determine "the fiducial limits that might reasonably be expected in biological assays of vitamin D using rats". British organisations employing this technique were asked to submit statements and opinions based on their own experience, and as a result of the information so collected the joint committee has now issued the following statement: "In the absence of any special circumstances, it is reasonable to expect that assays of vitamin D by the rat method in normal commercial practice should have fiducial limits (calculated to a probability level of 95 per cent) not wider than 60–170 per cent"; and the opinion is expressed that "the result of any assay conforming to these limits should be a commercially acceptable estimate of the true potency of the material assayed". Fuller details are being presented by the committee in the *Analyst* and in *Chemistry and Industry*.

Geophysics in Finland

GEOPHYSICAL studies in Finland on truly scientific lines started early in the eighteenth century, a movement in which an 'invitation' of date 1723 from James Jurin, secretary of the Royal Society, to co-operate in meteorological observation, played a part. An account of the early history of Finnish geophysical studies appeared in 1935 in the first issue of a journal, *Geophysica*, published by the Geophysical Society of Finland, a body founded in 1926. Papers are read at its meetings; but the Society is not in the main a publishing body. *Geophysica* No. 1 (financed by a grant from lottery funds) included, however, three general articles besides the historical summary, and also thirty-six pages of summaries (by the authors) of Finnish geophysical papers published during 1930–34, giving a view (though incomplete) of the then recent Finnish activity in the subject. This view is now extended by the appearance in 1947 of *Geophysica* No. 2, which, like No. 1, is written wholly in English and German. Apart from two short articles on the Finnish Geodetic Institute, 1918–38, and the Isostatic Institute (subsidized, except during the War, by the International Association of Geodesy), the volume is devoted to authors' summaries of Finnish geophysical literature during the period 1935–44. An improvement on No. 1 is the inclusion of alphabetical lists of authors under five subject-headings, which makes the volume very convenient for reference in searching for any recent work done in Finland on these topics. The volume well indicates the extensive and valuable work done in geophysics in Finland during ten troubled years.

Portable Barometer

A PORTABLE barometer made by the well-known clockmaker Daniel Quare (1649–1724) has been lent by Mr. R. Meyrick, of Corbridge-on-Tyne, to the Science Museum, South Kensington. The barometer is an early domestic form of the instrument, in which the tube and cistern are enclosed in a fluted walnut case carried on four metal feet. Thus the instrument can stand on a table, though a ring is also provided for hanging it against a wall. This barometer was the first designed for portability, having been made by Daniel Quare to his own patent specification of 1695. It uses a cistern with a flexible leather bottom which can be compressed by means of a screw so as to fill the barometer tube with mercury and thus avoid the risk of damage when the barometer is moved. To reduce this risk still further, there is a constriction near the top of the tube, to retard the flow of the mercury and thereby reduce the impact of the column on the upper, closed end of the tube. The instrument has a weather scale very similar to that still used on domestic barometers.

An Interesting Hemipterous Insect from New Zealand

IN the first volume of *Dominion Museum Records in Entomology* (Wellington, N.Z.), June 1948, p. 63, Carl J. Drake and J. T. Salmon contribute a short paper entitled "A Second *Xenophyes* from New Zealand". Under the name of *Xenophyes forsteri*, the authors describe a new species of the small and little-known family Peloridiidæ from New Zealand. The family, it may be added, is also known from southern Argentina, Patagonia, Australia and Tasmania. It provides, therefore, an additional link in the evidence from other sources of a direct land connexion between the South American and Australasian continents. Only seven species grouped under three genera of Peloridiidæ are at present known. What little biological evidence there is available indicates that its members feed largely, or wholly, on mosses, and inhabit damp situations. The family was originally placed in the Hemiptera – Heteroptera and, since the antennæ are concealed from view, it was relegated to the series Cryptocerata. Recent research, however, indicates that its affinities lie with the suborder Homoptera and that it represents a separate and new series named by Myers and China in 1929 the Coleorrhyncha. This view is now generally accepted by most students of Hemiptera. The species are all very small creatures the hind wings of which are vestigial or absent. The tegmina occur in probably all the species in two forms, macropterous and brachypterous, although both these types have not yet been found in all cases.

The Solar Apex

Mr. O. R. Walkey has examined the literature on the position of the solar apex (*Mon. Not. Roy. Astro. Soc.*, **106**, No. 4; 1946). Table 1 shows the marked divergences in the positions determined from 1933 to 1941. Mr. Walkey uses as his basis Moore's "Catalogue of Radial Velocities" (*Pub. Lick Obs.*, 18; 1932) and Boss' "General Catalogue" (*Carnegie Pub.*, No. 468; 1937). It is suggested that the divergences just referred to may be partly due to rotation in a probable local cluster which leavens the allowance made for galactic rotation—a view to which some support is given by the increased declination in the apex with increased magnitude of the stars used. Mr. Walkey believes that our ignorance of the actual peculiar motions of the stars, and the consequent assumptions required to fill this gap in our knowledge, may undermine "the refined mathematical edifice built thereon". Using the two catalogues mentioned, he considers the *sense* alone of their respective motions, whether reflecting "pro"-solar motion, or the reverse—"con". In this way he by-passes assumptions for distance (for cross-motions), etc., and also the general assignment of arbitrary limits for acceptable motions. A full explanation of the method appears in the paper, to which reference must be made for details of the method; Mr. Walkey states that the method is a development of that mentioned by Russell, Dugan and Stewart in "Astronomy", vol. 2. As a result of his investigation, involving 40,720 star motions, Walkey's conclusions are as follow: position of solar apex, 1900·0; R.A. 270·2° ± 0·3°, Dec. + 28·7 ± 0·5°. The solar velocity of approach was found to be 20·5 ± 0·6 km./sec., its galactic planar component being 19·0 km./sec. and the normal 7·75 km./sec.

Metal Caps for Test-tubes

We have received from Messrs. Oxo, Ltd. (Thames House, Queen St. Place, E.C.4), samples of metal caps for test-tubes. These caps have been used for some time in their laboratories, and Messrs. Oxo offer to supply them free of charge to other laboratories which ask for them. The caps are intended as a substitute for cotton wool plugs, and Messrs. Oxo claim for them the following advantages: test-tubes of media fitted with the caps remain sterile for long periods; there are no fibres to contaminate the media; tubes fitted with the caps can be sealed with 'Cellophane'; the caps can be labelled with an ordinary pencil and this labelling withstands autoclaving; they are easily removed and replaced and do not stick to the mouths of the tubes; the caps last a long time and can be cleaned by boiling in 0·5 per cent caustic soda, followed by rinsing and drying. The caps appear to be made of an aluminium alloy and are supplied in three sizes to fit standard test-tubes with outside diameters of ⅝, ¾ and 1 in.

Rare and Historic Maps

Mr. Francis Edwards, 83 Marylebone High Street, London, W.1, has issued a catalogue (No. 692) of maps and atlases of the British Isles from the sixteenth to the nineteenth centuries which contains several items of unusual interest. There is a first edition of Camden's "Britannia" with 57 double-page maps, and also a copy of Collins' "Coasting Pilot" of 1693 with 48 maps. Perhaps more noteworthy are several copies of different editions of Speed's atlas, including the rare fully-coloured one, and a first edition of Saxton's atlas of England and Wales. The catalogue also lists a copy of that rarest of all sea atlases, "Arcano del Mare" of Robert Dudley, Duke of Northumberland, with 133 maps, and plans and diagrams.

Geology in Scotland: Swiney Lectures

The first half of the course of Swiney Lectures on geology are being delivered (December 6–17) by Dr. Douglas A. Allan, director of the Royal Scottish Museum, at the Museum itself in Chambers Street, Edinburgh. The general title covering the twelve lectures is "The Geology and Scenery of Scotland". This is the first time that Swiney Lectures, which are under the direction of the British Museum (Natural History), have been given outside London, and Mr. N. B. Kinnear, director of the Museum, presided at the opening lecture. The last six lectures will be delivered at the same place at 5.30 p.m. on Mondays, Wednesdays and Fridays during January 17–28, 1949.

Announcements

Prof. Ernst Gaumann, of the Federal Technical College, Zurich, has been elected *correspondant* for the Section of Botany of the Paris Academy of Sciences, in succession to Dr. A. F. Blakeslee, who has been elected a foreign associate of the Academy.

Prof. E. G. Cullwick, director of the Electrical Research Division, Research Defence Board, Ottawa, will be the first occupant of the new Watson-Watt chair of electrical engineering at University College, Dundee.

Dr. J. L. B. Cooper, of the Department of Mathematics, Birkbeck College, University of London, has been appointed to the University readership in mathematics tenable at the College.

A series of four sessions on the "Educational and Social Significance of the Land" has been arranged by the Association of Agriculture and the University of London Institute of Education, to be held at the latter's headquarters in Malet Street, London, W.C.1. The first session has already been held and the remaining three will be at 10 a.m. on December 11, and February 5 and 19. At each session two lectures of one hour's duration will be delivered, and emphasis will be laid on teaching methods in the middle forms of secondary schools. Admission is 1*s.* per session or 2*s.* 6*d.* for all four, and further details may be had on application to the general secretary, Association of Agriculture, Abbey House, Victoria Street, London, S.W.1.

A series of three Christmas Lectures, especially adapted for a juvenile audience of from twelve to seventeen years of age, will be given in the Royal Photographic Society's House, at 16 Princes Gate, London, S.W.7, on December 29, 30 and 31, 1948. A special house exhibition, comprising Nature subjects, is being arranged by Mr. Oliver Pike to coincide with the lectures. The lecturers and subjects will be as follows: "The Chemistry of the Process", by Dr. H. Baines; "Formation of the Image and Making the Negative and Print", Part 1, by Mr. K. H. Gaseltine, and Part 2 the next day. Admission will be free but by ticket only, obtainable on application to the Secretary of the Society at the above address.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Artificial Stimulation of Rain

DURING the past summer here, the South African Council for Scientific and Industrial Research, with the assistance of the Division of Meteorology and the South African Air Force, arranged a series of experiments to examine the practical possibilities of the artificial stimulation of precipitation.

As natural conditions in the Transvaal in summer are particularly favourable for the development of convective cloud, the experiments were directed mainly to an investigation of the effects produced by the release of 'dry ice' into developing cumulus cloud or incipient thunderstorms.

Experiments were carried out from January to April, 1948, on days on which fairly numerous thunderstorms were expected to occur, and selected clouds were 'seeded' with 'dry ice', development being observed by means of a 3-cm. radar, the aerial system of which consisted of a rotating parabolic reflector producing a 2°-beam, the elevation of which was manually adjustable. Display was by PPI, and arrangements provided for the aircraft position to be indicated directly on the screen. A photographic record of the screen on 16-mm. film was made automatically at predetermined intervals.

'Dry ice', crushed to $\frac{1}{4}$–$\frac{3}{4}$ in. mesh, was dropped within, or 200–400 ft. above the tops of, thirty-six cumulus clouds on six days, and the following is a summary of the results of the photographic record of the radar display.

1. No echoes observed	4	occasions
2. Echoes doubtful owing to permanent echoes and close-in clutter	8	,,
3. Echoes of less than 15 min. duration :		
(*a*) First appearance in less than 30 min.	4	,,
(*b*) ,, ,, between 30 and 90 min.	4	,,
(*c*) ,, ,, after more than 90 min.	2	,,
4. Echoes of more than 15 min. duration :		
(*a*) First appearance in less than 30 min.	7	,,
(*b*) ,, ,, between 30 and 90 min.	5	,,
(*c*) ,, ,, after more than 90 min.	2	,,

'Dry ice' was dropped when air temperatures were between 7° F. and 29° F., and at a rate ranging from 20 lb. to 200 lb. per minute, into cumulus cloud which observation showed to consist of supercooled water droplets. Echoes from clouds seeded at the lower temperatures occurred more consistently than those from clouds seeded at temperatures nearer freezing; but from the limited number of experiments, no conclusions could be reached regarding the comparative effectiveness of the different quantities of 'dry ice' employed.

The experiments indicate that the use of 'dry ice' undoubtedly had the effect of inducing precipitation at an earlier stage in the life of the cloud than is normally the case. Such precipitation was often associated with lightning and, on one occasion at least, lightning was observed below a cloud fifteen minutes after it had been seeded, although its imminence was not suggested by the development and general appearance of the cloud.

The information at our disposal is not sufficient to draw any conclusions as to whether this stimulated precipitation affected the intensity of rainfall which would probably have occurred later from the seeded clouds, and whether it prolonged its duration or extended the area over which it fell.

Temperature observations made during these flights with a sensitive electrical thermometer show remarkably large temperature variations in horizontal flight. In one case a difference of 7° F. during a few miles of horizontal flight in clear air at about 20,000 ft. was noted. Temperatures recorded within cumulus clouds were frequently lower than those observed in clear air at the same pressure just outside the cloud.

We wish to thank the Director of the Division of Meteorology, the Director-General and officers of the South African Air Force, and Messrs. National Chemical Products for their generous co-operation and help in these experiments.

J. A. KING

Division of Meteorology,

E. C. HALLIDAY
F. J. HEWITT
D. G. KINGWILL

Council for Scientific and
Industrial Research,
Pretoria.
Aug. 4.

Condensation of Water Vapour Below 0° C.

AN apparatus has been constructed which permits ultra-microscopic observation of individual condensation nuclei in an expansion chamber. The chamber may be cooled by immersion in a low-temperature bath, and the air in it supersaturated on further cooling by sudden small expansions. The object has been to study cloud formation at temperatures below 0° C., particularly in order to discover under what conditions ice crystals appear and whether they are the result of direct sublimation from vapour to ice or of the condensation and subsequent freezing of water droplets. This question has considerable meteorological importance, since the presence of ice crystals in a cloud is often supposed to be essential to the development of rain.

Outdoor air. Experiments with outdoor air have shown that above − 32° C. condensation occurs almost entirely in the form of water droplets, and that ice nuclei, if present, do not exceed 1 per c.c. When the final temperature at the end of the expansion falls below a threshold, which appears to vary between − 32° C. and − 35° C., clouds are usually seen to contain ice crystals in numbers up to 20 per c.c., although water droplets remain far more numerous and may be about 1,000 per c.c. The number of ice crystals does not noticeably increase when final temperatures are lowered from − 35° C. to − 40° C., nor with increasing supersaturation. Between − 41° C. and − 42° C., however, a very sharp increase occurs, and below − 42° C. clouds are composed mainly, if not entirely, of ice crystals.

An important feature of all ice crystal formation in outdoor air is that it occurs only when the air, initially saturated with respect to ice, is cooled by expansion to the dew-point (to saturation with respect to water). This strongly suggests that the crystals are formed not by direct sublimation but by the condensation and immediate freezing of water droplets (no case has been observed of the freezing of a fully grown water droplet). It is therefore proposed that such ice nuclei should be known as 'freezing nuclei', and that the term 'sublimation nuclei' should be reserved for any which permit sublimation from vapour to ice strictly at the frost-point.

The ice crystals formed in outdoor air do not, on evaporation, leave behind any sublimation nuclei. If the temperature of the chamber be raised gradually, clouds again appear mainly as water droplets as soon as final temperatures fail to reach − 41° C.

Cleaned air. Experiments were made in air from which the great majority of nuclei had been removed by filtration. Down to − 55° C. and with expansions of ratio up to 1 : 10 (the limits obtainable), condensation or freezing occurred only on the few nuclei remaining. Irradiation of the chamber with gamma rays from a radioactive source produced no effect. This is in contradiction to the observation of Cwilong[1].

Contaminated air. The threshold at − 41° C. has been observed not only in outdoor air but also in cleaned air contaminated with a wide variety of artificial nuclei, including those from sprayed sodium chloride and sodium nitrate solutions and from a red-hot platinum wire.

Certain nuclei, however, have been found to stimulate ice formation at higher temperatures. Silver iodide, the effect of which on supercooled water fogs has been reported by Vonnegut[2], provides, when volatilized, freezing nuclei active at temperatures as high as − 6° C.

Only one instance of true sublimation has yet been observed. This was on nuclei produced by a spray of cadmium iodide solution, but only after an ice cloud had been formed on them by expansion to a temperature below − 42° C. The ice crystals thus formed left behind, on evaporation, small particles which acted as true sublimation nuclei at temperatures up to − 10° C. Further warming to − 9° C. caused a 'melting' of these nuclei, which then reverted to giving only water droplets, even on subsequent cooling to − 25° C. It may be noted that the freezing point of a saturated solution of cadmium iodide, in bulk, is in the neighbourhood of − 9° C.

Both silver iodide and cadmium iodide occur in hexagonal crystals which have lattice constants within 7 per cent of those of ice-I.

Nuclei from rain-water. Some recent experiments on the nuclei produced by a spray of rain-water collected during a thunderstorm have revealed the presence of small numbers of nuclei which gave ice crystals at temperatures as high as − 20° C., but which were evidently not common enough to be detected by normal experiments on outdoor air. These may be the nuclei discovered by Findeisen[3], though it was clear that they acted as freezing, and not sublimation, nuclei.

My thanks are due to Lord Cherwell for enabling me to work at the Clarendon Laboratory; and to the Department of Scientific and Industrial Research for a maintenance grant. It is a pleasure to acknowledge my debt to Prof. G. M. B. Dobson for his continued interest and valued advice on many occasions.

E. M. Fournier d'Albe

Clarendon Laboratory,
Oxford.
June 30.

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[1] Cwilong, B. M., *Proc. Roy. Soc.*, A, 190, 137 (1947).

[2] Vonnegut, B., *J. App. Phys.*, 18, 593 (1947).

[3] Findeisen, W. and Schulz, G., "Forschungs und Ehrfahrungsberichte des Reichwetterdienstes", A, No. 27 (1944).

A Concentration of Uranium in Black Muds

In the Cambrian black shales of the Oslo area, there is a considerable concentration of uranium, analyses values ranging from 25 to 180 gm./ton. (These and the following uranium analyses were made at the Norwegian Defence Research Institution, which has given permission for their publication.)

An interesting problem is how far a concentration is going on in the present-day black muds formed under anaerobic conditions. There is a large number of land-locked waters around the Norwegian coast, in which these black muds are deposited[1].

During the summer of 1947, I re-investigated these fjords, and the uranium content of some mud samples was determined. All analyses are made by the ether-extraction method and are thus independent of the radium content. In such recent sediments uranium and radium are not in an equilibrium.

The localities have already been described[1], and are here arranged according to the quantities of uranium found. The depth is also stated, as well as the content of hydrogen sulphide and oxygen in the deep waters.

Locality	Depth from which sample is collected (m.)	Content of uranium (gm./ton)	Maximum hydrogen sulphide or minimum oxygen in deep waters (cm.^{3}/l.)
Topdalsfjord	65	60	*c.* 1 H_2S
Søndeledpoll	18	50	5·4
Isefjærfjord	26	50	7·9
Hellefjord	70	40	40·7
Framvaren I	160	40	199·5
Framvaren II	160	35	199·3
Vestrhusfjord	53	35	9·9
Mortensfjord	34	20	1·6
Drammensfjord	117	15	4·8
Oksefjord	81	13	3·2 O_2

There seems to be a definite connexion between drainage from granite areas and uranium content in the black muds, this being most conspicuous with the record value of 60 gm./ton in Topdalsfjord, into which empties a large river draining extended granite areas.

The precipitation probably starts by the formation of sulphide on the interface between the upper ventilated brackish waters and the salt waters of the deep, containing hydrogen sulphide.

By comparing my old core samples with echo soundings taken during the summer of 1948, I was able to ascertain the thickness of the layers of blackish muds to range from less than a metre up to some 20 metres in a few isolated places.

Two of the three fjords which stand apart by their low values are, as a rule, quite well ventilated, while in the Drammensfjord the muds are not very black and there is probably a considerable redeposition of clay from the shores. Even here there is some concentration in relation to the granitic batholith in which the Drammensfjord is situated; but from which it receives only a very small part of its freshwater supply, and in which the uranium content is some 10 gm./ton.

Kaare Münster Strøm

Department of Limnology,
University of Oslo,
Blindern, Norway.
Aug. 10.

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[1] Strøm, K. M., *Skr. Vidensk.-Akad. Oslo*, 1, 7 (1936)

Range-Energy and Other Relations for Electrons in Kodak Nuclear Plates

KODAK Nuclear Track plates of type *NTP* 2, 30 μ in thickness, have been exposed in a low-resolution β-ray spectrograph using uniform magnetic fields of 279 and 302 oersteds. The focused line had a half-breadth of about 1 mm. The rays entered the plate at a grazing angle, the central ray meeting the plate at 6°. 'Line' sources of thorium (B + C) and radium E were used to provide continuous spectra. Exposure times were such as to give, in the 80-keV. energy region, about 2 × 10^5 β-rays per sq. cm. on a surface normal to the central ray. The plates were developed for 20 min. at 18° C. in 'Kodinol' developer.

Emulsions of two different sensitivities were used, the normal *NTP 2a*, and an experimental emulsion having larger grains and higher sensitivity than the *NTP 2a*. The chemical constitution of the two emulsions was the same. In the *NTP 2a* plates, electron tracks could be followed easily up to 50 keV., and with some difficulty up to 80 keV. energy. In the more sensitive emulsion, the upper energy limit for the range measurements was set by the thickness of the emulsion. The longest observed track was of 94·4 μ with corresponding energy almost certainly greater than 150 keV. (see below). Fig. 1, from a radium E plate, shows a 'background' track (probably of a secondary electron due to high-energy *Bremsstrahlung*). This track is 81·4 μ long and contains about 65 grains. Fig. 2 shows an 80-keV. track from radium E (27·8 μ and 32 grains).

Measurements were made of the ranges of unbranched tracks (a branch could not be identified with certainty if its energy were below about 20 keV.) starting in the surface of the emulsion and having an initial direction within 40° of the central ray direction. Working from grain to grain, observations were made of projected lengths and differences of depths. Depth measurements were corrected for shrinkage of the emulsion in processing. The range data from the higher sensitivity plates are given in Table 1. Because of the limited thickness of the emulsion, the 100-keV. range may be somewhat low; and is therefore enclosed in brackets.

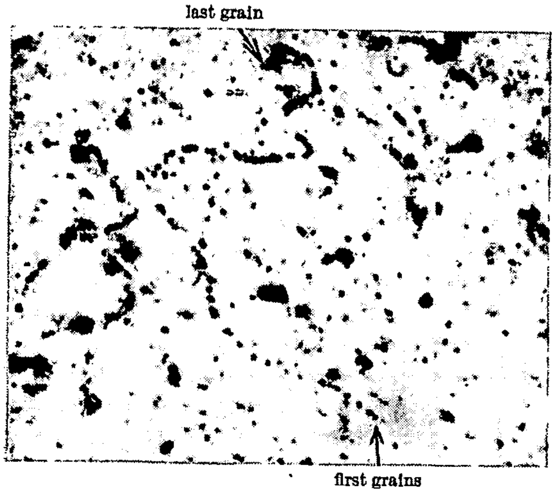

Fig. 1. Electron track of length 81·4 μ: magnification 1,260

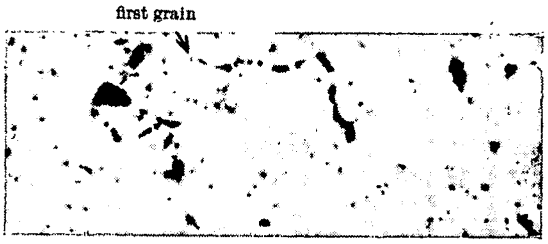

Fig. 2. Electron track of 80-keV. energy; magnification 1,260

Table 1

No. of tracks observed	Mean energy of tracks (keV.)	Mean range of tracks (μ)*	Standard deviation of ranges	Mean No. of grains per track*	Standard deviation of number of grains
25	30	6·90±0·33	1·67	10·8±0·4	2·0
25	40	11·00±0·57	2·84	14·4±0·4	2·0
25	50	15·78±0·50	2·51	20·4±0·7	3·6
25	60	22·15±1·12	5·62	22·4±1·0	4·9
25	80	32·65±1·55	7·74	35·5±1·4	6·9
25	100	(42·09±1·99)	9·94	41·0±1·6	7·9

* With standard error.

The grain density along the 100-keV. tracks was analysed in 5 μ portions of the tracks, working backwards from the last grain of the track. The results are given in Table 2.

Table 2

Portion of track from the last grain	Mean number of grains per 5 μ*	Standard deviation of number of grains
0–5 μ	7·0±0·3	1·7
5–10	5·3±0·3	1·3
10–15	5·2±0·3	2·5
15–20	4·6±0·3	1·3
20–25	4·3±0·2	1·0
25–30	4·3±0·3	1·3
30–35	4·1±0·3	1·1
35–40	3·7±0·3	1·0

* With standard error.

The relative stopping power of the emulsion may be defined as $\Delta R_a/\Delta R$, where ΔR_a is change of range in air at 760 mm. mercury pressure and 15° C., and ΔR is change of range in emulsion for the same change of energy of the β-particles from V_A to V_B. Thus defined, the relative stopping power is a function of the mean energy $V = \frac{1}{2}(V_A + V_B)$. Values of relative stopping power given in Table 3 were deduced from the data in Table 1 and from calculated mean ranges of electrons in air given by Tsien, Marty and Dreyfus[1], and shown by Tsien[2] to be in close agreement with experimental values in the region of energy up to 50 keV. If the 100-keV. range in Table 1 is low, the 90-keV. stopping power in Table 3 will be high.

Table 3

V in keV.	Relative stopping power of emulsions, with standard error
35	2640± 420
45	2720± 430
55	2290± 440
70	3130± 570
90	(3840±1030)

MARION A. S. ROSS
BARBARA ZAJAC

Department of Natural Philosophy,
University,
Edinburgh. Oct. 23.

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[1] Tsien San-Tsiang, Marty, C., and Dreyfus, B., *J. Phys. et le Rad.*, 8, 269 (1947).

[2] Tsien San-Tsiang, *Ann. de Physique*, 19, 327 (1944).

The Superconductive Transition

In 1931 de Haas and Voogd[1] showed conclusively that the electrical resistance of a single crystal of very pure tin vanishes discontinuously at the transition temperature. In this experiment the external magnetic field was zero, and the transition curve was extrapolated to zero measuring current. They showed also that physical or chemical impurity produces an extended transition region. Since then it has been generally assumed[2] that such an abrupt change of resistance also takes place when the transition occurs in a (longitudinal) magnetic field, extended transitions being ascribed to impurities. Experiments carried out in this Laboratory[3,4] on very pure lead exhibiting transitions extending over a wide range of magnetic field cast doubt, however, on the validity of this assumption.

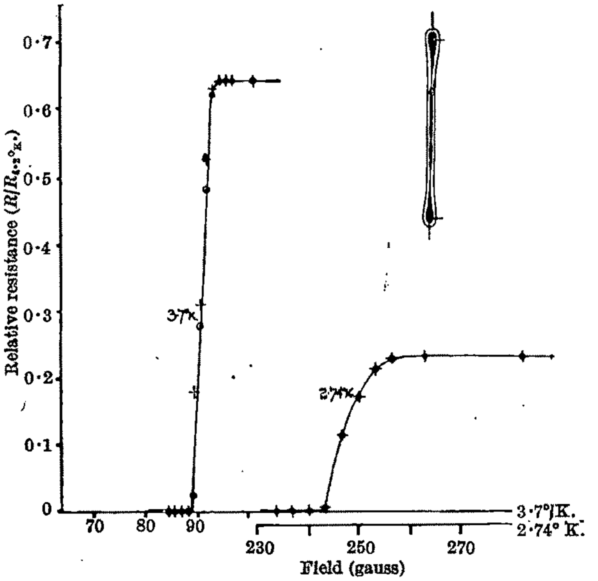

Fig. 1. ○ Ascending; + descending

The true shape of the transition curve is clearly of fundamental significance when analysing the mechanism of the disappearance of the electrical resistance, and we have therefore investigated this problem more carefully. Specimens of very pure tin, lead and mercury which had been prepared *in vacuo* were examined in a longitudinal magnetic field. Preliminary experiments showed that the way in which the leads were attached strongly affected the transition, and finally a method was adopted (to be described in detail elsewhere) by which the potential leads were attached free of strain, without solder and without causing distortion of the magnetic field over the length of the specimen. Under these conditions, in all three metals, the transition curves were of a similar general shape (see Fig. 1). The width of the transition region increases rapidly with the *absolute* value of the critical field (H_c), which means that for a given value of H_c/T a transition in lead is more extended than in tin. Incidentally, this behaviour makes it clear that the transition broadening cannot be simulated by inhomogeneities in the external field. The ultimate criterion for the purity of our specimens was, in the case of tin, provided by comparison of the transition in zero field with those observed by de Haas and Voogd[1]; this showed that our specimen corresponded to their purest single crystal.

It was remarkable, in view of the purity of our specimens, that in no case did we observe hysteresis, a phenomenon commonly ascribed to the transition of pure single crystals. It had been suggested by one of us[5] that resistance hysteresis[6] may be due to the geometrical shape of the ends of the wires, and we therefore investigated a mercury specimen which ended in bulbs carrying the contacts. In every other respect its preparation was identical with the specimen of Fig. 1, thus ensuring similar purity and crystalline state. The result, illustrated in Fig. 2, shows quite marked hysteresis with *discontinuous* jumps, thereby demonstrating that these features are produced, in fact, by the overall geometry of the specimen. A full explanation of this curious behaviour cannot be provided at this juncture. A most puzzling feature is that on occasion the whole transition from zero to normal resistance, when hysteresis is present, can cover a narrower range of magnetic field than the reversible transition of the straight specimen.

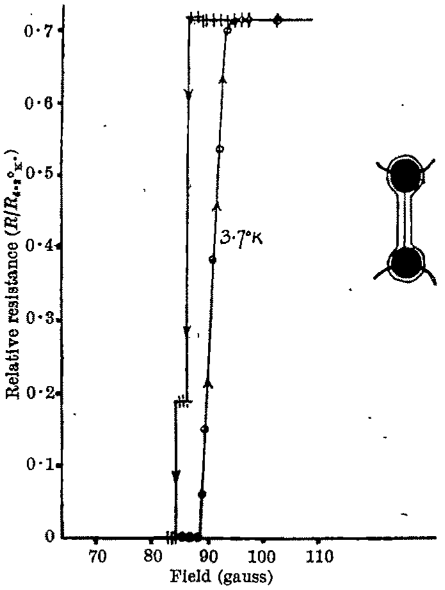

Fig. 2

Summarizing our results, we have found no evidence whatever (once the disturbing effect of geometrical shape is removed) that either discontinuous change of resistance or hysteresis are to be regarded as characteristic attributes of the superconductive transition in a magnetic field.

D. K. C. MacDonald
K. Mendelssohn

Clarendon Laboratory,
Oxford.
Oct. 22.

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[1] de Haas, W. T., and Voogd, J., Comm. Leiden No. 214c (1931).
[2] Shoenberg, D., "Superconductivity" (Camb. Univ. Press, 1938).
[3] Pontius, R. B., *Phil. Mag.*, **24**, 787 (1937).
[4] Daunt, J. G., *Phil. Mag.*, **28**, 24 (1939).
[5] Mendelssohn, K., *Proc. Roy. Soc.*, A, **152**, 34 (1935).
[6] de Haas, W. H., *Leipziger Vortraege* (1934).

Measurement of Alkaline Earth Ion Concentrations by Rennet Action

THE relatively high temperature coefficient of the second or cationic precipitation stage of rennet action on casein allows its separation from the first or enzymic stage to be made by appropriate choice of temperatures[1]. Thus the first stage can be completed at 0–5° C., and the second afterwards initiated at about 35° C. The coagulation time at the higher temperature, extremely sensitive to variations in alkaline earth ion concentration within a fairly narrow range, can then serve as a measure of such concentrations.

Measurements are made on solutions of the appropriate caseinate, relatively small volumes of which have been brought, by dialysis at 0–5° C., into equilibrium with the solutions to be tested and a suitable range of standards. Solutions tested and standards for comparison should both agree approximately in content of ions of other valencies, the presence of which, particularly of polyvalent anions, influences the alkaline earth ion concentration for coagulation.

Determinations made by this method of the dissociation constants of calcium and barium citrates, $K = [\mathrm{Me}^{++}] \times [\mathrm{Citr.}''']/[\mathrm{Me\ Citr.}']$, at 2° C. and an ionic strength μ 0·03 give the values $0{\cdot}35 \times 10^{-3}$ and $1{\cdot}2 \times 10^{-3}$ respectively, in fair agreement with those obtained by other methods[2,3].

A fuller account of this work with further applications will appear elsewhere.

G. T. PYNE

Dairy Chemistry Department,
University College,
Cork. June 28.

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[1] Berridge, N. J., *Nature*, **149**, 195 (1942).

[2] Hastings, A. B., McLean, F. C., Eichelberger, L., Hall, J. L., and Da Costa, E., *J. Biol. Chem.*, **107**, 351 (1934).

[3] Joseph, N. R., *J. Biol. Chem.*, **164**, 529 (1946).

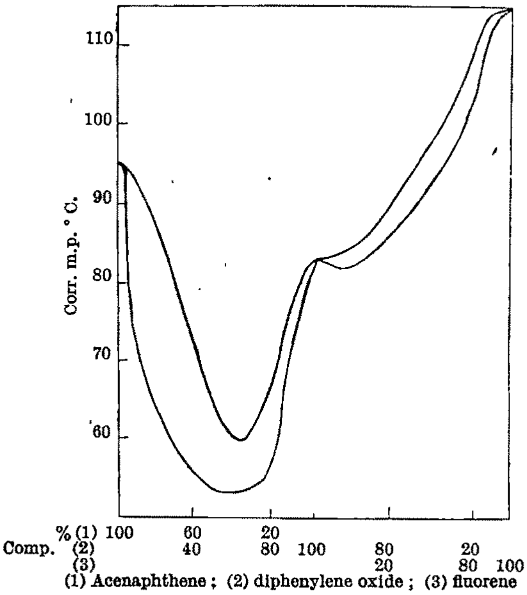
Purity of Diphenylene Oxide (Dibenzofuran)

WE wish to direct attention to the anomalous melting points (82–87° C.) quoted in the literature[1-7] for diphenylene oxide. It is likely that these anomalies are due in part to the mode of formation, and we have examined the particular cases of the isolation of diphenylene oxide (*a*) from coal tar distillates, and (*b*) by the distillation of phenol over litharge[2].

In the latter case, we isolated diphenylene oxide (styphnate, m.p. 139° C.), corresponding to the classical formula $C_{12}H_8O$, of melting point 82·8–83° C. (corr.)—not 87° C. as found by Gallewsky and afterwards by Cullinane. The melting point remained unchanged by further crystallization from alcohol and/or acetic acid, and ultimate analysis gave carbon 85·3 per cent, hydrogen 5·0 per cent.

The isolation of diphenylene oxide from coal tar is closely attended by the lower boiling acenaphthene ($C_{12}H_{10}$, melting point 95° C., boiling point 278° C.) and the higher boiling fluorene ($C_{13}H_{10}$, melting point 114–115° C., boiling point 293° C.). The accompanying graph illustrates equilibrium diagrams, based on pure components, which we have constructed using the thaw-melt method for the systems acenaphthene–diphenylene oxide, diphenylene oxide–fluorene.

It will be noted that diphenylene oxide isolated from coal tar and possessing a melting point lower than 82° C. is probably contaminated with acenaphthene, a higher melting point indicating probable contamination with fluorene.



It is where fluorene is the contaminant that caution is needed in describing the purity of diphenylene oxide, for up to 20 per cent contamination changes the melting point but little from 82·8° C. From the graph, coal tar diphenylene oxide with a melting point of 86° C. would contain about 35 per cent fluorene: this is roughly substantiated by our ultimate analysis of such a sample (carbon, 88·0 per cent; hydrogen, 5·2 per cent), which can be calculated to correspond with a mixture of 7 parts of diphenylene oxide and 3 parts of fluorene.

A. FOWLER WILLIAMS

Powell Duffryn Research Laboratories,
140 Battersea Park Road,
London, S.W.11. June 23.

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[1] Hoffmeister, *Ann.*, **159**, 211 (m.p. 80–81° C.).

[2] Gallewsky, *Ann.*, **264**, 189 (1891) (86–87° C.). (Cullinane, *J. Chem. Soc.*, 2268 (1930) (86–87° C.).)

[3] Graebe and Ullmann, *Ber.*, **29**, 1876 (1896) (80–81° C.).

[4] Cullinane, Morgan and Plummer, *Rec. Trav. Chim.*, **56**, 6 (83° C.).

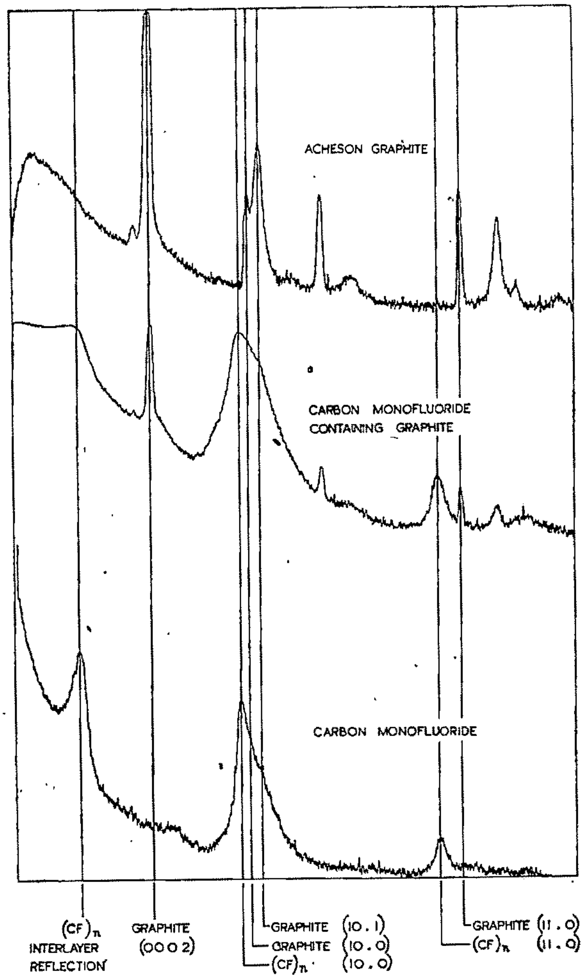
[5] Kruber, D.R.P., 491, 594 (84° C.).

[6] Hale and Stoesser, U.S.P. 1,808,349 (82–83° C.).

[7] "International Critical Tables", 1, 244 (87° C.).

Structure of Carbon Monofluoride

Ruff and Bretschneider[1], in collaboration with Ebert, reported that the X-ray diffraction pattern of carbon monofluoride, $(CF)_n$, had similar (*hk.*0) reflexions to graphite, but that the (000*l*) and other reflexions dependent on the *c* or carbon interlayer spacing were absent. From this they assumed that in carbon monofluoride the graphite structure is retained with expansion perpendicular to the carbon layers and, from a determined density of 2·39, calculated the carbon interlayer spacing to be 8·17 A. They postulated that the fluorine atoms acquire electrons from the carbon rings and that the ions so produced lie in a closely packed structure in six parallel layers between each pair of carbon planes requiring a theoretical carbon interplanar spacing of 8·05 A. Although, such a structure could reasonably account for the low electrical conductivity and explosive decomposition of the compound, it is very doubtful, as pointed out by Bigelow[2], whether such an arrangement would have even limited stability. Bigelow proposed an alternative structure in which the fluorine atoms lie in two parallel planes about each plane of carbon atoms, to which they are linked by polarized covalent bonds. Assuming a normal C—F bond of about 1·4 A., the excessively high spacing of 5·3 A. between the planes of fluorine atoms was explained by electrostatic repulsion resulting from the polarization.



Carbon monofluoride has recently been prepared in this laboratory by the action of fluorine on Acheson graphite at temperatures between 420° and 450° C. The product is grey-fawn in colour, has an analysis of 37·2 per cent C, 61·2 per cent F (theoretical for CF: 38·7 per cent C, 61·3 per cent F) and a maximum density determined by immersion of 2·78 gm. per ml.: this density is considerably greater than that reported by Ruff and Bretschneider. X-ray diffraction photographs of this material are also rather different from those described by Ruff and Bretschneider. Photometric plots of the carbon monofluoride pattern, together with plots of the original Acheson graphite and a sample containing some free graphite for comparison, are shown in the accompanying figure. Carbon monofluoride shows fairly intense low-angle scattering terminated by a broad line (not reported by Ruff and Bretschneider) corresponding to an interplanar spacing of about 6·0 A. In addition, it is seen that the other two strong reflexions with interplanar spacings of 2·23 and 1·30 A. do not coincide with the (10.0) and (11.0) reflexions of graphite, which have spacings of 2·14 and 1·24 A. respectively. The ratio of these two spacings for carbon monofluoride is 1·716 against the theoretical 1·732, that is, $\sqrt{3}$, for $d_{(10.0)}/d_{(11.0)}$ in a hexagonal lattice. It therefore seems probable that the carbon atoms in carbon monofluoride are arranged similarly to those of graphite, with an expansion of the C—C distance and a slight distortion from the true hexagonal arrangement. This hypothesis is supported by the observation of two very weak reflexions with spacings 1·11 and 0·84 A. which can be indexed as (20.0) and (12.0) respectively. The calculated average C—C spacing is 1·49 A., compared with the value of 1·42–1·43 A. for graphite.

With the expanded hexagonal lattice, the corresponding *c* or carbon interlayer spacing calculated from the determined density of 2·78 is 6·3 A.; and it is reasonable to assume that the measured spacing of 6·0 A. corresponds to this dimension in the carbon monofluoride structure, since the above density is likely to be a minimum. The increase of the C—C distance to 1·49 A. suggests the loss of part of the double-bond character of this link, and supports Bigelow's suggestion of the formation of a polarized C—F covalent link. Taking the C—F distance in this bond as about 1·5 A., as against the normal value of 1·43 A., the distance between the fluorine planes would be 3·0 A., which is a reasonable polarized van der Waals' separation. The marked change in the intensity ratio of the (10.0) : (11.0) reflexions from 8 : 10 in graphite to 10 : 1 in carbon monofluoride, and the observation of the (20.0) and (12.0) reflexions, support the probability of a fairly rigid C—F bond in carbon monofluoride; although the actual positions of the fluorine atoms cannot be deduced with any certainty. The absence of general (*hk.l*) reflexions may be caused by a turbostratic arrangement[3] of the carbon/fluorine layer-plane units. This may also account for the falling off at higher reflexion angles, usually associated with cross-lattice reflexions[4], of the (10.0) reflexion; but this is difficult to reconcile with the symmetrical (11.0) reflexion, unless the matter is further complicated by the slight distortion from the true hexagonal lattice.

Calculation of crystallite size from the line broadening shown in the diffraction patterns gives 20–40 A. in a direction perpendicular to the carbon layers and about 50–80 A. in the layers for carbon monofluoride, compared with an approximate 200 A. for the original graphite. This marked decrease in crystallite size is consistent with the reduced van der Waals' forces and the partial utilization of the π-electrons of the graphite structure in the formation of C—F bonds.

Note added in proof. We have since seen a review of the work by Rüdorff and Rüdorff[5], but not their original papers. Our experimental results are essentially similar to theirs, but it is difficult to reconcile their proposed 'hydroaromatic giant molecule' structure with the marked change in reflexion-intensity ratio reported by us.

D. E. Palin
K. D. Wadsworth

General Chemicals Division,
Imperial Chemical Industries, Ltd.,
Widnes Laboratory, Widnes.
May 11.

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[1] *Z. anorg. Allgem. Chem.*, **217**, 1 (1934).

[2] *Chem. Rev.*, **40**, 83 (1947).

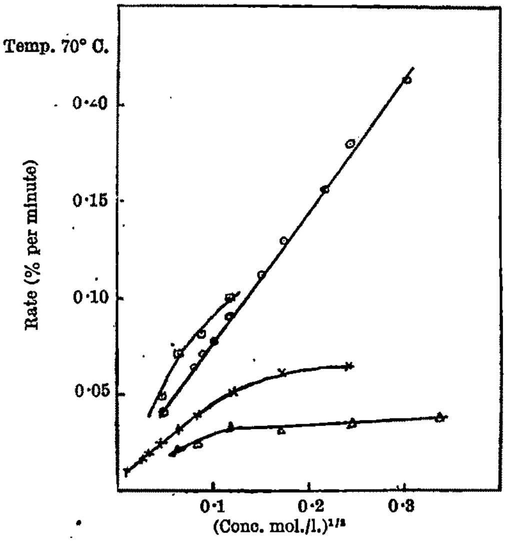
[3] Briscoe and Warren, *J. App. Phys.*, **13**, 364 (1942).

[4] Warren, *Phys. Rev.*, **59**, 693 (1941).

[5] *Wiener Chem. Z.*, **47**, 191 (1944).

Peroxide Catalysed Vinyl Polymerization

In recent months the importance of the reactivity of the free radicals in polymerization systems has been stressed, in particular the ability of a free radical both to initiate and terminate reaction chains[1]. The emphasis, however, has been on the ability of the radical in question to terminate the growing chains[2], and it is the object of the present communication to direct attention to the lowered rate of initiation of growing chains which results from the use of certain catalysts.



⊙—⊙—, Benzoyl peroxide.
△—△—, Di-*m*-nitrobenzoyl peroxide.
×—×—, *m*-Nitrobenzoyl benzoyl peroxide.
□—□—, Di-2,3,4,5-tetrachlorobenzoyl peroxide.

A feature of peroxide catalysed vinyl polymerizations is that the rate of reaction is proportional to the square root of the catalyst concentration. This, however, is true only for catalysts which generate active free radicals, when the catalyst is used over a wide range of concentrations. The results given in the accompanying graph show that in the polymerization of styrene using di-*m*-nitrobenzoyl peroxide, *m*-nitrobenzoyl benzoyl peroxide and di(2,3,4,5-tetrachlorobenzoyl) peroxide this relationship does not hold. Initial rates of reaction were determined, as the rate fell off fairly rapidly with time in the case of these poor catalysts. Benzoyl peroxide gives a good linear agreement. The observed deviation from linearity occurs with catalysts which give radicals of low activity. (It will be shown again that the activity of a radical is related to the distribution of electron density; thus electron repelling substituents increase the reactivity of a radical, and electron attracting substituents lower the reactivity. Mesomeric effects either supplement or reverse the inductive effect, depending on the direction of electron transfer.)

When incorporated in the kinetic scheme:

$$\begin{array}{llll} & C & \xrightarrow{k_i} & R. \\ R. + & M & \xrightarrow{k_p'} & P_1. \\ P_1. + & M & \xrightarrow{k_p} & P_2. \\ P_r. + & M & \xrightarrow{k_p} & P_{r+1}. \\ P_r. + & P_s. & \xrightarrow{k_{t_1}} & M_{r+s} \\ P_r. + & R. & \xrightarrow{k_{t_2}} & M_r \\ R. + & R. & \xrightarrow{k_{t_3}} & R_2 \end{array}$$

application of the stationary state method of analysis used by Melville and others[3] gives, when the three termination coefficients are considered to be equal (k_t) (the terms having their customary significance):

$$\Sigma(P_r.) = \frac{k_p'(M)(R.)}{\sqrt{k_i k_t (c)}},$$

$$(R.) = \frac{k_i(c)}{\{k_p'(M) + \sqrt{k_i k_t (c)}\}}.$$

Thus the reaction-rate:

$$-\frac{dM}{dt} = k_p'(M)(R.) + k_p(M)\Sigma(P_r.)$$

$$= k_p'(M)\sqrt{\frac{k_i(c)}{k_t}}\left\{\frac{k_p(M) + \sqrt{k_i k_t(c)}}{k_p'(M) + \sqrt{k_i k_t(c)}}\right\}$$

This reduces to the usual form for zero-order initiation when $k_p' = k_p$. This expression gives a linear relationship between the reaction-rate and the square root of the catalyst concentration only when the concentrations used are very small or when k_p' and k_p are nearly equal. To suggest, as has been done, that the three termination constants are equal is a great over-simplification since, for definite values of k_p and k_t, at low concentrations of catalyst the rate would be dependent upon $\sqrt{k_i(c)}$, which is probably not true. However, preliminary results from the intrinsic viscosities of the polymers indicate that these fall normally with increase in catalyst concentration, as would be predicted from the above scheme.

Also:

$$\overline{P_n} = \frac{V\,(\text{prop.})}{V\,(\text{init.})} = \frac{(M)\{k_p'(R.) + k_p\Sigma(P_r.)\}}{k_p'(M)(R)}$$

$$= \frac{k_p(M)}{\sqrt{k_i k_t(c)}}.$$

W. Cooper

Chemical Research Division,
Dunlop Rubber Co., Ltd.,
Fort Dunlop,
Erdington,
Birmingham.
July 27.

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[1] Mayo, F. R., and Gregg, R. A., *J. Amer. Chem. Soc.*, **70**, 1284 (1948).

[2] Breitenbach, J. W., and Schneider, H., *Ber.*, **76**, B, 1088 (1943); *Chem. Abs.*, (38), 4914 (1944); also *ibid.*, 2416, 4933.

[3] For example, Gee, G., and Melville, H. W., *Trans. Farad. Soc.*, **40**, 240 (1944).

Red Lead as a Selective Oxidant

Since the fundamental investigations of Dimroth[1], Criegee[2], Malaprade[3] and Fleury[4], lead tetra-acetate and periodic acid as selective oxidants have played an important part in organic chemistry, particularly for the elucidation of the structure of carbohydrates and related compounds and also from the preparative point of view[5]. It has been found now that red lead (Pb_3O_4) in many cases can be used successfully instead of the above-mentioned oxidants either in aqueous acetic acid medium or in organic solvents containing anhydrous acetic acid. It may be supposed that, in the presence of acetic acid, red lead gives rise with a limited velocity to intermediate formation of lead tetra-acetate which, in the presence of a suitable hydrogen donor, will be promptly reduced to lead diacetate. Therefore, the reaction mixture never contains an excess of tetra-acetate. Hence red lead can be more generally used for the oxidation of aqueous solutions than lead tetra-acetate itself, as this rapidly hydrolyses in aqueous medium into uneffective lead dioxide.

For example, as preliminary experiments show, if an aqueous solution of 1 mol. of 1 : 2-propylene glycol is shaken or stirred with a mixture of 1 mol. of red lead and 8 mol. of acetic acid (initial acetic acid concentration 20–25 per cent) at room temperature, the red lead completely disappears within two to three hours and the propylene glycol yields, without formation of lead dioxide, 1 mol. of formaldehyde and 1 mol. of acetaldehyde respectively. One mol. of mandelic acid reacts with 1 mol. of red lead, yielding quantitatively benzaldehyde and carbon dioxide. 1 : 3, 2 : 4-Diethylidene sorbitol yields an aqueous solution of formaldehyde and 2 : 4, 3 : 6-diethylidene *l*-xylose, from which after acid hydrolysis crystalline *l*-xylose was obtained. Under the same conditions glycerol, sorbitol, mannitol, tartaric acid, lactose and sucrose were also smoothly oxidized without formation of lead dioxide. The oxidation of 1 : 2-propylene glycol and mandelic acid, respectively, by red lead in a chloroform solution in the presence of anhydrous acetic acid gave the same result as was obtained in aqueous medium.

On the other hand, ethylene glycol, α-methyl glucoside, diamino-ethane and alanine were not oxidized in appreciable amount in aqueous acetic acid medium. In these cases the red lead changed almost quantitatively within one to two hours into lead dioxide and lead diacetate.

Further studies on the selective oxidative effect of red lead are in progress; the results will be published later elsewhere.

L. VARGHA

Institute of Organic Chemistry,
"Bolyai" Hungarian University,
Cluj-Kolozsvár.

June 17.

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Phosphorylase in Plastids

IN a previous paper[1], a method has been described for the detection of the enzyme phosphorylase in plant tissues. Briefly, it consists of incubating free-hand sections of the tissue, previously freed of starch by starvation, in a buffered solution of glucose-1-phosphate, and subsequent staining in iodine–potassium iodide for the resultant starch. With this method a survey has been made of the distribution of phosphorylase in the tissues of many higher[1,2] and lower[3] plants. An interesting outcome of these observations is the finding that the enzyme is localized solely in the plastids. The evidence may be summarized as follows.

In the leaves of higher plants (*Verbena*, tobacco, squash, potato, corn, soybean, broad bean, castor bean) the enzyme activity is chiefly confined to the mesophyll and the guard cells. In these cells the activity is further limited to the chloroplasts. No reaction is ever found in the nucleus or the general cytoplasm. Each chloroplast may contain one or several loci of activity, which after prolonged incubation fuse to form a large starch grain. Thus the localization of the enzyme corresponds well with the site of normal starch synthesis as observed by Strasburger[4] and Zirkle[5].

Similarly, in the green algæ (*Spirogyra, Zygnema, Cosmaria*) phosphorylase activity is localized in the chloroplasts. It bears no observable relation with the pyrenoids, and is more or less evenly distributed in the plastids. Longer incubation often results in plasmolysis and appearance of fine starch granules outside the protoplast due, perhaps, to injury and leakage.

In plant parts which contain plastids coloured other than green, for example, the petals of nasturtium and the fruit of tomato, the enzyme is again only found in the chromoplasts.

Meristematic cells and cells not fully differentiated generally contain colourless plastids which may turn green later on. It is in these leucoplasts that phosphorylase activity resides, as proved in the embryos and seedlings of soybean, broad bean, potato, corn, etc. Each leucoplast may contain several centres of activity. Long incubation results in filling up the whole cells with starch, and some evidence of plasmolysis. In some cases (soybean) minute starch-like particles can be seen in the cytoplasm. They may have come from broken plastids or are masked original reserve[2], since they also appear in boiled sections and without incubation with glucose-1-phosphate. Sections of these tissues have also been made with the paraffin method and stained to bring out the cytoplasmic components. Again the enzyme activity is traceable to the leucoplasts, and no relation can be established with mitochondria or other cytoplasmic constituents[2].

In plants without visible plastids, for example, the blue-green alga *Oscillatoria* and the fungus *Rhizopus*, phosphorylase activity is found dispersed in the cytoplasm and gives rise to finely divided granules of starch or glycogen[3]. Long incubation results in whole sections of cells stained with iodine. Whether these loci of activity bear any relation to specific cytoplasmic entities remains to be investigated.

The only exception to the phosphorylase-plastid coincidence so far is found in the case of the red algæ. In *Batrachospermum*, reddish-brown staining polysaccharide formed from glucose-1-phosphate appears not in the chromatophores but scattered in the general cytoplasm[3]. It is interesting to note here that, in normal growth, the reserve polysaccharide of these algæ has long been known to be separate from the chromatophores[4]. Hypotheses have been advanced as to the origin of these particles of 'Floridean starch'. They are supposed either to have originated in the cytoplasm itself or grown out of the plastids. Our result supports the first contention, since the responsible enzyme phosphorylase is shown to be outside the plastids.

It may be added here that phosphorylase activity is not normally detectable in plant parts which form no starch. Examples are found in the shoot of onion and the petals of a number of flowers. Plants normally poor in the polysaccharide, for example, castor bean, are also low in phosphorylase activity[1]. In germinating seeds the number of starch grains finally formed in a cell is always smaller than the detectable loci of phosphorylase activity[2].

Summing up, we may say that phosphorylase in plants is localized in the plastids. No activity has been found in the nucleus and, except in the blue-green and red algæ and in fungi, in the cytoplasm.

The result lends support to the statement of Schimper and of Meyer[4] that starch is always formed in the plastids. It confirms also the anticipation of Hanes[6] that starch formation in the plastid (for that matter also outside the plastid, cf. *Batrachospermum*) is due to the phosphorylase mechanism.

H. C. YIN

Botany Department,
National Peking University,
Peiping.

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Vestibular Effect of Streptomycin in the Mouse

UP to the present, experimental methods have yielded very little information concerning vestibular toxicity due to streptomycin; in medical practice these accidents are very frequent (80–90 per cent of cases treated). Indeed, the fundamental work of Molitor and his collaborators leads to the conclusion that most of the animals used in laboratory work show no recognizable vestibular disturbance, whether as the result of a single heavy dose of streptomycin or of several fractional doses administered over a period of time. According to Molitor[1], dogs are the only animals which show any evidence of cerebellar or vestibular damage comparable to that which has been observed in human beings, whereas mice, frogs, rats and guinea pigs are unaffected. Although Molitor kept under observation a considerable number of animals, we believe that his conclusions should not be accepted as final.

Our researches involved: (1) developing procedures which would enable us to study the vestibular function in the mouse; (2) the development of a suitable technique of labyrinthectomy for these animals, and a study of the phenomena which follow upon this operation, whether unilateral or bilateral; (3) the study of the reactions of a mouse upon receiving a single heavy dose of streptomycin or fractional doses over a period of time. By proceeding on these lines, we have been able to demonstrate a vestibular toxicity of streptomycin in the mouse, moderate in the case of acute intoxication, clear in the case of chronic intoxication[3]. When a heavy dose is administered, the response to the rotation test is in the nature of hyper-excitability. In chronic intoxication (30 mgm. in two daily doses), after about a week, a syndrome appeared which was progressively accentuated, and reproduced, in a lesser and variable degree, the effects of destruction of the labyrinth on both sides, namely, agitation, violent movements of the head in a vertical plane, absence of reaction to rotation, circling or waltzing, total loss of equilibrium and inevitable drowning in the swimming test.

In the mouse, then, the vestibular apparatus is remarkably sensitive to the action of streptomycin, a circumstance highly favourable for the study of this action, which at present is still very obscure.

Streptomycin is one of the two substances which are known to have specific toxic properties on the vestibular apparatus, the other being arsacetin, as Ehrlich[4] discovered when he described the 'artificial' dancing mouse. There appear to be no other compounds which, in the same conditions, display such a property.

R. CAUSSÉ
I. GONDET
B. VALLANCIEN

Laboratoire d'Otologie Expérimentale,
École Pratique des Hautes Études,
Paris.
June 18.

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Permeability of Muscle Cells

SINCE the advent of artificial radioactive elements, a considerable amount of work on the exchange of labelled ions or molecules against unlabelled ones of the same chemical nature has been carried out on biological material. Krogh has reviewed[1] a number of applications of the technique to exchanges between living cells and their surroundings, and Ussing[2] reports results obtained for the exchange of sodium between isolated muscle and Ringer solution. The remarks made by A. V. Hill[3] concerning measurements of so-called permeability of tissues appear to have been overlooked. He emphasized that diffusion might play the most important part in determining the rate of transfer of dissolved substances from lymph to tissue, even when the size of the tissue is only that of, say, a frog sartorius muscle. It appears, therefore, necessary when attempting to study cell-wall permeability either to use single cells, or to make allowance for the effect of diffusion being the means by which the extra-cellular fluid comes into eventual equilibrium with the fluid surrounding the assembly of cells. Experiments made *in vivo* will be less affected by the retarding influence of diffusion than will those made *in vitro*. This is because in the former case the blood-flow through the capillaries brings the substance being investigated into the interior of the tissue.

We have been making measurements of the rates of exchange of sodium and potassium between isolated frog sartorii and the surrounding medium. Equations describing the time-course of the combined permeation-diffusion process have been obtained. These allow the calculation of the apparent diffusion constant of sodium in the extra-cellular space of the muscle, and of the permeability to sodium and potassium. The apparent diffusion constant for sodium is $2{\cdot}0 \times 10^{-6}$ cm.^{2}/sec., which is a third of the value in free solution; this would correspond to the ion having to traverse a path $\sqrt{3}$ times the measured distance between outside and centre, which is not far from that expected if it has to pass round a series of cylinders. The permeability constant has to be defined, as there is no generally accepted formulation. For a cell in which the total concentration of the ion in question is static (that is, irrespective of whether the ions are labelled or not), the amount of ion entering per unit time equals the amount being lost, and we can write

$$P_oM_o = P_iM_i$$

for the equilibrium of total M, and

$$\frac{V}{S} \cdot \frac{dM_i^*}{dt} = P_oM_o^* - P_iM_i^*$$

for the rate of change of internal M^*, where V is cell volume, S is cell surface, and the suffixes i and o distinguish internal and external concentrations of the ion M, and an asterisk denotes labelled M. The P's are the two permeability constants.

Krogh[1] discussed P_i; but Conway[4] pointed out that P_o is the figure which measures the amount of M entering the cell per unit time and area, when the external concentration of M is unity. As the concentration can be measured in arbitrary units per unit volume, the result is that P_o expresses the amount entering the cell in terms of the quantity of M per unit volume in the solution; and if P_o is a true constant, the quantity entering the cell per unit time and area will be linearly related to the concentration of M in the external solution. We have found that this is the case in the physiological range of potassium and sodium concentrations, and P_o for sodium is about 0·0004 cm. hr.$^{-1}$ and for potassium about 0·0038 cm. hr.$^{-1}$.

A full description of the methods and results will appear later.

E. J. HARRIS
G. P. BURN

Biophysics Unit,
University College,
London, W.C.1.
July 19.

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In vitro Effect of Penicillin on Prothrombin Activity of Bovine Plasma

Moldavsky, Hasselbrock and Caterno[1,2] have recently reported that both oral and intramuscular injections of penicillin consistently shorten the coagulation time of normal blood and produce a non-retractile clot. They also observed decreased bleeding-times in patients receiving penicillin. J. H. Lewis[3] investigated more thoroughly the effect of penicillin on blood coagulation in both normal and hæmophiliac subjects. *In vitro* tests indicated that oral and intramuscular administration of penicillin did not have any effect on the blood-coagulating mechanism in either, in spite of high plasma penicillin levels. His *in vitro* tests to determine the effect of penicillin at various concentrations on the coagulation time of normal and hæmophiliac blood showed no change on the coagulation time.

In view of the contradictory nature of such results and the clinical application of Moldavsky, Hasselbrock and Caterno's[1] finding ("the possible use of penicillin as a hæmostat and the danger of intramuscular clotting"), the influence of penicillin on prothrombin activity was investigated.

In vitro experiments conducted in this laboratory have shown that penicillin at a concentration of 3,400 units and more increases the prothrombin time of bovine blood plasma, while concentrations lower than this appear to decrease the prothrombin time. The effect of penicillin at lower concentrations is not, however, very significant. Further work is in progress. The result of a typical experiment is given in the accompanying table.

Incubation at 37° C. for 2 hours

Final concentration of penicillin (Oxford units) in the total volume of the mixture (1·4 c.c.) containing 0·4 c.c. of bovine plasma	Prothrombin time (in sec.) of 0·5 c.c. of resultant mixture
19,500	120
10,200	70
3,400	42
1,700	34
425	30
106	30
Control 0·4 c.c. plasma plus 1·0 c.c. distilled water	37

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I. M. CHAK
Department of Biochemistry,
J. F. PEREIRA
Department of Fermentation Technology,
K. V. GIRI
Department of Biochemistry,
Indian Institute of Science,
Bangalore.
June 18.

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Symbiotic Micro-organisms of Aphids and Fixation of Atmospheric Nitrogen

MANY insects have associated with them specific micro-organisms, often present in special organs, which are passed on from generation to generation. Their function is in most cases unknown. In many instances where it has been possible to rear sterile insects lacking their symbionts, these have been stunted in growth and deformed, in other cases such insects have been found to develop in an apparently perfectly normal manner[1]. Fraenkel and Blewett[2] have shown that the poor growth of sterile larvæ of certain beetles, without their usual symbionts, may be restored to normal by the addition of certain factors of the vitamin B complex. In this case the role of the symbionts appears to be to provide the insect with these substances. It has been suggested from time to time, and more recently by Toth, that the symbionts are in many cases capable of assimilating gaseous nitrogen from the atmosphere. In his monograph[3], Toth concludes that a large number of insect species, including aphids, are able to fix nitrogen with the aid of their symbionts.

The direct experimental evidence for this conclusion rests on what is called 'the surviving system technique'. In this technique, aphids are ground up in a nutrient solution containing glucose and oxaloacetate, incubated at a suitable temperature and pH, and the increase in nitrogen content of the system (assumed to be due to fixation by the symbionts) measured by micro-Kjeldahl analysis. Following Toth's procedure exactly, I have measured the changes in total nitrogen content of such 'surviving systems' produced by grinding young individuals from actively multiplying colonies of either *Myzus persicæ* or *Doralis fabæ* in a nutrient medium ($MgSO_4$, 1 gm.; Na_2CO_3, 1 gm.; glucose, 5 gm.; oxaloacetic acid, 1·3 gm.; $CaCO_3$, 2 gm.; in $M/20$ phosphate buffer, pH 7, to 1 litre). These cultures were incubated, with shaking, either at 15° C. or 24° C. In all cases no increase in nitrogen content was observed—occasionally nitrogen was lost. Such cultures are by no means sterile, and the nitrogen gains observed by Toth might equally well be ascribed either to the symbionts or to contaminant micro-organisms.

A further series of experiments was carried out in which young feeding colonies of *Myzus persicæ* or *Doralis fabæ* were left in an atmosphere of oxygen and nitrogen containing 31·5 per cent of the stable isotope nitrogen-15. After 20–64 hr. the insect material, together with leaf material controls, was assayed for nitrogen-15. No uptake of nitrogen-15 by the insects could be detected. An uptake of nitrogen gas equal to 0·03 per cent of the total nitrogen content of the insects would easily have been observed. It is apparent that the aphids used in these experiments showed no trace of nitrogen-fixing activity.

The question remains whether, in view of their high rate of proliferation, aphids can obtain enough nitrogenous foods from the plant to balance their nitrogen economy. After considering the ratios of protein to carbohydrate in aphid food and excreta, Toth[3] considers this is not possible. He quotes the following figures of the composition of the solid material taken in and of that excreted.

	Protein (per cent)	Carbohydrate (per cent)
Food	1–2–(5)	90
Excreta	3·5	93

However, if Maskell and Mason's[4] figures for the amounts of nitrogen and carbohydrate in the sieve tubes of cotton plants are representative, the amount of nitrogen taken in must be much higher. They found such sieve tubes to contain 1 gm. nitrogen/100 ml. water and 5·95 gm. carbohydrate/100 ml. (ratio $\frac{\text{total nitrogen}}{\text{carbohydrate}} = 16 \cdot 8$ per cent). Furthermore, to compute the nitrogen balance of the insects, it is also necessary to know their rates of feeding and of proliferation. By following the increase in weight of single aphids (*Myzus persicæ*), Lea, Markham and K. M. Smith (unpublished) found the rate of uptake of food by a single aphid feeding on tobacco leaves to vary between 9 μgm. and 35 μgm./hr., with a mean of 25. Assuming the density of the food solution to be 1, and using the data of Maskell and Mason, it is seen (taking the mean rate of food uptake) that this corresponds to an uptake of combined nitrogen from the phloem of at least 0·25 μgm./hr. The total nitrogen content of an aphid is about 14·5 μgm. These aphids would thus double their nitrogen content in 58 hr. They were producing few offspring, and this doubling period falls well within the wide variability in rates of aphid multiplication. (Nitrogen lost by excretion has been neglected in this calculation, as it would appear to be negligible compared with that taken in.) It is interesting to note here that more than a hundred years ago Boussingault[5], from measurements of nitrogen contents of food and excreta of a cow, a horse and a turtle-dove, concluded that these animals do not fix nitrogen.

Finally, the mere fact that Peklo[6], from a study of the morphology of the symbiotic micro-organisms of aphids, places these in the *Azotobacter* group, gives no direct evidence that they are capable of fixing nitrogen.

From the above experiments the conclusion must be drawn that aphids do not take up nitrogen from the air. I wish to thank Dr. A. S. McFarlane for supplying the nitrogen-15, and Dr. Bentley, of the National Institute for Medical Research, for carrying out the nitrogen-15 assays.

J. D. SMITH

Molteno Institute,
University of Cambridge.
Oct. 12.

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Activation of Unfertilized Sea Urchin Eggs by Trypsin

PREVIOUS workers[1,2] have reported that commercial trypsin, crystalline trypsin and chymotrypsin are all able to activate the nuclei of unfertilized sea urchin eggs. The elevation of fertilization membranes has also been reported after treatment with low concentrations of crystalline trypsin[1]. In unfertilized *Pomatoceros* eggs, crystalline trypsin and chymotrypsin cause the formation of typical fertilization cones, but do not activate the nuclei[3].

As it is of interest to know to what extent the cytoplasm and the surface of the egg are involved in the parthenogenetic activation of sea urchin eggs by proteolytic enzymes, a reinvestigation of the whole subject has been undertaken, and a preliminary account of the results is given below.

The experiments described have been carried out on the eggs of *Psammechinus microtuberculatus* (Blv.). A 0·5 per cent solution of undialysed commercial trypsin (Kahlbaum) at pH 7·8–8·0 produced nuclear changes in 50–100 per cent of these eggs after two to four hours. The extent to which the nuclei were activated showed some variation, due, no doubt, to variations in the maturity of the eggs, taken from various females. The effect of the trypsin on the nuclei was to make them become enlarged but still with a distinct nuclear membrane. In some eggs this was followed by disintegration of the nuclear membranes and monaster formation. Within this space of time nuclear division rarely took place. After 5–8 hours irregular cleavage occurred in up to 60 per cent of the eggs.

When placed in hypertonic salt solution (0·6 c.c. of 2·5 *N* sodium chloride to 2 c.c. of egg suspension) the trypsin-treated eggs containing activated nuclei became spherical with smooth surfaces, as occurs in freshly fertilized eggs after similar treatment and in contrast to the wrinkled surfaces of unfertilized and unactivated eggs. This must indicate changes in the cortical layers of the eggs[4,5]. Angular plasmolysis, the characteristic response of older fertilized eggs to this treatment, did not occur.

After 4–6 hours there was found on the surface of trypsin-treated eggs a thin layer, presumably of extruded cortical material. During normal fertilization, cortical material is extruded and participates in the formation of the fertilization membrane (cf. ref. 2). The layer of extruded material may indicate a slight activation of the egg surface in the direction of the formation of a fertilization membrane; but a fertilization membrane cannot be formed as the vitelline membrane, which forms the basis of the fertilization membrane, is digested by trypsin of this strength[6].

The hyaline layer, which is differentiated after normal fertilization, is broken down rapidly in trypsin solution, and when fertilization occurs in the presence of trypsin the hyaline layer is not formed[6]. It is unlikely, therefore, that the layer of extruded material has any affinities with the hyaline layer.

Experiments with crystalline trypsin and chymotrypsin gave no activation of the nuclei or of the surfaces of the *Psammechinus* eggs, and thus the results of previous workers have not been confirmed, at least in respect to this species.

The results with commercial trypsin show that activation is more comprehensive than was formerly thought, the activation involving the surface of the eggs as well as the nucleus. The destruction of the surface layers of the egg by the trypsin prevents, however, the possible expression of the surface phenomena associated with normal fertilization.

The negative results with crystalline trypsin and chymotrypsin indicate that the activating substance in commercial trypsin may be neither trypsin nor chymotrypsin, as was formerly supposed.

AAGE BOHUS JENSEN

Zoological Station,
Naples.
June 24.

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Soil Phosphate Uptake as Influenced by Phosphatic Fertilizer

PERENNIAL rye-grass was sown in small pots (12 cm. in diameter) on August 3, and harvested on October 22, 1947. Seven plants per pot were grown, and six replicate pots per treatment were provided. Two top soils from North Auckland Province, both very poor in available phosphate, were used. The Maunu loam derived from basalt is akin to a lateritic type; the Wharekohe silt loam, derived from an early tertiary claystone, is a mature podsol. They are classified respectively as "immature red brown loam" and "strongly podsolized yellow earth" by the New Zealand Soil Survey. Primary calcium phosphate labelled with radioactive phosphorus was used as fertilizer in amounts equivalent to 100 mgm. P_2O_5 per pot, this being roughly equal to a rate of 100 kgm. P_2O_5 per hectare, calculated on an area basis. Dry-matter yields, total phosphorus and radioactivity were determined in the harvested plants.

The accompanying table gives some of the results obtained, the figures referring to sums of six replicates (pots). A full account will be published elsewhere.

	Maunu loam		Wharekohe silt loam	
1 per cent citric acid soluble P_2O_5 per cent	0·009		0·001	
P_2O_5 added (mgm.)	0	600	0	600
Yields (tops and roots) in gm.	0·61	8·56	0·84	13·24
P_2O_5 taken up by plants (mgm.)				
From fertilizer	0	37·2	0	95·5
From soil	1·1	3·3	1·65	14·5
Total	1·1	40·5	1·65	110·0

Thus plants that received the phosphatic fertilizer took up three to eight times as much P_2O_5 from the original soil phosphate as the controls.

This experiment was finished when there came to hand a paper by Spinks and Barber[1], who, using a radioactive tracer technique, obtained similar results with wheat. The occurrence of this phenomenon can thus be accepted as well established.

To my knowledge, the first hint that phosphate fertilizer might in some circumstances stimulate the uptake of phosphorus from the soil came from Leopold Zaleski[2] (the paper appeared probably in the twenties, but unfortunately at the moment I am not able to give a more exact reference). In his experiments small doses of superphosphate placed beneath oat seeds increased the phosphorus uptake by more than the amount of phosphorus contained in these small doses, thus giving an apparent rerecovery or utilization of more than 100 per cent. Without a tracer technique, however, it would not have been possible to prove a stimulating effect of this kind in conditions less definite than those of Zaleski's experiment.

K. STRZEMIEŃSKI

Soil Bureau,
Department of Scientific and Industrial Research,
Wellington, New Zealand.
June 15.

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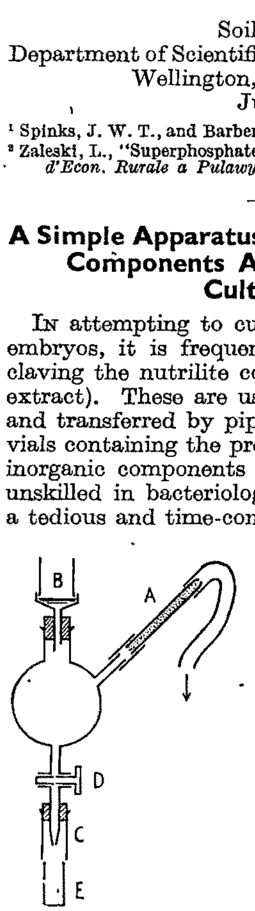
A Simple Apparatus for Adding Seitz-Filtered Components Aseptically to Embryo Culture Media

IN attempting to culture excised immature plant embryos, it is frequently desirable to avoid autoclaving the nutrilite components (for example, malt extract). These are usually Seitz-filtered separately and transferred by pipette to the individual culture vials containing the previously autoclaved sugar and inorganic components of the medium. To workers unskilled in bacteriological methods, this represents a tedious and time-consuming operation.



(*A*) Bacterial trap; (*B*) Seitz filter; (*C*) glass shield; (*D*) stop-cock; (*E*) culture vial

The apparatus illustrated is simpler to handle and satisfactorily avoids contamination. Essentially it consists of a separatory type funnel with side vent to which can be attached a simple bacterial trap *A*, namely, a glass tube with one end partially closed, filled with loosely packed cotton-wool. The apparatus is autoclaved before use, the apertures at *B* and *C* being plugged with cotton-wool, and the stop-cock *D* closed. During filtration, suction is applied through *A*, the partially sealed orifice preventing withdrawal of the contents of the trap. After filtration, the shield *C* is unplugged and the requisite number of drops (previously calibrated) added to the culture vials through the stop-cock *D*. The diameter of the shield should be slightly greater than the diameter of the culture vials *E*, which can then be inserted as illustrated while the filtrate is added. The bacterial trap *A* allows air to pass into the apparatus without contaminating the filtrate as the latter is withdrawn.

S. G. STEPHENS

Department of Agronomy,
Texas Agricultural Experiment Station,
College Station, Texas.
July 6.

Correlation Between Lewis Blood Group and Secretor Character in Man

A NEW blood group character, designated as 'Lewis', was first described by Mourant[1], who found that the blood of 25 per cent of English people contained the Lewis factor, and that this group character is independent serologically of the *ABO*, *MN*, *Rh*, *P*, Lutheran and Kell systems. Somewhat later, Andresen[2] described 'anti-L sera' which are now known to be anti-Lewis sera. These sera agglutinated the red cells of 21 per cent of adult Danes and the cells of about 70 per cent of Danish children less than seven months old. Andresen put forward the view that the Lewis blood group was inherited by means of two allelomorphic genes L and l, the three possible genotypes being LL, Ll and ll. The data observed indicated that anti-Lewis serum agglutinates the red cells of adults if they are of genotype LL only, whereas in young children the genotype Ll is also detectable.

I have observed that the Lewis blood group character is intimately correlated with the secretor–non-secretor status within the *ABO* classification, Lewis-positive adult persons being non-secretors. This statement is based on the results obtained in the determination of the secretor type of twenty Lewis-positive and forty-two Lewis-negative persons. The twenty Lewis-positive persons were all non-secretors. Of the Lewis-negatives, forty-one were secretors and one (group A_1) was a non-secretor. On the basis of probability, it would appear that this result cannot be attributed to chance. In this sample the proportion of non-secretors is somewhat in excess of that found in the general population; there has, indeed, been a deliberate selection of Lewis-positive persons.

The classification of persons as secretors or non-secretors for the *A*, *B* and the so-called *O* factors was made by agglutination inhibition tests, using freshly collected and boiled saliva as inhibiting agent. The salivas from persons of group *A* (6 Lewis-positive, 19 Lewis-negative), *B* (1 Lewis-positive, 2 Lewis-negative) and *AB* (1 Lewis-positive, 2 Lewis-negative) were tested for inhibition of α- and β-agglutinins respectively. The salivas from persons of group *O* (12 Lewis-positive and 19 Lewis-negative) were examined with the following 'anti-*O*-sera': (1) Serum from a rabbit immunized with blood group substance obtained and purified from ovarian cysts of secretors of group *O*[3]. (2) A selected specimen of serum from the eel *Anguilla vulgaris*[4,5]. (3) Serum from a chicken immunized with suspensions of *Shigella Shigœ*[5]. Group *O* erythrocytes believed to represent the genotypes LL, Ll and ll of Andresen were agglutinated to the same titre by these sera.

Preliminary observations show that the salivas of Lewis-positive persons (non-secretors of the *A*, *B* and *H* substances) may inhibit the action of a strongly agglutinating dose of anti-Lewis serum at a dilution of 1 : 100 or more. The salivas of most Lewis-negative persons, possibly heterozygotes, show some power of inhibiting the action of Lewis agglutinins. Other salivas from Lewis-negative persons do not neutralize anti-Lewis serum.

Witebsky and Klendshoj[6] observed that the water-soluble substances in the secretions of those persons, classified as non-secretors owing to their inability to secrete the *A*, *B* or '*O*' (now called *H*)[7] substances, were nevertheless similar in general chemical properties to the *A*, *B* and *O* substances. A mucoid material possessing chemical characters common to the group substances and isolated from pseudomucinous ovarian cyst fluids obtained from secretors and non-secretors has been examined. The material inhibits completely and at high dilutions the action of two to three strongly agglutinating doses of anti-Lewis serum on Lewis-positive *O* cells[8]. Investigations in this field are being continued.

I wish to convey my sincere thanks to Dr. W. T. J. Morgan, Dr. R. R. Race, Miss Ruth Sanger and Dr. A. E. Mourant for their valuable advice and help.

R. GRUBB*

Lister Institute, London, S.W.1.

Oct. 29.

* Address: Department of Bacteriology, University, Lund, Sweden.

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Equations of Piezoelectricity

RECENTLY, Dr. Richard K. Cook[1] has criticized as errors certain equations in my book[2] in which mixed units occur. In particular, he points to my Eq. (1), which expresses the energy stored in a crystal upon which an arbitrary mechanical strain and an arbitrary electric field are impressed. His assertion that "the reader is therefore obliged to examine closely the origin of the formulæ he uses" would be more convincing if he had cited instances in which an incorrect conclusion has been drawn from Eq. (1). This equation is:

$$\xi = \tfrac{1}{2}\sum_{h}^{6}\sum_{i}^{6} c_{hi}S_hS_i + \tfrac{1}{2}\sum_{k}^{3}\sum_{m}^{3} \eta''_{km}E_kE_m + \sum_{m}^{3}\sum_{h}^{6} e_{mh}E_mS_h + \tfrac{1}{2}\frac{J\rho C\theta^2}{T} + \theta\sum_{h}^{6} q_hS_h + \theta\sum_{m}^{3} p_mE_m,$$

where the *c*'s are elastic constants at constant field, the *S*'s are strain-components, η'' is the dielectric susceptibility of the clamped crystal, *E* the field-strength, *e* a piezo-electric stress-constant, *J* is the mechanical equivalent of heat in ergs per calorie, ρ is the density, *C* the specific heat in cal.gm.$^{-1}$ deg.$^{-1}$, *T* the absolute temperature, $\theta = \Delta T$ is a small change in temperature, *q* is a thermo-elastic constant, and *p* a pyro-electric constant.

Dr. Cook's objection is to the use, in the same equation, of the co-ordinate *S* along with *E*, which may be regarded as a generalized force.

It should be recalled that mixed units occur in some of the classical equations in thermodynamics. In piezo-electric theory, following the method of thermodynamics, they were used by Voigt, for example, on p. 816 of his "Lehrbuch der Kristallphysik"; they occur in the treatment of electro-elastic phenomena by Born, and in such handbooks as that of Geiger and Scheel and the "Encyclopädie der mathematischen Wissenschaften". There is therefore nothing novel in the use of mixed units in certain energy equations. It is true that in interpreting the derivatives of my Eq. (1) it is necessary —as was also the case with Voigt—to distinguish carefully between internal and externally impressed stresses; the same may be said of my Eqs. (243) and (243*a*). Equations (1), (243) and (243*a*), although thermodynamically correct, are not such that their derivatives lead immediately to the desired results. Nevertheless, the relations between mechanical and electrical quantities, in the commonly accepted form of coupling equations with stresses applied externally, are obtained by appropriate treatment of these derivatives, as may be seen by inspection of my Eqs. (186), (246), (248*a*) and (250).

On page 246 of my book are four equations analogous to the expressions for the internal energy U, the Helmholtz function A, the Gibbs function G, and the enthalpy H. Although the analogies are not exact, the equations were formulated as leading to the defining expressions for the piezo-electric coefficients.

More recently, I have undertaken the formulation of a set of equations in the form of exact differentials, such that, when integrated, the partial differentials lead directly to expressions for the coupling between thermal, mechanical and electrical quantities. It turns out that this can be done very simply by adding to the thermal and mechanical terms in the dU, dH, dA and dG functions, further terms expressing the electrical contribution to the energy. In the equations below, the field-strength E and polarization P are treated as generalized force and co-ordinate, respectively. Absolute temperature and entropy are denoted by Θ and σ, while the stress and strain matrices are denoted by T and S. With solids, $-T$ and S replace the pressure p and volume v that are used in the case of gases or vapours; here each component of T is considered as positive when it tends to produce a positive component of S. The equations are:

$$\begin{aligned} dU &= \Theta d\sigma + TdS + EdP \\ dH &= \Theta d\sigma - SdT + EdP \\ dA &= -\sigma d\Theta + TdS - PdE \\ dG &= -\sigma d\Theta - SdT - PdE \end{aligned}$$

From Maxwell's relations, and assuming (over a limited range) known linear relations between Θ and σ, between T and S, and between E and P, one can integrate and find equations for U, H, A and G. (The extension of the thermodynamic equations to include electrical parameters was developed independently by Prof. K. S. Van Dyke and discussed by him in "A Manual of Piezoelectric Data", Fifth Semi-Annual Report to U.S. Army Signal Corps, Part II, under Contract No. W28–003 sc–1556 with Wesleyan University, January 20, 1948. I am indebted to him, and also to Dr. J. S. Mendousse, for helpful suggestions.) The partial derivatives of these equations yield at once the usual equations for coupling, in which the externally applied stress and the actual field in the crystal are given directly. These coupling equations may be regarded as *equations of state*. The equation for dG leads to Eq. (2) in my book. The equations for dA, dU and dH lead, respectively, to modifications of my Eqs. (1), (243) and (243*a*).

It is easily shown that dA as expressed above is related to $d\xi$, as obtained from my Eq. (1), as follows:

$$d\xi = -dA + 2c^{E}SdS.$$

The fact that in using Eq. (1) a discrimination had to be made between internal and external piezoelectric stresses may be said to be due to the presence of the term $2c^{E}SdS$. If I had written Eq. (1) with the sign of the first term reversed, $d\xi$ would have been the same as $-dA$ and all stresses in the derivatives would have been external.

Equations similar to the foregoing may also be written, in which the polarization P is replaced by the displacement D.

WALTER G. CADY

Wesleyan University,
Middletown, Conn.
Sept. 2.

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Pulsating Stars and Nuclear Energy

THE explosion in an 'atom bomb' occurs when two masses of uranium-235, each too small to retain sufficient neutrons to start a chain reaction, are brought into juxtaposition within a certain critical volume. A similar state of affairs will account for the phenomena of pulsating stars, but with this difference, that whereas in terrestrial experiments the reacting material is dissipated by the force of the explosion, in the interior of a star those heavy nuclei which have escaped fission during the course of one explosion are reconcentrated by gravitational attraction and are available as a neutron source, or for fission, a few days later.

The data necessary for mathematical investigation have not yet been fully released, but it may be assumed that heavy nuclei will gravitate toward the centre of a star when convection currents and other types of instability have subsided. With the immeasurably larger quantities of available matter as compared with terrestrial standards, the critical conditions of explosion will be quite different. Instead of a few grams or kilograms of highly concentrated fissile material brought together into a critical volume measured in cubic centimetres, it is possible that neutron generation will exceed dissipation when the necessary minimum number of tons is concentrated into a space of thousands or millions of cubic kilometres. If the pressure of radiation engendered by nuclear fission is great enough to overcome the structural forces in the star, it will reach the surface and carry away with it a halo of gaseous material, and this is clearly seen in the case of a nova. If, however, the gravitational field and the opacity of the star are sufficient to withstand the pressure, the greater part of the explosion will be kept within the bounds of the star, and after a period of expansion and increased luminosity the star will collapse under its gravitational field, until the reactive materials have again been brought together in sufficient concentration to start another cycle.

Although mathematical proof is not yet available, this suggestion will account in general terms for the successive phases in the cycle of the Cepheid variables —the rapid expansion with little change of surface brightness, due to a wave of compression from within; the slower collapse under gravitational force, showing irregularities due to secondary waves; the quantitative relation between absolute magnitude and period; and the almost limitless supply of energy. In the case of supernovæ, quantitative considerations of the energy radiated support the belief that the origin of the energy is a nuclear chain reaction[1].

D. STANLEY-JONES

Buckshead, Townshend,
Hayle, Cornwall.

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ADSORPTION BY MONTMORILLONITE, AND ITS RELATION TO SURFACE ADSORPTION

By DR. D. M. C. MACEWAN
Pedology Department, Rothamsted Experimental Station, Harpenden

THE nature of the forces giving rise to the intracrystalline swelling of montmorillonite has been several times discussed. The recent work of Bradley[1] and of myself[2,3,4] on the swelling caused by adsorption of organic liquids enables us to get a clearer view of the problem, because these liquids form well-defined complexes in which the influence of the exchangeable ions is less marked than with water.

The questions which have to be answered are: (*a*) Why do the organic molecules penetrate into the montmorillonite 'crystals'? (*b*) Why is the resulting expansion limited in extent? X-ray photographs show that the molecules between the structural sheets of the clay mineral are not in the form of a normal liquid, but are arranged in well-marked layers, reminiscent of the layer-structure which has been postulated for adsorbed films on the actual surface of crystals[5]. On this basis it may be suggested that one factor in the formation of these complexes is a repulsive force which comes into operation when crystalline surfaces are brought very close together in a liquid medium, due to their collecting layers of strongly adsorbed molecules[3]. In order to explain the observed equilibrium an attractive force must also be found.

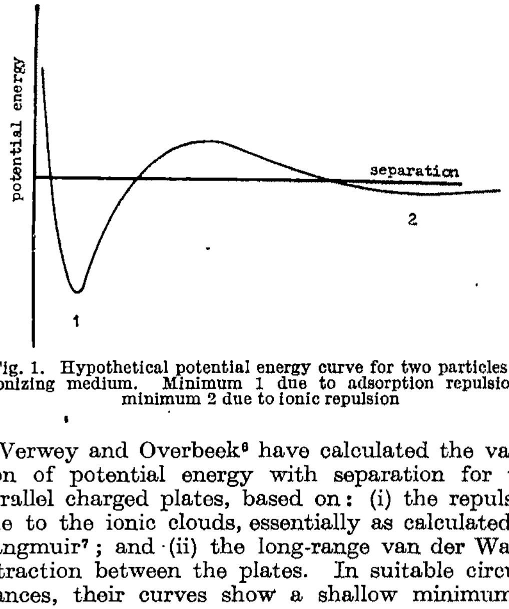

Fig. 1. Hypothetical potential energy curve for two particles in ionizing medium. Minimum 1 due to adsorption repulsion; minimum 2 due to ionic repulsion

Verwey and Overbeek[6] have calculated the variation of potential energy with separation for two parallel charged plates, based on: (i) the repulsion due to the ionic clouds, essentially as calculated by Langmuir[7]; and (ii) the long-range van der Waals' attraction between the plates. In suitable circumstances, their curves show a shallow minimum of potential energy at considerable distances of separation (50–500 A.), followed by a maximum and a monotonic decrease as the plates are brought closer together. If to the terms considered by Verwey and Overbeek we add a term corresponding to the free energy of adsorption of the superficial layers of molecules, we will get a further (rapidly dying out) repulsive contribution, and we might thus expect a second minimum in the total potential energy curve corresponding to separations of the order of a few molecular diameters (Fig. 1).

It is noteworthy that such a minimum has been postulated by Verwey and Overbeek[8] in order to explain the phenomenon of repeptization, and to get it they had to invoke the Born repulsion. The considerations given here suggest that a minimum may be obtained at separations which are quite large in comparison with those at which the Born repulsion will be able to act. Verwey and Overbeek's treatment, of course, was confined to lyophobic systems, and particle-solvent interactions were specifically excluded; but it is doubtful if the formation of adsorbed surface layers of molecules is confined to systems that would be described as 'lyophilic', and it may well be quite a general phenomenon.

When one attempts, however, to express the above ideas in quantitative form, certain difficulties appear. There are no adequate data on the change of surface-free energy with adsorption of organic liquids by montmorillonite, but Bangham and Mosallam's[5] careful measurements enable this quantity to be obtained for mica in contact with methanol, benzene and carbon tetrachloride; and in view of the close structural similarity of mica and montmorillonite[9], it does not seem unreasonable to suppose that these results will apply fairly well to montmorillonite also. The lowering of free energy for a given quantity of organic liquid adsorbed is given by Bangham's form of Gibbs' expression $RT\int\Gamma d\log p$, taken between the appropriate limits, and all the quantities here can be derived from Bangham and Mosallam's data. We need, of course, to know the value of Γ corresponding to one, two, . . . layers; and to calculate this I assumed (i) that the density of the adsorbed layers is the same as that of the normal liquid, and (ii) that the orientation and thickness of the adsorbed molecules are those given by direct X-ray spacing measurements on the montmorillonite complexes[4]. The general correctness of the assumptions is suggested by the fact that the completion of successive layers as thus determined corresponds in most cases with points of discontinuity in Bangham and Mosallam's adsorption isotherms.

In applying these results to the montmorillonite complexes, one must allow for the fact that, unlike the surface films on mica, they have no free liquid surface (by adding the free surface energy of the liquid). The final result for methanol is shown in Fig. 2, curve I, which gives the lowering of free energy per unit cell as a function of the separation of the montmorillonite sheets, the value for no separation being arbitrarily set equal to zero. On the same graph is shown the potential energy variation due to van der Waals' attraction, as calculated from Verwey and Overbeek's formula[10] with $A = 10^{-12}$ (curve II). Clearly this energy is far too small in comparison with the adsorption energy to give a position of equilibrium at any suitable distance. The assumed value of A is likely to be too large rather than too small, so the van der Waals' force cannot account for the observed equilibrium unless the adsorption energy is seriously in error, which seems unlikely. There must therefore be another type of attractive force at short separations.

The possibility of this force being electrostatic in origin is worth considering. At larger separations, of course, the net force due to the ions is repulsive, and the treatment of Langmuir[7] essentially applies. But here we are dealing with the case where not only the Gouy, but also the Stern layers may overlap, and the essential assumption underlying the application of the Poisson–Boltzmann equation, that each ion moves in the mean potential field of all the ions, may break down. The ions will then rearrange themselves in a single layer, so that each one occupies a certain 'cell', bounded on either side by the two interacting surfaces, from which other ions are excluded. The force between the sheets will then be attractive, and its potential will increase uniformly with separation, at a rate depending on the dielectric constant of the medium. Assuming this is the same as for *solid* methanol, we get curve III in Fig. 2, and combining it with the curve of adsorption free energy we get curve IV, showing a stable position with two layers of methanol molecules between the montmorillonite sheets, which is what is actually found.

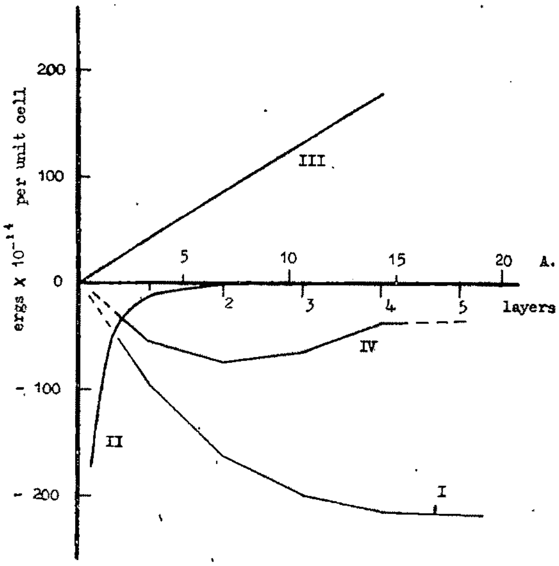

Fig. 2

The electrostatic force, unlike the van der Waals' force, is thus of the right order of magnitude to explain the observed effect. Its actual value is subject to error, because no account has been taken of the effect of segregation of the cations towards one or other of the two sheets. With 'bare' cations, this effect should lead to a considerable lowering of the attractive force at 10 A. separation. It is probable, however, that the cations will co-ordinate polar groups (or residual water molecules) in such a way as to increase their effective size, and make this effect less marked. At separations greater than about 10 A., such segregation is bound to set in, reducing the attractive force, until finally, with the attainment of the normal Gouy layer distribution, the force becomes repulsive. Actual values for the separation in organic complexes[4] vary up to about 11 A. The case of adsorption of large complex ions, for example as studied by Gieseking[11], is, of course, quite a different one.

I am grateful to Dr. D. H. Bangham, Dr. S. Levine and Dr. R. K. Schofield for conversations on the subject of this communication, but they are not responsible for the opinions expressed in it.

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HIGH VACUA

GLENEAGLES CONVENTION

ON October 12 and 13, the Society of Chemical Industry sponsored a convention on high vacua under the presidency of Sir Charles Darwin, director of the National Physical Laboratory. It is worthy of record that there was much appreciative comment at the choice of Gleneagles for the meeting, and the view was expressed widely that the so-called 'country house party' system in which interested persons meet in conditions of intimacy for a time with little or no distractions has much to recommend it.

The meetings opened with a brief historical survey and some personal recollections by Sir Charles Darwin. His remarks on the interaction of pure science and technological practice reminded his listeners that modern developments have produced a situation in which the contribution of the highly expert technician is now an essential to success. As he rightly remarked, it is no longer practicable for the physicist or the chemist in his research laboratory himself to make the apparatus he requires for his own use.

Dr. Saul Dushman, of Schenectady, dealt with the scientific aspects of vacuum technique. He referred to the advances resultant on the advent of the vacuum tungsten lamp and its developments, the magnetron, and fluorescent-screen cathode-ray tubes. The introduction of high-vacuum technique has enabled the production of high-energy accelerators such as the cyclotron, betatron and synchrotron. Many of the developments, the result of war-time demands, would astonish those concerned with these matters even ten years ago, he remarked, and it is fair to say that the technique has now emerged from the experimental stage to take its place as a valuable tool for the physicist. Oil-vapour pumps are available with speeds of exhaust ranging up to, and above, 7,000 litres/sec. (15,000 cu. ft./min.) and producing ultimate vacua ranging from 10^{-3} microns to 10^{-5} microns mercury pressure.

Dr. Dushman spoke of the difficulties of producing accurate gauges for such measurements; he believes that, in some cases at least, the limit of measurement has, for the time being, been reached.

Dr. J. C. Swallow and Dr. J. S. Gourlay, of Welwyn, discussed the applications of high vacua in the paint and plastics industries. The first part of their paper dealt with the technique of metallization now becoming increasingly important on a large scale. This technique involves the deposition *in vacua* of a thin partially transparent layer of metal over a surface.

The metal is evaporated from a small source so placed that it impinges on the surface at an oblique angle. Irregularities on the surface produce local variations in the thickness of the metal layer, and the shadows cast by these enable their heights to be calculated. A very interesting process has also been developed for coating polymethyl methacrylate with aluminium. This is used to make the spherical plastic mirrors of diameters from 3 in. to 11 in. used in television projection.

In high-vacuum distillation it is hoped that the progress recently made will soon permit the separation of the various molecular species in a pure state. In plastics, short-path distillation can now be employed in the manufacture of a high molecular weight plasticizer by removing the ester from the reaction before its completion, which would require such high temperatures as to cause discoloration. In general, in a reaction $A + B = C + D$, the procedure is to remove by high-vacuum distillation C or D, and the technical requirement of purer and still purer plasticizers of high molecular weight may well lead to the adoption of this procedure.

An interesting suggestion by Dr. Swallow was to consider not only the use of high-vacuum technique in the production of plastics, but also the use of plastics in high-vacuum apparatus, particularly for gaskets, inspection windows, and sheathing.

Dr. R. S. Morse, of Cambridge, Mass., contributed two papers on high-vacuum dehydration and distillation. An exciting feature of his papers was the evidence of applying highly complex processes to the production of very large quantities of materials like penicillin, sera, and the like. The cold-trap vapour pumping system in which air pressure is reduced to less than 50 microns of mercury with a mechanical pump is now in use on a large scale for drying biological preparations. For the production of penicillin and streptomycin, however, diffusion pumps are used to reduce the free-air pressure to 1–10 microns. The vapour is condensed and continuously removed as ice by rotating scraper blades. In an effort to eliminate all mechanical problems and convert a desiccant system to a continuous operation, continuous liquid chemical absorption processes are being studied. In these, free air is removed to 10–100 microns and vapour is continuously absorbed with a hygroscopic medium. The medium is afterwards reconcentrated and, at reduced temperature, again circulated and additional water vapour removed. There are particular and unique problems involved in designing high-vacuum drier equipment, such as the heat transfer to the product. Efforts have been made also to reduce the drying time to a minimum, and Dr. Morse suggested that the time is approaching when high-vacuum drying operations will compete with more usual procedures such as spray drying.

Dr. E. W. M. Fawcett, of the Paint Research Station, discussed the application of high-vacuum distillation to the processing of triglyceride oils. Molecular distillation is limited generally to distillands in the molecular weight range 300–1,200; it has a poor fractionating power and is rather high in cost. The rapid development of solvent fractionation processes may well also limit the application of the distillation process in some directions. It would appear, said Dr. Fawcett, that molecular distillation is a process for the special case, such as the recovery of vitamin A from fish liver oils, and, in his view, it is unlikely to be applied generally on a commercial scale. In contradistinction to its rather limited scope in commercial-scale practice, however, molecular distillation as a laboratory process has great possibilities and will undoubtedly find increasing usage with the perfection of the necessary high-vacuum technique.

Mr. R. A. Stauffer, of Cambridge, Mass., spoke on vacuum metallurgy, where much of the interest is still in the research and development stage. The two major advantages of processing metals *in vacuo* are that metals so processed are protected from reaction with gases, and those metallurgical reactions in which gaseous products are formed from solid or liquid reactants are favoured by maintaining a low gas pressure over the reactants. During the War very large quantities of magnesium were produced in Canada and the United States using a high-vacuum technique, but most of the plants are now closed because of high operating costs and poor plant locations. It is probable, said Mr. Stauffer, that lithium metal will be produced in the near future using vacuum techniques, and the production of other metals of the alkali and alkaline earth metal group have been studied, but so far only on a small scale. Small quantities of barium and cæsium are being made but the amount is limited to a few tons per year.

It is theoretically possible to drive reactions involving dissociation of metallic compounds which give rise to gaseous by-products; but in practice the number of metals which might be prepared by those techniques is extremely limited. Many of the halides can be dissociated by heating to high temperatures, but these reactions cannot be readily driven by vacuum techniques since most of the halides are quite volatile themselves and are removed, along with the halogen formed, as a by-product. A promising application for vacuum vaporization is in conjunction with the 'Kroll' process whereby titanium chloride is reduced with magnesium, forming a mixture of titanium, magnesium, and magnesium chloride from which titanium must be recovered. A vacuum-vaporization technique is used for removal of magnesium and magnesium chloride in order to avoid a leaching operation which would contaminate the titanium.

Vacuum technology as applied to the design and construction of vacuum furnaces is progressing rapidly and new techniques for melting are being developed. There appears, however, to be little to be gained in the mechanical properties of metals by vacuum heat-treating operations.

Mr. Stauffer concluded by saying that the advantages to be gained by the use of vacuum technology have not been fully evaluated and in some cases the equipment required for its industrial application to metallurgical processes is not fully developed.

The final session was devoted to two papers, one by Dr. C. R. Burch, of Bristol, who spoke of developments arising out of experiments on vacuum distillation, considered as an illustration of the impact of one technology on another; and the other was by Prof. M. L. E. Oliphant, of Birmingham, who spoke of high vacua in nuclear physics, mentioning in particular some of the practical difficulties of work in this field. Dr. Burch's talk was largely historical for, as he explained, he has not worked on the subject for some years.

Prof. R. V. Jones, of Aberdeen, in his concluding remarks, directed attention to some of the main points made by the speakers and in the discussions. The convention concluded with an expression of thanks to those who had made it possible.

BEHAVIOUR OF PIGS

IN the course of experimental work of a nutritional and physiological character at the National Institute for Research in Dairying, R. Braude has noted some interesting features about the behaviour of pigs (*Bull. Animal Behaviour*, No. 6; January 1948). These observations have been recorded without any attempt to fit them into the framework of existing theories of behaviour, and, in the words of Dr. E. S. Russell, they merely "serve to illustrate what is the most characteristic feature of behaviour, namely, that the animal tries or strives to do something specific, that it seems to achieve some end, to satisfy some need".

On one occasion a wooden block resembling a sow with two rows of rubber teats fitted at the approximate spot was put into the farrowing pen. It was placed as near as possible to a sow which was farrowing. Not one of the fourteen piglets born on this occasion showed any interest whatsoever in the dummy teats, while all were keenly interested in the real teats, and as usual fought for access to them.

Another observation concerns the behaviour of piglets in suckling usually from the same teat. Donald has stated that "this ability must be founded mainly on sight, with some capacity to recognize the feel of a nipple playing a secondary part. Hearing may be disregarded, and so may a sense of smell, for pigs placed with a foster mother will, if they are able, take up the position they had on their original mother." From the start it seems to be of importance to the piglets to obtain a correct position on the udder. The quality of the teats varies to such an extent that it is not surprising that in the early stages of suckling the piglets are prepared to fight for access to the good ones and those successful occupy them permanently. The resultant growth-rate of the victors indicates the importance of this selection. With a small litter the best teats are soon discovered and continue to be sucked throughout lactation, while the poor ones are completely abandoned, and gradually dry off. With large litters some of the piglets never secure the chance of settling down at a good teat, and this fact seems to be mainly responsible for the usual one or two 'runts' in a large litter.

The effects of massaging the udder by the piglets just before the actual suckling have also been observed. With cows, the composition of the milk obtained depends on whether the udder has been previously stimulated or not, while in pigs there is evidence that the milk obtained by draining it off is only half as rich in fat as that obtained by the young pigs suckling. That the controlling factor is of a hormonal nature has been confirmed by Kon, Thompson and Braude, and by means of 'Pitocin', a proprietary extract from the posterior lobe of the pituitary which contains the oxytocic principle, it is now possible to milk a sow in much the same way as a cow. To milk the sow after treatment with 'Pitocin' the sow has to be roped. Here an interesting aspect of behaviour is shown. It is well known that a sow will struggle against roping and that once caught she will try to get rid of the rope. What she usually does, however, is to pull back with all her strength, and by so doing makes the noose only more secure. On the other hand, if she were to walk forward—and there is nothing to stop her doing so—the effectiveness of roping would be completely lost. For some unknown reason this never occurs. The explanation that she can see the holder of the rope in front of her and tries to back away from him has proved to be untrue. The holder of the rope has been concealed and two people have been placed behind the sow. Those behind have had to push with all their strength to make the sow step forward.

Other observations show that, once a sow has done a long walk to the piggery where the boar is kept, she seems to learn the route and needs little guiding on subsequent occasions. Sows usually keep to the road and are careful when leaving it, making sure that the path they are taking is safe for them.

Except when mating, two grown pigs brought together will fight each other until one establishes a complete supremacy; sometimes even death may result. Mixing young weaners from different litters invariably results in a fight; but these soon settle down together. On the whole, however, pigs like company, and cases have been known when separated pigs have had to be brought back to their mates because "they went in seclusion on what amounted to a hunger strike". It is also known that a strong pig will keep a weaker one away from the food trough, while in the pen the favourite place for sleeping is occupied by the stronger. On occasions when two lots of pigs are mixed together in one pen, the usual fight is followed by the relegation of the defeated to the dunging passage.

That pigs quickly become accustomed to new routines which have to be introduced into an experimental piggery is shown by the following. Pigs have to be weighed at frequent intervals, sometimes daily and at least once weekly. At first it is difficult to get them into the weighing pen; but, after a few times, they walk into it of their own accord as soon as the door of the weighing pen is opened. A clearer example of a conditioned reflex is quoted by Braude from Denmark. There, a certain pigman arrives at his piggery in the morning and, as his first job, rings a heavy bell. This was a signal for all the pigs in that piggery to get up and go out into the dunging passage to defecate and urinate. The procedure was repeated as regularly in the afternoon, and this practice kept the piggery clean.

Information on the feeding habits of pigs has also been collected and shows the pig is a selective feeder. The now well-known story of its liking for copper is re-told, together with further evidence which has been collected by experimental inquiry.

NATURE AND CONSTITUTION OF GLASS

AT the recent joint meeting of the International Commission on Glass and the Society of Glass Technology, a symposium was arranged having as a general title "Some Aspects of the Nature and Constitution of Glass". Fifteen papers, presented by American, British and Continental investigators, ranged widely over the subject and raised, in each of three sessions, lively and sustained discussions.

In an introduction to the series of papers, Prof. W. E. S. Turner reviewed the important historical developments of the subject and referred to the place of theory in glass technology. Whereas for some forty years or more Tammann's theory of glass as a supercooled liquid had done much to account for many of the properties of glasses, greater insistence was now being laid, as indicated in the paper "Solid

Liquids" submitted by Dr. F. W. Preston (Butler, U.S.A.), on the elasticity and therefore solid character of glass, with a definite atomic structure like a crystalline material, although without the regular repetition of the structural units found in a crystal.

Mr. S. M. Cox (Sunderland), in his paper on "An Elementary Kinetic Theory of Dilute Silica Glass", developed further a kinetic theory he had previously outlined. He employed an ingenious short film to illustrate the movements of the atoms at different temperatures and to explain his concepts. He suggested that an important term in equations describing the variation of physical properties with temperature is the proportion of loosely linked oxygen atoms, and he showed that the equation for this proportion can be derived from a simple distribution of potential energy curves. Equations relating the electrical conductivity with temperature, and of viscosity with temperature, were derived, and it was shown that the calculated results compare favourably with known experimental data.

Dr. G. O. Jones (Oxford) stressed the view that the study of glass can make a great contribution to the theory of the liquid state and the theory of melting. He outlined the present state of knowledge of the property-temperature changes in the transformation range and indicated the need for experimental work designed to provide full thermodynamic data. He also emphasized the need for experimental work on the kinetics of the crystallization process in glasses, on the stabilization phenomena, on the chemical durability of very thin films, and on the need for a theory of viscosity which would include the delayed elasticity effect. In the discussion, Prof. A. Smekal (Darmstadt) referred to work in Germany during the last eight years, particularly to the electron microscope examination of fracture surfaces, and to substances which have their transformation ranges near the melting point.

Mr. J. E. Stanworth (Sheffield) reviewed recent ideas of glass from the point of view of their ionic structures, referring particularly to the use of the electro-negativity values of the elements as a guide to their behaviour in a glass structure, and to the unusual behaviour of lead, bismuth and thallium, three ions which can be introduced in large percentages into glasses because of their high deformabilities.

Dr. J. M. Stevels (Eindhoven) discussed the relation between the dielectric losses and the constitution of glass, first describing briefly the theory of Gevers and du Pré, and the manner in which the theory explains the formulæ of Strutt and von Schweidler for the dependence of loss angle on temperature and frequency, respectively. Dr. Stevels pointed out the need for measurements at temperatures approaching absolute zero, and then outlined his theory of the effect of composition on losses, developing an equation which agrees with known data at a frequency of about 10^6 cycles per second.

Dr. S. P. Varma first presented a paper written in collaboration with Prof. W. A. Weyl (Pennsylvania State College), and also one by Dr. F. L. Jones and Dr. N. J. Kreidl (Rochester, N.Y.), both papers dealing with the optical properties in relation to constitution. Dr. Varma emphasized the fact that cations with electronic structure not of the noble gas type have bonding properties to neighbouring ions markedly different from corresponding noble gas-type ions. A series of curves showing molar refraction against composition, for silicate and borate glasses, emphasized the high contribution of lead ions as compared with barium and strontium ions, and of zinc ions as compared with magnesium ions.

A paper by Mr. J. B. Murgatroyd (Greenford) (read by Dr. E. J. Gooding) described the delayed elastic effect in glass fibres and showed that this effect increases with decrease in fibre diameter. Some conclusions were made concerning the arrangement of the bonds in fibres, and the relation between the structure of chilled and liquid glass.

Mr. R. W. Douglas (Wembley) outlined a theory of viscosity for simple glasses, based on the idea that there are two equilibrium positions (separated by an energy barrier) for each oxygen atom, the application of a stress enabling the oxygen atom to move from one potential minimum to the other; together with the thermal agitation of the atoms, this movement can provide flow. An equation for viscosity derived from this theory was used to compare calculated with known data, and the conclusion drawn that in complex glasses other atoms than the oxygens (for example, the sodium atoms) are probably involved in the flow mechanism.

Dr. G. O. Jones also spoke on the flow of glass, with particular reference to temperatures below the transformation range; he described the experimental results of strain-time measurements, and suggested that a model representing accurately the observed values could be either a number of Maxwell models in parallel or Voigt models in series, using a suitable distribution of relaxation times. In the discussion, Prof. A. Smekal referred to the measurements in Germany of the rate of crack propagation, using ultrasonics, and to theoretical work showing that the Griffith flaw theory can explain the continuous distribution of relaxation times and elastic after-effects.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 13

British Museum (Natural History) (at the Royal Scottish Museum, Chambers Street, Edinburgh), at 5.30 p.m.—Mr. Douglas A. Allan: "The Geology and Scenery of Scotland" (Swiney Lectures).* (Further Lectures will be given on December 15 and 17, January 17, 19, 21, 24, 26 and 28.)

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Dr. E. Lind: "Cheshire Meres".*

University of London (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. Corder Catchpool: "Education for International Understanding—Central Europe".*

Tuesday, December 14

Society of Chemical Industry, Plastics Group (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 2.30 p.m.—Dr. D. D. Eley: "Biological Polymers". (Members of the Biochemical Society are invited.)

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. D. Craggs: "Some Limitations of Particle Counting with Electron Multipliers and Geiger Counters".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Frequency Modulation versus Amplitude Modulation" (to be opened by Mr. H. L. Kirke).

Institution of Naval Architects (joint meeting with the Institute of Marine Engineers, at 85–88 The Minories, London, E.C.3), at 5.30 p.m.—Prof. L. C. Burrill: "Latest Developments in Reversible Propellers".

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. J. N. Aldington: "The Gas Arc—a New Light Source".

Institution of Structural Engineers, Lancashire and Cheshire Branch (at the College of Technology, Manchester), at 7 p.m.—Mr. R. A. Foulkes: "The Use of Light Alloys in Structures".

Society of Dyers and Colourists, Scottish Section (at the St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. M. R. Fox: "The Relationship between the Chemical Constitution of Vat Dyes and their Dyeing and Fastness Behaviour".

Royal Institute of Chemistry (in the Material Research Laboratory, Philips Electrical, Ltd., New Road, Mitcham Junction), at 7.15 p.m.—Mr. R. J. Hercock: "The Theoretical Basis of Photography".

British Cultural Committee for Peace (at St. Pancras Town Hall, Euston Road, London, N.W.1), at 8 p.m.—Discussion on "Culture and Peace—with Reference to the Congress at Wroclaw" (to be opened by Prof. J. D. Bernal, F.R.S., Mr. Peter Blackman and Dr. Olaf Stapledon).

Wednesday, December 15

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 4.45 p.m.—Scientific Papers.

Royal Meteorological Society (joint meeting with the Royal Astronomical Society, in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Discussion on "Post-Glacial Climatic Change".

Institute of Welding, North London Branch (at East Ham Technical College, Barking Road, London, E.6), at 7.30 p.m.—Open Discussion on "Welding Methods".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Relations between Scientists and Administration" (to be opened by Mr. F. A. Cobb, M.P., Dr. R. Cockburn and Dr. C. Gordon.

Thursday, December 16

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. B. Katz: "The Electrical Properties of the Muscle Fibre Membrane"; Dr. M. F. Perutz: "An X-Ray Study of Horse Methæmoglobin", Part 2.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. G. Szegö: "Recent Investigations on Electrostatic Capacity and related Quantities".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.15 p.m.—Messrs. R. C. Trumbull, W. Hardiek and E. G. Lawford: "Notes on the Treatment of Pyrites Cinders at the Plant of the Pyrites Co., Inc., Wilmington, Delaware".

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Mr. J. B. Birks: "The Physical Applications of Microwaves".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. D. J. Lyons: "Present Thoughts on the Use of Powered Flying Controls in Aircraft".

Textile Institute, London Section (at the Holborn Restaurant, 218 High Holborn, London, W.C.1), at 6.30 p.m.—Discussion on "Technical Education" (to be opened by Dr. J. C. Withers).

British Institute of Radiology (at 32 Welbeck Street, London, W.1), at 8 p.m.—Dr. Denis Taylor: "British Radiation Monitoring Equipment".

Friday, December 17

Institute of Navigation (with the Royal Geographical Society, at Kensington Gore, London, S.W.7), at 4.30 p.m.—Opening by H.R.H. the Duke of Edinburgh of an Exhibition "Navigation through the Ages": at 5.30 p.m.—Sir Robert Watson-Watt, F.R.S.: "Radio and Position". (The Exhibition will be open at 10,30 a.m. until January 31.)

Physical Society, Low-Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Third Annual General Meeting; at 5 p.m.—Prof. D. M. Newitt, F.R.S.: "The Use of Thermodynamic Diagrams in Industry".

Physical Society, Optical Group (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 5 p.m.—Scientific Papers.

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. H. A. V. Bulleid: "Cinematography in Engineering".

Society of Public Analysts and other Analytical Chemists, Biological Methods Group (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Annual General Meeting: at 6.30 p.m.—Scientific Papers.

Society of Instrument Technology, Midland Section (at the Arden Hotel, New Street, Birmingham), at 7 p.m.—Mr. E. Simpson: "Optical Devices—Simple Optical Devices Applied to Weighing and Measuring".

Friday, December 17—Saturday, December 18

Association of Universities of the British Commonwealth (at the University of London, Senate House, London, W.C.1).—Conference of the Universities of Great Britain and Northern Ireland.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Assistant in Biochemistry, and a Technical Assistant in Biochemistry—The Secretary, Department of Pharmacology, Medical School, The University, Birmingham 15 (December 18).

Unestablished posts at the National Physical Laboratory, Teddington, in connexion with work which is being undertaken to promote the use of automatic control devices in industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.384/48A (December 18).

Senior Laboratory Technician with special experience in biochemistry—The Group Pathologist, Archway Hospital, London, N.19 (December 18).

Mathematicians (Senior Scientific Officer grade) at a Ministry of Supply research and development establishment near London for (*a*) theoretical investigation into the detonation of explosives, (*b*) numerical analysis of problems in applied mathematics, and (*c*) work on fluid mechanics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.391/48A (December 18).

Mathematicians and Mathematical Physicists (Scientific Officer grade) for work in solid and fluid mechanics and high-speed gas dynamics, statistical mechanics and quantum theory, statistics, in Ministry of Supply research and development establishments in and near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.392/48A (December 20).

Lecturer in Industrial and General Psychology in the University of Western Australia—The Agent-General for Western Australia, 115–116 Strand, London, W.C.2 (December 20).

Lecturer in the Department of Biochemistry—The Registrar, The University, Liverpool (December 24).

Research Assistant in the Department of Chemistry—The Registrar, The University, Manchester 13 (December 24).

Assistant Experimental Officers to assist with performance testing of aircraft at a Ministry of Supply establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.393/48A (December 30).

Professor of Physics, and a Lecturer in Bacteriology, in the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 31).

Lecturer in Applied Psychology in the Joint Department of Psychological Medicine of King's College and the Royal Victoria Infirmary—The Registrar, King's College, Newcastle-upon-Tyne (December 31).

Lecturer (Grade III) in Chemistry—The Registrar, Queen Mary College, Mile End Road, London, E.1 (December 31).

Physicist (either Lecturer or Assistant Lecturer grade) in the Department of Textile Industries—The Principal, Municipal College of Technology, Manchester (January 3).

Reader or Senior Lecturer in Biochemistry in the University College of the West Indies—The Secretary, Special Committee of the Senate on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (January 15).

Civil Engineers (Hydro-electric Design Section), a Mechanical Engineer (Hydro-electric Design Section), and Mechanical Engineers (Mechanical Section), in the New Zealand Government Department of Works—The Official Secretary, Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (January 15).

Senior Lecturer or Lecturer in Anatomy—The Registrar, The University, Sheffield (January 22).

Chair of Applied Chemistry, the Chair of Applied Physics, and the Chair of Applied Mathematics, in the New South Wales Technical University—The Agent-General, New South Wales Government Offices, 56 Strand, London, W.C.2 (January 25).

Senior Lecturer or Lecturer in Mathematics, and a Senior Lecturer or Lecturer in Physical Chemistry, in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (February 15).

Chair of Anthropology in Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (March 1).

Lecturer or Assistant Lecturer in Anatomy in the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (March 1).

Botanist (male) to undertake cytogenetical research on sugar cane at the British West Indies Central Sugar Cane Breeding Station—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Assistant Sugar Technologist in the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2.

Demonstrator (woman) in the Department of Anatomy—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

Organic Chemists (2) to undertake research initially on the chemistry of vulcanization, a Physical Chemist to study problems arising in the oxidation of rubber, a Colloid or Physical Chemist for fundamental studies in surface chemistry, a Colloid or Physical Chemist for applied research on rubber latex, a Rubber Technologist, and a Latex Technologist—The Director of Research, British Rubber Producers' Research Association, 48–52 Tewin Road, Welwyn Garden City, Herts.

Candidate (with a university degree in chemistry) to organise collation and indexing of chemical abstracts and to supply information to the chemistry division of the Atomic Energy Research Establishment, Didcot—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1021/48A.

Biological Assistant (with degree in physiology or zoology)—Mrs. Simpson, Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1.

Physicist (preferably with some research experience) to study rheological properties of yarns and filaments—The Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.

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EDUCATIONAL ADMINISTRATION

TWO recent broadsheets by P.E.P. ("Councils and their Schools") have directed attention to the local administration of education and its implications for democracy. The first, which is mainly concerned with the administrative structure of education in Britain, is introduced by the two pertinent questions : "Can provisional standards of efficiency be achieved if real responsibility rests with the ordinary citizen ? If not, does the interest of the child demand that the management of its education be surrendered wholly to the expert specialist ?"

The 1944 Act provided for an administrative framework in which a harmony of democratic control and technical efficiency could be achieved, and in this broadsheet an account is given of the hierarchy of education authorities, of the composition and functions of local education committees and of schemes of divisional administration in county areas. The second broadsheet discusses educational administration on the level of the individual school, as well as parent–teacher associations and other voluntary organisations connected with the schools.

In examining the machinery of local educational administration, the writers of the first broadsheet have brought together, in a form not otherwise readily accessible, information about the size and populations of the local education authorities and divisional executive areas as well as methods of co-opting members on to education committees. As they rightly point out, assessment of the merits and defects of the 1944 Act can only be tentative, because several of its main provisions have not yet been implemented and many bodies have only recently been constituted.

Some general principles of educational administration have been clearly defined by the Act. The relation between the central Ministry of Education and the local education authorities has been significantly altered. Instead of being merely advisory, the Ministry of Education is now more an executive agency possessing the right to make final decisions on many of the administrative schemes and policies of the local education authorities. This change in the Ministry's function has been unusually prominent during three years of acute shortage of man-power and materials necessitating direct control of available materials from the centre, and many local education authorities are finding it increasingly difficult to distinguish the new permanent statutory functions of the central department from its recently acquired temporary functions. Although these are due to the pressure of special circumstances, local education authorities are feeling the limitation of their sovereignty more acutely than they might otherwise have done, and tend to forget that there is considerable scope for local initiative. The most important elements of educational policy, for example, are the conduct and curricula of schools, and these are still subject to local decisions. Moreover, no significant intermediate regional agencies have been developed, and contact with the Ministry is still direct. His

Majesty's inspectors possess no executive functions except that they may approve certain items of expenditure.

Under the 1944 Act, the Ministry and the local education authorities are thus clearly defined as the chief levels of administration. The Act also provides for a considerable degree of decentralization. In county areas divisional executives have been established, while in all areas managers and governors have to be appointed for individual schools or for groups of schools. This, at least, is the theoretical division between the different levels of administration. In practice the division is less clearly defined, and the place of the divisional executive has proved to be one of the less happy developments of the 1944 Act. Divisional executives were created as a compromise between those who believed that education administration should be vested solely in the county and county boroughs, and those who thought the larger non-county boroughs and urban districts should become local education authorities in their own right. Neither faction has been satisfied. Schemes of divisional administration exist in only thirty-eight counties, and in twenty-one of these there are only one or two divisional executives. Most of the divisional executives set up under county schemes are *ad hoc* bodies and often do not sufficiently represent a community of interests to interpret local views effectively. Yet, the broadsheet concludes, "in spite of all the problems and inconsistencies found within the system, it appears that the chief purpose of the divisional schemes—the participation of a larger number of people, and the expression of local interests, in educational administration—is being achieved. The new method is costly and generally rather slow, for the delegation of functions involves the use of more officers, together with delays in passing on reports and in waiting for decisions from one committee to another on the different tiers of administration.".

While this cautious optimism might be justified in some cases, many divisional education officers are feeling acutely frustrated and, as their president, Alderman C. Barton, M.P., said to the recent annual conference: "While there is this apparent tendency towards a broader interpretation of the powers of divisional executives, it is true to say that the restrictive effect of over-elaborate regulations, highly centralized control of supplies, and quite minor details of administration all tend to weaken the real effectiveness of delegated powers. In many cases, too, the stringency of financial control exercised by the county council reduced the delegation to a mere farce."

Nor is discontent confined to the divisional education officers themselves. Before the introduction of divisional executives, some further education establishments in county boroughs were under the control of the county education authority. Now they come under the dual control of both the county authority and the divisional executives, and heads and principals of these establishments are placed in a dilemma as to the proper arbiter of their problems. In certain matters the head is instructed to refer to the divisional executive; in others to the county authorities; on occasion to both.

After three years experience of divisional executives there is a growing body of opinion that they have no executive place in educational administration and that they should be abolished in favour of a second tier of local administration. This should be made up of those people in intimate touch with the schools, the governors and managers. Selected governors and managers could form local educational advisory committees served by a staff whose duty it would be to keep in touch with schools, teachers, parents, managers and governors.

It is with the composition of governing and managing bodies of schools and the link between parents and teachers that the second broadsheet is chiefly concerned. Starting with the assumption that most people have some real interest in schools and should possess some method of making their influence felt, the broadsheet reviews the means whereby the various interests and experience of different kinds of people could be brought within the administrative system. Besides the establishment of divisional executives, the 1944 Act provides for co-option to education committees and, for every school maintained by a local education authority, a body of governors for secondary and managers for primary schools. These bodies have been only slowly established, and the problem of finding people to serve on them has frequently been the cause of delay. The 1944 Act provides for the grouping of schools, and, usually from expediency, this provision has been widely used. Like most expedient solutions the grouping has proved to be widely unpopular, particularly with those head teachers who are trying to build up local pride and interest in their schools.

Most appointing bodies are trying to discharge their responsibilities conscientiously; but they have been seriously criticized for doing too many jobs themselves instead of bringing new people into local administration. Their reply that new people cannot be found is more a commentary on the narrowness of the contacts of local representatives than of the shortage of public-spirited citizens. "Councillors do not always look beyond the members of their political party and their circle of friends."

The Ministry of Education has issued model articles of government which have been generally used by local education authorities in preparing their schemes for government and management. A division of responsibility is suggested in which "the L.E.A. would have the right to settle the general educational character of the school and its place in the local system. Subject to this general responsibility the governors would have general direction of the conduct and curriculum of the school. The headmaster or headmistress would control the internal organisation, management and discipline of the school, and would also have the power of suspending pupils, subject to a report being made forthwith to the governors and the L.E.A." This provides a *modus vivendi* between the local education authority and the governors and managers. Where there is no system of divisional administration these school bodies are the only local agents of the education authority. "Wherever there is a three-tier system of administration, competition and conflicts between the different levels are more likely to arise. On each step of the hierarchy there is a latent and sometimes active conflict between those which are immediately above and below each other. The local education authorities have very much the same attitude towards the Ministry of Education as the divisional executives have towards the local education authorities."

It is difficult for divisional executives to take an objective and positive attitude towards governors and managers, because they themselves are agents of decentralized and detailed administration. The boundary between their field of activity and that of the school boards is often blurred, some of the functions assigned to them belonging in principle to governors and managers as well.

It is also easy to forget that the object of educational administration is the individual school and the effect it has on the children in the schoolroom and the playground. The interpreters of educational ideals are the teachers in the schools, and their relationship with governors and managers is the most difficult and subtle problem of all. Primarily this is a relationship which has to be worked out amicably with head teachers; but "in a democratic system it is important that assistant teachers should feel that there is someone who, in matters of discipline and promotion as well as in the day-to-day routine of the school, is there to hold the balance and to see that justice is and appears to be done".

The authority of governors and managers must be wisely and tactfully used and rests on the fact that the head and his staff are the servants of the community; the authority of the school board is a sanction against abuse of power and neglect of duty.

At the school the most vitally concerned representatives of the community are parents. Yet they are the least organised, and their official place within the educational system is that of bystanders rather than of active participants. It is rare for them to sit on committees or act as governors or managers, because they are mothers and fathers and for no other reason. It is only through parent or parent–teacher associations that they can nominate representatives and make representations to governors or managers. Their more active participation in local education administration will depend on whether parent associations intend and are able to take part in the running of the nation's schools. The aims and associations of these parent or parent–teacher associations are very varied, and they seem to grow more freely in schools which serve a socially homogeneous area than in others; they exist most frequently in artisan and middle-class neighbourhoods and are found more often in nursery and secondary schools than in primary. Examples of the work of parent–teacher associations show that they can be a powerful instrument of educational progress. Their effectiveness can be considerably increased if the basis of association were communal rather than sectional; parent–teacher groups which take an active interest in all the broader aspects of education are the exception rather than the rule. There might be much more concern to form such groups if the reward of representation on education committees and similar bodies were offered to them. Examination of local administration suggests that too narrow a field is harvested in the choice of people to serve on education committees and local school bodies. The belief among councillors that the verdict of voters at a council election should be the only passport to participation in local government should give way to the conviction that education should have a wider appeal than that of ordinary local government and politics. Many parents would be glad to serve on government and managing bodies and local education committees if given the chance. Local education administrators should possess the will and the wit to bring them in. In so doing they would do well to remember the prudent rule of the London County Council, that no parent may become a manager while he has a child in the school concerned; parents with children who have left school may be the people to nominate.

TEN YEARS PROGRESS IN HORTICULTURAL SCIENCE

Hormones and Horticulture

The Use of Special Chemicals in the Control of Plant Growth. By George S. Avery, Jr., and Elizabeth Bindloss Johnson, with the collaboration of Prof. Ruth M. Addoms and Prof. Betty F. Thomson. (McGraw-Hill Publications in the Botanical Sciences.) Pp. xi+326. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 27*s*.

TWELVE years ago Avery and Burkholder, with other collaborators, translated "Die Wuchstofftheorie" (Boysen-Jensen) and published a very useful introductory account of "Growth Hormones in Plants" which reviewed the literature concerned with the discovery and isolation of highly active substances from plant tissues, and with the application of these substances and chemically prepared compounds to plants. The ensuing interval has witnessed a rapid and wide extension of the list of synthetic compounds of very high activity, and has also afforded some, but perhaps not as yet sufficient, time in which to estimate the value of their practical application on a commercial scale to cultivated plants. The present volume deals with this expansion and the more practical applications, as the sub-title indicates.

The preface contains the remark that, "a chemical revolution is sweeping through the agricultural world"—others may think it is seeping through some parts of the world—and that, "by the application of minute amounts of growth controlling hormones we enter an important new era". Whether or not such bold claims be true, there can be no doubt that the diversity of the uses to which these substances can be put affords great interest to chemist, botanist, horticulturist and practical growers of many crops. To cater for such diverse readers the text has been prepared on broad general lines, without undue technicality.

The term 'hormone' is used in the widest possible sense, to permit, for example, the inclusion of a discussion of the use of dinitro-cresylic acid to thin out fruit blossoms, and the application of ethylene chlorohydrin to terminate dormancy (here reverting to the classical derivation of the term). Somewhat surprisingly, a chapter is included on the use of colchicine in the production of polyploid varieties.

A tabular presentation of the results of many experiments, made with a fairly wide range of chemical substances on many plants in an endeavour to facilitate plant propagation by acceleration of rooting from cuttings, is a valuable feature; it occupies a quarter of the whole text and is even then far from complete. A further list of unresponsive plants is provided; but the discussion of the results from the point of view of the later growth of the stimulated cuttings is perhaps not sufficiently critical. The statement that the use of such compounds is now standard practice does not generally apply to Great Britain.

The extensive tests made in America on the control of the pre-harvest fall of apples, by means of both sprays and aerosols, are well reviewed; as yet the difference in response shown by varieties remains to be fully explained; but in wind-swept districts this treatment has proved of high value, especially overseas. Another chapter is concerned with the stimulation of the ovary by chemical means and the subsequent seedless development of the fruits, a subject of current interest at research stations in Great Britain, where the process of parthenocarpy is being analysed into distinct phases. As this example shows, it is well-nigh impossible for any text to be quite up to date in such a subject. Again, a valuable table shows the range of plants that have responded to the applied chemicals. The authors have very rightly taken up a more critical attitude when reviewing the application of such compounds to seeds in attempts to stimulate early growth; these have been generally unsuccessful. As elsewhere in the book, there are helpful illustrations showing the injury that high concentrations may cause to plant tissues, and lists of the plants that have been damaged by selective weed-killers are given.

Prominent specialists have co-operated with the authors by supervising the preparation of the reviews of their own particular subjects, so that the text has an authoritative air; each chapter concludes with a general evaluation of the methods reviewed, although there is a slight tendency towards a favourable verdict discernible in the judgments. The chapters are briefly summarized, and selected references are freely provided. Author and subject indexes are also provided. The format maintains the well-known high standard of presentation associated with the publishers.

In such a rapidly developing subject, plant physiologists, after reading this book, are left to work out their own theories, and to discard their older ones; chemists will make new substances of yet greater activity, and no doubt together these workers will evolve new theories to explain the relationship between chemical structure and physiological activity. The horticulturist must try repeated tests with more varieties of his plants; no one can yet predict the reaction of related species in regard to weed-killers. But all these workers, together with a body of present-day and future students, will be grateful for this review of a decade's progress in applied science.

M. A. H. TINCKER

GOODNESS DEFINED

The Definition of Good

By Dr. A. C. Ewing. Pp. vii+215. (London: Routledge and Kegan Paul, Ltd.; New York: The Macmillan Company, 1947.) 12*s*. 6*d*. net.

FROM age to age, men have contemplated the problem of good; not infrequently, however, they have found themselves discussing what *things* are good, an entirely different question. Dr. A. C. Ewing is quite clear; his concern is with the former. This being so, he sets out to offer stout resistance to subjectivism and to naturalism in ethics. Why exactly does he do this? Because these tenets erode, as it were, any rational basis, and therefore render the superstructure of moral obligation insecure. The approach is positive and impressive—criticism, counter-criticism and the development of an appropriate alternative. The author modestly (and no doubt rightly) declines to put pressure upon "people to do what they know to be their duty"; unluckily, however, the number of readers of this book cannot be expected to be very great, and outside them must be a multitude by whom guidance—perhaps even direction—would willingly be accepted. In a word, we need an interpreter, somebody like Thoré, who in his day demonstrated to the uninitiated the power and majesty of the Barbizon painters; for, power and majesty these pages possess, but they are not easy reading.

An example occurs quite early (p. 4) in dealing with the advance of scepticism in ethics. The author fastens upon the belief that, in the minds of many, ethics are bound up with religion. This may well be so; but few would deliberately maintain that these activities are identical, or that the failure to hold to the one necessarily—or even probably—invalidates the other. As Dr. Anderson Scott once put it, they "interlock", a phrase which at once suggests that they can well be separated. And separable they must be, if both are to fructify.

Again, the axiological dilemma—a matter of taste rather than of objective truth—admits of no answer beyond that expressed with exceptional beauty and humility by the late Prof. A. E. Taylor (1926), that we shall never find what we are not sincerely looking for, and very likely value almost at zero. The instrument is there, but the will to use it is not.

Ethics thus emerges as a study *sui generis*, incapable of reduction or derivation to or from any other subject. In an illuminating chapter, concepts like good, right, obligation, are said to be capable of being related to some non-ethical forms, without the possibility of identity with any combination of such. Nevertheless, on the next page, the proof of the pudding ['s goodness] is [still] in the eating, implication and all.

'Good' is then subjected to analysis in terms of 'ought', using Moore's expression "worth having for its own sake", and the pro attitudes of Ross. 'Fittingness' becomes the king-pin of ethics rather than moral obligation. The author gives three excellent reasons for this choice, the strongest—it seems to me—being that belief that the proposed act is fitting is a necessary (and sufficient ?) state of mind to be in before any moral obligation can be willingly accepted. Inversion is easily seen to make nonsense.

One cannot expect to discuss a book on ethics without trespassing over other cultivated ground. The very nature of the subject invites excursions;

there is no trespass without wilful damage, and a little *Ausflug* can be wholly innocuous. Such a venture is rendered attractive by what Dr. Ewing has to say about art, or rather about works of art. 'Right' and 'harmonious' are words applicable to composition and balance; it is possible perhaps to go further and to assert that any "*merely* [my italics] rational analysis" is wholly incapable of adequate discernment in matters of æsthetic fittingness. The interesting thing is, however, that this is precisely the upshot, in analytic form, of Ruskin's lovely passage in his "Law of Help" ("Modern Painters", vol. 5), wherein he stakes his all upon composition as an individual achievement. Without it there is no picture; it is the creation of *that* artist, and of nobody else.

All these meditations may serve to show how rich in content is "The Definition of Good", and more, how valuable in suggestiveness. The historical pattern of ethical thought is present throughout as an unobtrusive background against which the author hangs his own definition, set off in a delicate frame. Yet he will not expect a crowd to be there gazing at it; in a better world there might be,

> "But knowledge to their eyes her ample page
> Rich with the spoils of time did ne'er unroll. . . ."

F. I. G. RAWLINS

OPERATIONAL CALCULUS AND ITS APPLICATIONS

Modern Operational Calculus

With Applications in Technical Mathematics. By Dr. N. W. McLachlan. Pp. xiv+218. (London: Macmillan and Co., Ltd., 1948.) 21*s*. net.

THIS book is intended as an introduction to operational calculus based upon the transform of $f(x)$ defined by

$$\varphi(p) = p\int_0^\infty \exp(-pt)f(t)dt,$$

that is to say, the Laplace transform multiplied by p. The function $\varphi(p)$ so defined is identical with what Heaviside called the operational form. The advantage of the present treatment over Heaviside's is that the theorems of operation can be placed upon an impeccable basis without the necessity for acts of faith. The contents are: 1, the Laplace transform; 2, rules of the operational calculus; 3, solution of ordinary linear differential equations with constant coefficients; 4, solution of partial linear differential equations with constant coefficients; 5, evaluation of integrals; 6, derivation of Laplace transforms; 7, Laplace transform for a finite interval; impulses.

This last chapter is stimulating and makes accessible the theory of a method of outstanding importance. There are six appendixes concerning matters on which the reader should be more fully informed. These articles form what the author calls the "mathematical limit gauge". Indeed, a valuable feature of this work is the actual checking of the validity of operations, such as inverting the order of integrations, integration of infinite series, term-by-term differentiation and so on.

Although the book is intended for postgraduate engineers and technologists, it will be seen from the foregoing remarks that the presentation is more rigorous than is usual in this kind of work. This departure is greatly to be welcomed, for should a costly design be based upon intuitive reasoning and the reasoning prove false, the result may be disastrous.

This book will no doubt appeal to a wider class of readers than the author expects. It should certainly be regarded as indispensable by all engaged in the many branches of science in which the operational calculus, to which Dr. McLachlan has made important original contributions, is a powerful tool.

L. M. MILNE-THOMSON

AN INTRODUCTION TO RADIO ENGINEERING

Essentials of Radio

By Morris Slurzberg and William Osterheld. Pp. xii + 806. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

THE object of this book, according to the preface, is to describe at an intermediate level the principles of operation of thermionic valves and their associated circuits. It is intended for students at technical institutes or for radio technicians wishing to improve their basic knowledge of the operation of radio and electronic equipment; and, while it deals primarily with the applications of valves and associated circuits to radio receivers and transmitters, it serves also to give a general background to other industrial applications of electronic techniques.

The book achieves its declared purpose very well. For this very reason, the serious engineering student proceeding to a university degree is not likely, however, to find it very useful. It is essentially a technician's rather than an engineer's text-book.

The reader is assumed to have an elementary knowledge of electricity and magnetism, the authors having wisely avoided the fault, all too common in books of this sort, of beginning their book with an elementary course on electricity and magnetism. The reader's knowledge is 'refreshed' at appropriate points by restating fundamental relations in elementary theory in an appropriate practical form. Though the purist will find something to complain of in many of these practical restatements, the class of reader for whom the book is primarily intended is not likely to suffer much on account of an occasional lack of rigour. The analogy between radio and coal supply in Chapter 1 seems rather unnatural, and is unlikely to add to the understanding of the subject.

In spite of the title, the book deals almost exclusively with equipment. Wave propagation, though briefly mentioned, is not dealt with adequately. The appendixes provide much useful reference data in a convenient form, although, of course, the symbols and terminology are American, as also is the bibliography. From the point of view of the British reader, at least, the latter point is rather a pity since, though the field is necessarily not so large as the American, there are a number of British publications which could usefully have been included.

The book is excellently produced, as we have come to expect of books from these publishers, and the radio technician and others concerned with the operation and maintenance of electronic equipment will find it a useful general text- and reference-book.

W. R.

A Hundred Years of Chemistry

By Prof. Alexander Findlay. (100 Years Series.) Second edition. Pp. 318. (London: Gerald Duckworth and Co., Ltd., 1948.) 21*s.* net.

THE numerous admirers of Prof. Alexander Findlay's writings will welcome this new and revised edition of a remarkably interesting and useful book. His masterly review of a century of effort and achievement in the constantly widening domain of chemistry constitutes a great tribute to the author's power of taking a comprehensive view of a subject of bewildering complexity and expressing it in a way as attractive as informative. The book offers something to all who have an interest in chemistry; its character is such that it will be equally at home on the chemist's favourite bookshelf or in the lending or reference section of a library.

The new edition takes cognizance of the outstanding advances that chemistry has made in the last ten years, notably in the fields of atomic constitution, artificial transmutation of elements, nutrition, and medicinal specifics. During this fateful period, as the author remarks, "we have been the witnesses of one of the greatest achievements of the human mind, the utilization of atomic or nuclear energy. That this great achievement should have found its first use in human and material destruction by an atom-bomb is one of those tragedies which are a constant challenge to man's moral nature but which do not diminish the greatness of the achievement or make more difficult the application of man's knowledge to beneficent ends." In this work Prof. Findlay maintains his high reputation for accuracy; the only error of any note that has caught the eye of one with a peculiar interest in the immediate subject is the usurpation of hydrogen by hydroxyl in the molecule of chloroiodomethanesulphonic acid (p. 65).

The numerous footnotes illuminate in a striking way the writer's painstaking care and industry in going to original sources for his detailed information. The thumb-nail sketches of celebrated chemists given at the end of the book under the heading of "biographical notes" are very apt and replete with the concise facts so often needed and so hard to find.

JOHN READ

Historical Geology

The Geologic History of North America. By Prof. Russell C. Hussey. Second edition. Pp. xi+465. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 19*s.*

THIS account of the geological history of North America is intended for students and readers interested in the cultural aspect of the science. The author, like all geologists, believes that a knowledge of the major events in the history of the earth should be part of a liberal education. Since a new edition has been called for only three years after the first publication of the book, it appears that he has attracted the public he desires and deserves. This revised edition has been simplified by removal of some material (an all too rare operation in the preparation of new editions) and has been brought up to date, and better illustrations have been given where possible.

The arrangement follows that of the first edition. First are presented the general principles of historical geology, the organisation of the geological record, the nature and significance of fossils and the main concepts of evolution. Special aspects of these general principles are developed in the account of the geological history of North America which follows. For example, the causes of marine transgressions are discussed with the Cambrian, the habitats of marine animals with the Ordovician, coral reefs with the Silurian and so on. For each geological period, the lands and seas and their sediments, the climate, crustal disturbances and life are dealt with in this order so that the story keeps moving. Emphasis throughout is placed on the development of life in this story, and this emphasis is increased as we approach modern times. The account of Tertiary life includes the geological history of the horses, elephants and other mammals, and the last chapter, one of more than thirty pages, deals with that of man. The illustrations, many from the great American museums, are abundant and mainly excellent. In spite of its sub-title, this book will be of service outside the United States as well as within, for it presents the broad essential principles by which the history of the earth's crust everywhere should be read.

The Mineral Key

By Howard B. Graves, Jr. Pp. viii+178. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 20*s.*

MOST of this small book consists of mineral identification tables which are preceded by introductory chapters on equipment and chemicals needed and methods of identification. The determinative tables list some six hundred minerals, classified primarily according to colour, streak, cleavage and presence or absence of water, but optical properties and specific gravity are not included. Isomorphous series are each shown under one species, and varieties are omitted: amethyst and agate are, for example, excluded although many rare minerals are listed. The tables will be useful to experienced mineralogists, more particularly for determining opaque minerals; but in a book intended for amateurs more emphasis should, perhaps, have been placed on the caution necessary in identifying minerals with certainty. The price seems rather high for a book of this format. P. A. S.

Insect Pests of Glasshouse Crops

By Prof. Herbert W. Miles and Mary Miles. Second edition, revised. Pp. 200+24 plates. (London: Crosby Lockwood and Son, Ltd., 1948.) 15*s.* net.

A SURPRISINGLY large number of species of insects and related small animals occur in glasshouses and cause injury to the plants that are grown therein. A perusal of the present handbook will convince the reader on this point: at the same time it will enable him (or her) to recognize any of these creatures that he is likely to come across. The grower, whether he has only a conservatory or farms an acre or more of glasshouses, will find just the sort of information that he needs and what control measures are best suited for any particular enemy of his plants. The first edition of the book appeared in 1935, and the present issue is a revised version with some modification as regards the presentation of the text and the addition of several new illustrations. Since the book no longer has pages of trade advertisements incorporated, the increase of price from 8*s.* 6*d.* to 15*s.* is reasonable under present-day conditions. Well printed and illustrated, and with a good index, it is indeed excellent value for the price.

A KINETIC APPROACH TO THE THEORY OF THE STRENGTH OF GLASS

By S. M. COX
Wear Glass Works, Sunderland

THE theory advanced by A. A. Griffith[1] in 1920 has served as a background to subsequent theories of rupture in brittle materials. The solid is regarded as an elastic continuum containing microscopic flaws, and the failure of the material under a stress less than that corresponding to the 'theoretical strength' (that is, as estimated from the heat of vaporization, or from Van der Waals' equation) is attributed to the enhancement of the stress in the locality of the flaws rather than to any intrinsic weakness of the material itself. Subsequent theories[2,3] have assumed the acuteness of the flaws to be modified either by chemical attack by the atmosphere or by viscous yield in order to account for the apparent decrease in strength of glass with increasing duration of load. This is but one of the difficulties which can only be met by rather artificial additions to the theory.

The advance in recent years of the theory of liquids suggests that a kinetic approach might directly resolve many of the difficulties—at least in so far as glass is concerned. Broadly surveying the phenomena connected with the fracture of glass, one is impressed by the consistency of some aspects and by the consistently variable nature of others. The glazier's control of the crack-direction, the geometrical simplicity of some crack-systems—the simple conchoidal crack and the familiar helixical cracks in tubing—these aspects are suggestive of elastic-continuum crack-propagation initiated by a flaw. On the other hand, there is the spread of results under tensile test, the dependence of strength on time, on sample size and on temperature; if these effects arise from intrinsic properties of the glass and are not due to the experimental conditions, an element of time, an element of size and an element of energy are to be accounted for. An atomic view provides three such intrinsic elements: there is the period and the energy of vibration, and the size of the atoms or ions themselves, and it is conceivable that the observed phenomena might be some macroscopic manifestation of the discrete nature of glass.

Kinetic treatment has been neglected on the grounds that the activation energy necessary for the spontaneous formation of flaws is too high, in comparison with the thermal energy, for the possibility of such an origin of flaws to be a significant factor except near the boiling point. This would certainly seem to be the case if one accepts Griffith's estimate that at least 10^8 atoms must synchronize and be in phase to initiate rupture. A little consideration will show, however, that this possibility cannot be dismissed so lightly. In the first place, a local discontinuity of any kind must cause a stress enhancement of the same type as that caused by a crack, and a local change in state of the material must provide such a discontinuity. There is now ample evidence to support the contention that atomic configuration-changes, characterized by comparatively small activation energies, can take place in glass. The large differences in volume associated with these changes become apparent in the annealing range. The necessary activation energy may then correspond to the annealing point rather than to the boiling point. Further, in the case of such 'configuration-flaws', the critical size, which must be achieved if the flaw is to grow, will be set by the relative stabilities of the two types of configuration and not by Griffith's criterion—which latter defines only the subsequent stage in the rupture sequence where the configuration-flaw gives place to the first true rupture. Finally, an immense number of opportunities are provided for the occurrence of a local accumulation of energy. The energy is so rapidly interchanged (vibration frequency 10^{12} cycles per second) and the atoms so numerous (Avogadro's number 10^{23}) that in a test lasting one second on 1 c.c. of glass the rare event is sought some 10^{35} times.

The problem of expressing the tensile strength in kinetic concepts must turn on the question of determining the conditions under which a local disorder will become cumulative. On Maxwell–Boltzmann theory all energies are possible, so there is no difficulty in supposing a single atom to become sufficiently energetic to leave its site in the array. The atom can only retain this energy for a time comparable with the period of its oscillation, unless its immediate neighbours are equally energetic. This event would also provide the opportunity for configuration-change, so that both the energy and the opportunity for a configuration-change would occur where a group of (say w) neighbouring atoms becomes activated. The experiments on annealing-range configuration-changes disclose that they are pressure-sensitive and reversible. If then the event in which the w atoms become activated occurs under stress, because this occurrence causes a stress enhancement at the boundaries of their locality, there will be a critical value for w, for larger values of which the extent of the configuration-flaw will grow and lead to eventual rupture, while for smaller values the flaw will have but a transient existence.

Taking into account the reversible nature of the change, an expression can be derived for the probability of such an event in terms of the temperature and stress. Assuming that each such event will lead to rupture, the tensile strength is given by setting this probability equal to one half—in accordance with the usual definition of the breaking point as that stress at which the chances of rupture and survival are equal.

$$\frac{\nu N t}{\tau}\left[A\left(\exp.\frac{S}{kT}-C\right)\exp-\frac{B}{kT}\right]^{w}=\frac{1}{2}.$$

In this expression νN is the number of different ways in which the w neighbouring atoms constituting a flaw-nucleus may be chosen out of the N atoms in the sample under a stress proportional to S; t is the duration of test, and τ the vibrational period of the atoms. A and C are constants depending upon the composition and temperature of the glass, and B is the activation energy for the configurational-change involved. It will be noticed that there is a minimum tension corresponding to $S = kT \log_e C$ below which the glass should not break, however large the sample or prolonged the test.

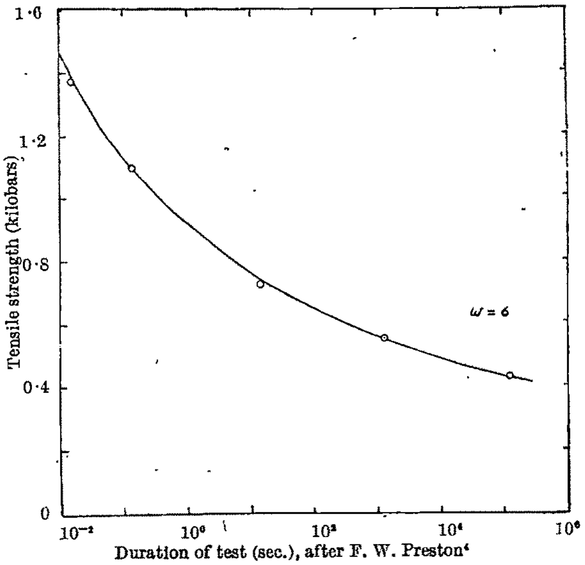

Fig. 1

The relations between strength, duration of test and sample size given by this expression are in good agreement with experiments, as may be seen in Figs. 1 and 2. The spread of experimental results is also predictable (Fig. 3). In all these figures the full line represents the calculated results and the crosses or circles the observed values. The derivation of the formula is given in more detail in work already published[9].

In making these comparisons the value of w must in most cases be found by trial. It is natural to suppose that the value of w for a surface flaw would only be half that for an internal flaw, for on purely geometrical grounds a flaw of half the volume of an internal flaw would be equally weakening on the surface—in the same way the roughness of the surface on an ionic scale will influence the strength because of the smaller value of w required to make an equally effective flaw. One has then the same type of explanation of surface effects as in Griffith's theory, but on a sub-microscopic level. One of the troubles with Griffith's findings was that his flaws should be visible, and at least in the ordinary course of events there is no visible evidence for them. On the contrary, as Murgatroyd has shown, visible single scratches are sometimes ineffectual in weakening the glass. This is an interesting point, because on the basis of the above equation, such a scratch—in spite of the enhanced stress at its edge—is not necessarily the most probable origin for the breakage; the size of the sample (N) must also be taken into account, and where the size is reduced to the area of the scratch, the probability of breakage from this particular locality is reduced in the ratio of this area to the effective area of the whole sample.

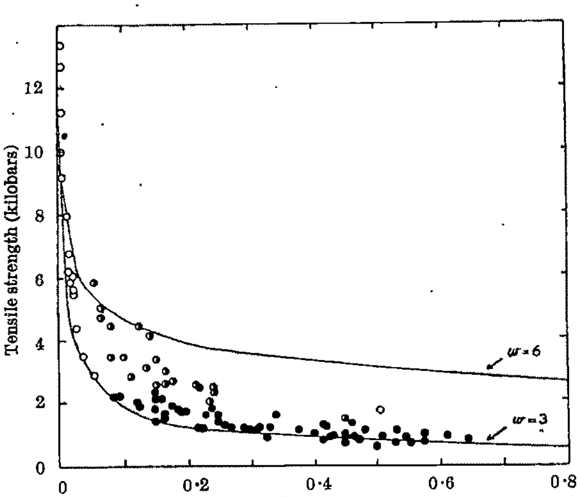

Fig. 2. o—o—, Data by A. A. Griffith[5]; ●—●—, data by E. J. Gooding[6]; ◐—◐—, acid-polished specimens

Another feature of brittle rupture which finds a ready explanation on this theory is the behaviour of the crack-propagation velocity and the nature of the broken surface. The velocity of crack-propagation is set by the calculable probability of the atoms at the crack-tip becoming activated. It has a maximum corresponding to the requirement that the energy cannot be transferred from atom to atom in a time less than τ. When this maximum is reached, there is no corresponding limit in elastic theory to the stress-enhancement due to the flaw; and a stage is reached at which the probability of breakage is not limited only to the crack-apex; but cracks also develop at an angle to the principal stress. This is the point at which the mirror surface gives place to the hackled surface so often observed on broken surfaces.

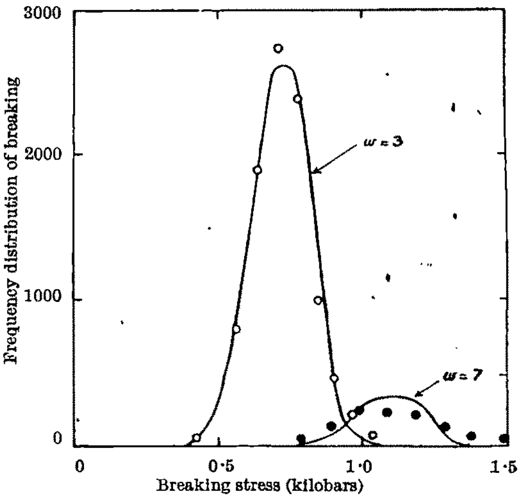

Fig. 3. o—o—, 9983 samples, after B. P. Dudding[7]; ●—●—, 115 fire-polished samples, after Holland and Turner[8]

The numerical assessment of the probabilities and the determination of the effect of temperature on the strength of glass is made difficult because one cannot assume that all atoms have average activation energies. A consequence of the random arrangement of the atoms must be a spread of activation energies, and as those of lower value are obviously of most significance, it would be necessary to have some knowledge of the shape of the distribution curve. Assuming the distribution of activation energies to be similar to the distribution of inter-ionic distances from X-ray data, a crude estimate can be made, and in this way it is found that the product of the quantities on the left-hand side of the equation given may well be of the right order, that is to say, one half.

To summarize, if the strength of glass does depend on the spontaneous development of flaws under the applied stress in the way described, then breakage can only occur if the stress exceeds a certain minimum. Above this minimum stress the probability of breakage increases with sample size and with time for the same reason, namely, that such increases provide increased opportunity for the rare event which is automatically recorded by the fracture of the specimen.

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MINIMUM OXYGEN LAYER IN THE OCEAN

By Dr. R. B. SEYMOUR SEWELL, C.I.E., F.R.S.
University of Cambridge
AND
Prof. LOUIS FAGE
Institut Océanographique, Paris

THE fact that there is in every ocean a zone of minimum oxygen is of interest not only to the physicist and chemist but also to the biologist, and it is very desirable that we should know what influence this layer has on both the quantitative and qualitative distribution of the fauna, or, alternatively, whether this layer is to be attributed to the biological activity of the fauna and especially of the plankton. The facts that we possess regarding this problem are very impressive and are somewhat contradictory.

The depth at which this minimum oxygen layer is found differs in different oceans and in different regions of the same ocean. In the Atlantic its depth below the surface varies from 350 to 900 m. In the Indian Ocean, according to the results obtained by the *Dana* and the *Mabahiss*, the distribution of oxygen is less simple; the oxygen content of the tropical surface water decreases abruptly within the thermocline to an intermediate minimum, which at all stations north of the equator is found at a depth of about 150 m.; below this level the oxygen content of the water increases slightly and then again falls abruptly in those regions in which the Indian Intermediate Current flows southward at a depth of approximately 250–1,500 m., and at this depth the actual content may be well below 0·1 ml. per litre. In the Pacific the depth of this layer varies between 400 and 1,000 m.

Le Danois[1] considers that this zone of minimum oxygen is the result of stagnation of the water at this depth and the presence of what he terms 'fossilized' water. Wüst[2] concludes that in the Atlantic Ocean between lat. 45° S. and 20° N. the layer of minimum oxygen coincides with the boundary between the surface stratum and the Antarctic Intermediate Water, while farther north it marks the boundary between the surface water and the water that has flowed out of the Mediterranean Sea; he, too, considers that the low oxygen content is the result of stagnation or of very slow horizontal movement. Wüst[3] also claims that over the greater part of the Atlantic Ocean the depth of the layer coincides with the 8° C. isotherm; but in the North Atlantic between lat. 30° and 45° N., owing to the influx of Mediterranean water, this isotherm lies about 600 m. below the minimum oxygen layer. Vallaux[4] points out that in the Atlantic between lat. 0° and 20° N. the fall in the oxygen content, which commences at 200 m., reaches a minimum at the 400–800 m. depth, and thus stands in close relationship to the complete disappearance of the phyto-plankton and to the relatively great abundance which the zoo-plankton manifests at this level.

T. G. Thompson[5] and others show that there is a marked correlation between the minimum concentration of oxygen and the maximum concentration of carbon dioxide, and they claim that the reduction of oxygen is due almost entirely to the oxidation of organic matter at this depth. Seiwell[6] stresses that the minimum oxygen concentration may primarily be due to either a proportionally greater oxygen consumption per unit of time or a slower renewal by horizontal currents; and he suggests that biological activity plays an important part in fixing the minimum oxygen concentration at mid-depths. This may be brought about by a maximum concentration of oxidizable organic matter at the depth of the minimum oxygen concentration, or, if the supply of oxygen by horizontal currents varies with depth, by vertical variations of biological activity, causing the ratio, oxygen utilized/oxygen supplied, to be continuously increased as the depth of the minimum oxygen concentration is approached both from above and below. He points out that the minimum oxygen concentration in the western North Atlantic tends to occur at the level of the density value $\sigma_t = 27{\cdot}232 \pm 0{\cdot}008$, which implies that the settling velocities of organic particles are perceptibly slowed at this level, resulting in an increase of oxygen consumption per unit time. He adds, "however, the results of oceanic biological investigations have not yet furnished evidence for the adoption of this hypothesis".

Redfield[7] claims that it has been found that in the North Atlantic the phosphate maximum and oxygen minimum may be derived chiefly from the oxidation of organic matter within a few hundred metres of the surface in the region about lat. 40° N., and further that in the equatorial region additional phosphate is added to and oxygen removed from the water by processes other than isentropic movement, namely, by the sinking of decomposing organisms from the surface of the tropical ocean to considerable depths. In the belt between lat. 20° S. and 25° N. it is difficult to explain the observations without assuming that active decomposition is occurring down to a depth of at least 600–800 m. Harvey[8] maintains that the reduced concentration in the oxygen-poor layer is due, in part, to consumption of oxygen during the oxidation of falling particles of organic matter, coupled with slow renewal through eddy-conductivity from the surface layer and from the deep water below; minimum values are found in the most stable part of the water column, where the density of the water is increasing most rapidly with depth, and, furthermore, the size of these particles decreases rather rapidly with time. Thus we are faced with the question, "Is this oxygen consumption caused by bacterial action on dead or decomposing organic particles?"

Redfield[7] has pointed out that the quantity of such falling organic debris is not great in the relatively barren areas of the Atlantic, and that its oxidation is likely to be nearly complete before it has fallen as deep as the layer where the least oxygen is found. The work of ZoBell and Anderson[9,10] has shown that the number of bacteria that could carry out this destruction of organic particles is high in the photic zone of the ocean in the top 20 m., but then decreases extremely rapidly until it is at a minimum at about 500-m. depth, increasing again rapidly at the bottom in the sediments. ZoBell[11] claims that "considering that most of the organic content of sea-water is highly refractory to bacterial oxidation, it appears that the concentration of organic matter is near the threshold of the requirements for bacteria, which probably accounts for the paucity of bacteria in the ocean". It would thus appear to be very doubtful whether the minimum oxygen layer can be attributed to the bacterial decomposition of dead organic matter, and one must therefore consider the possibility that the living plankton may be the cause.

It is frequently stated that the total amount of living plankton steadily and progressively decreases with depth, and Schott[12] has given figures that indicate this very clearly. Off the Californian coast, at five stations carried out in 1933 at a point 100 miles west of Cape Arguello in Central California by the steamship *Pioneer* of the United States Coast and Geodetic Survey, the total plankton showed a steady decline from the surface downwards, and the minimum oxygen layer, with a concentration of oxygen as low as 0·2 ml. per litre, lay at a depth of about 100 m., with an increase of oxygen to more than 2·0 ml. per litre at greater depths. Hauls with the Nansen closing-net over intervals of about 100 m. showed that the total amount of plankton appeared to decrease uniformly with depth, so that there was less plankton below the oxygen-minimum layer than in it. Dr. Revelle, who participated in these investigations, states that at the time he thought that the controlling factor for the plankton concentration was food-supply, that is to say, organic material settling from the photosynthetic zone near the surface and being eaten as it sank. Sverdrup, Johnson and Fleming[13] (p. 872) state that on the coasts of California the diminution of pelagic life with depth is not in agreement with that of oxygen, since between 150 and 800 m. oxygen is almost entirely absent, but one captures Copepods and other planktonic forms at these depths. Bogorov[14] reached the same conclusion regarding the distribution of the Copepoda in the White Sea and Barents Sea. But this steady decrease in the quantity of plankton with depth does not always hold good. In the Gulf of Panama, A. Agassiz[15], during the cruise of the *Albatross*, found between 366 and 732 m. depth an azoic zone which contrasted strongly with the richness of life observed above and below this depth, and it is between 400 and 500 m. that in this region one finds the zone of minimum oxygen (0·6 ml. per litre). In the same region the observations made on board the *Dana* by Joh. Schmidt[16] and P. Jespersen[17] show a remarkable quantitative difference in the plankton; they found, in contradistinction to the observations of others, that the plankton is incomparably richer at a depth of 1,000–1,500 m.w. (500–750 m. depth) than it is nearer the surface at 50–300 m.w. (25–150 m. depth); the volumes captured per hour for a net having a diameter at the mouth of 1·50 m. are, on the average, 527 c.c., as compared with 262 c.c., the observed minimum of 105 c.c. occurring at a depth of about 600 m.w. (300 m. depth).

A study of the hauls of Copepoda made at different depths by various expeditions in different regions seems to indicate that, as one passes from the surface to greater depths in the tropical region, there is at first a steady reduction in the number of both species and individuals until one reaches a depth of some 400–500 m.; the species inhabiting this upper zone are clearly warm-water, surface-living forms. At this point the curve changes its direction and the number of species and individuals begins to rise again; these latter species are cool-water, deep-dwelling forms. The greatest concentration of individuals of these deep-dwelling species occurs at some distance above that of the greatest concentration of species, and in most cases seems to fall near the level of the zone of minimum oxygen (Sewell[18]). In this connexion it is of interest to note the results obtained during recent under-water sound investigations that have been carried out by the United States Navy Electronics Laboratory, San Diego, California. These investigations have revealed the presence of a deep layer in the ocean that causes a scattering effect. This scattering layer lies at or near the surface at night; but before sunrise it commences to descend and during the day-time is found to lie at depths ranging from 150 to 450 fathoms (274 to 823 m.); in the evening, starting before sunset, it ascends again to the surface. This layer seems to be present throughout the tropical and temperate regions of the Pacific, but was absent or only sporadically present in the Antarctic during the period of almost permanent daylight. In some regions double or even treble layers were detected at different depths.

It has been suggested that these layers of scattering may be due to the presence, and to the daily vertical migration under the influence of light, of a concentration of zoo-plankton, and that the double or triple layers may indicate that different species, or different stages of development of the same species, may be implicated. The most common depth at which the scattering layer was found is about 350 fathoms (640 m.), and hauls with the closing-net gave evidence that at about this depth there seemed to be indications of a considerable increase in the numbers of Euphausians and *Sagitta*.

Sverdrup, Johnson and Fleming[13] (p. 730) remark that "a few scattered observations indicate that organisms are found even when the oxygen content is as low as 0·1 ml. per L.". During the *John Murray* Expedition several hauls were carried out at intermediate depths at certain stations in the Arabian Sea; in each case the net used was one having a diameter at the mouth of one metre. Here the minimum-oxygen layer lies at a depth of 600–1,000 m., and in the table below is given the actual numbers of four species of Copepods that were taken in this zone:

Station identity number	186	172	76	172	76
Depth in m.	0–250	0–400	0–600	0–850	0–1500
Eucalanus attenuatus	—	250	—	473	—
,, *elongatus*	191	302	2,061	567	351
Rhincalanus nasutus	167	744	803	1,249	—
Pleuromamma xiphias	—	222	—	247	—
Oxygen concentration in ml. per litre	0·536	1·02	0·323	0·455	1·09
Duration of haul	1 hr.	2 hr.	1 hr.	2 hr.	1 hr.

The main haul was taken at the maximum depth indicated. These observations clearly point to the presence of a flourishing population, belonging to several species, in this zone of minimum oxygen; and for the maintenance of this relatively rich fauna there must be an equally rich food-supply.

Another point of interest is to be found in the prevalence at these intermediate depths of species that possess a red or purple coloration; this is particularly striking in the Crustacea and in certain species of fish. Above this level, planktonic animals tend to be colourless, while below it many species of fish are brown or black. In the words of Sverdrup, Johnson and Fleming, "the further examination of the distribution of such organisms and their adaptation to the extreme condition represents one of the fascinating biological problems".

Another problem that requires investigation is whether this minimum-oxygen layer forms an obstacle to the admixture of surface-living forms with those of greater depths. In this connexion Dahl[19] has pointed out that a large number of species of Copepoda are to be found in the upper stratum, while below this lies a second, extending down from about 300 to 1,000 m., in which there are only a few Copepods that are common to the upper layer; and the few species that are common to both strata are mostly rare in one while being numerous in the other, in which they are really at home. It is interesting to note that Grace Pickford[20] in a study of *Vampyroteuthis infernalis*, captured by the *Dana*, shows that the vertical distribution of this Cephalopod appears to be limited in all the oceans by the zone of minimum oxygen. According to Torsten Gislen[21], the minimum-oxygen zone will equally play a part in the distribution of the benthonic species; basing his conclusion on the catches of Echinoderms made by the *Albatross* off Panama and the California coast, he believes that not only is there a remarkable paucity of the fauna at a depth of 500–600 m., but also he shows that the species above and below this level are entirely distinct.

It is thus abundantly clear that a detailed study of this zone and of the fauna that inhabits it, as well as a comparison of the faunas above and below it, present a number of problems that are of considerable interest, not only to the taxonomist but also to the physiologist and biochemist; and it seems worth while, now that oceanographic investigations are once again being contemplated or actually carried out, to direct the attention of investigators to this zone.

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USE OF LIQUID FUELS

CONFERENCE AT BIRMINGHAM

IN scientific research, and in the application to industry of the results of research, the problems encountered are of increasing complexity. Scientific workers engaged in this work feel the necessity for consultation or collaboration with specialists in fields other than their own. Indeed, it has become a commonplace that most industrial research problems require teams of experts from many branches of science and engineering. The interdependence of the various branches of science and technology has long been recognized; but collaboration between the corresponding societies has been practised to a noticeable extent only in comparatively recent years. Joint conferences, such as that held at the University of Birmingham during September 21–23, are therefore welcome not only for their immediate value, but also as tokens of the growing integration of science.

The Birmingham Conference on "Modern Applications of Liquid Fuels" was organised by the Institute of Petroleum and the Institute of Fuel, in recognition, as Mr. J. A. Oriel, the president of the Conference, put it, of their joint responsibility for ensuring that all kinds of fuel available in Great Britain are used with maximum efficiency. The scope of the Conference was wide, and while the use of oil fuels for prime movers, as in petrol and Diesel engines, was in general excluded, the seven sessions, into which the Conference was divided, furnished opportunities for the exchange of information, experience and opinion about the design, operation and performance of burners and furnaces, agricultural driers, Diesel rail traction-engines, the use of oil in the gas industry, and the principles of combustion-chamber design for the gas turbine.

One evening was devoted to a lecture on the uses of liquid fuel in domestic heating, largely based on the work of the Liquid Fuel Installations Committee of the Institute of Petroleum. This Committee is preparing a report on the use of liquid fuels for domestic heating at the request of the Minister of Fuel and Power, similar to the Post-War Building Studies arranged by the Ministry of Works in reference to electricity, gas, and solid fuels. The oil fuels chiefly used, for both space- and water-heating, are liquefied butane and other gases, kerosine, and Diesel oil. The development of modern domestic appliances burning kerosine was described, and attention was directed to their high thermal efficiencies; such appliances have many advantages in rural areas.

The Conference was concerned in the main, however, with the industrial application of oil fuels for purposes for which coal and petroleum may be used alternatively, and the chief scientific interest of the Conference, therefore, was the opportunity which it provided for making a comparison of the two fuels. In Great Britain, coal always has the advantage of lower cost, and the opinion is widely held that but for this advantage, oil would always be used in preference to coal. Oil has a higher calorific value, and is certainly easier to handle and store than is coal; and it is cleaner in use—qualities which account, for example, for the replacement of coal by oil for use at sea. Petroleum, moreover, has a very small content of mineral matter; this becomes concentrated in residual fuels by distillation, and the use of distillate fuels is accordingly entirely free from the troubles due to ash-formation which are associated with the use of coal. The same is, however, not true of residual fuel oils; although ash-formation is much less than with coal, it may give rise to serious problems, as, for example, in the gas turbine, where ash-deposition is a major obstacle in the development of this prime mover to use heavy fuel oils. Fuel oils, of course, still have a great advantage over coal in this connexion; but it is important to realize that the use of oil is by no means entirely free from the problems which attend the use of coal. Thus both fuels contain sulphur, and the fuel oils available for use in Great Britain often have high sulphur contents (two per cent or more) which may cause deterioration of product quality in the steel and metal industries. In this respect, therefore, the advantage frequently lies with coal or the fuels derived from it, namely, producer-gas and coal tar.

The oil flame has a higher radiation efficiency than the gas flame—a property which has contributed to the improved results which have been obtained in the manufacture of steel in the open hearth furnace by conversion to oil firing. Several other factors are, however, also involved, and there was considerable divergence of opinion at the Conference as to the relative merits of oil and coal in this and similar applications. In some instances, conversion to oil firing has shown little advantage; but the bulk of the evidence supports the conclusion that it leads to greater steel production. It is, in fact, probable that the use of oil has made an important contribution to the record steel output in Britain now being obtained. It cannot, however, be immediately concluded that conversion from coal to oil firing is necessarily advantageous to the steel industry.

In the first place, consideration must be given to the cost of any technical advantage, and the differential price of coal and oil in any particular locality is clearly a most important factor. This is illustrated very clearly by the American experience which was recorded in one of the papers contributed to the Conference. The steel industry in the United States was originally based on coal; but oil firing was adopted, at a time when fuel oil was relatively very cheap, with a consequent increase in thermal efficiency and steel production. At present, however, the supply position and the changing price differential have started a reverse trend from oil to coal firing. The combined use of oil and coke-oven gas has given good results, and it is suggested that other combinations, including such fuels as coke breeze and powdered coal, might be used with advantage.

A second factor in the achievement of improved results with oil firing is the greater ease of control which attends the use of oil. Partly in consequence of this, the application of oil firing has usually been made with greater instrumentation and scientific control, and it seems likely that improved results could also be obtained with producer-gas if similar methods were employed. This consideration suggests that the comparison between oil firing and conventional practice with producer-gas has not always been fair to the latter. It is certainly also true that the comparison has sometimes been unfair to oil firing because of unsuitable furnace design. Thus it has been shown that the jet action due to the greater velocity of the oil flame may result in a serious air inleakage which could be avoided in a furnace designed specifically for the utilization of oil.

The use of fuel oil in glass furnaces also gives the advantages of greater ease of control and increased rate of glass melting, but the intense radiation from the oil flame results in increased wear on refractories; and although increased efficiency could be obtained by greater preheat of the combustion air, it is concluded that oil firing is not at present economic in comparison with an efficient producer-gas system. It is evident that the assessment of the relative values of coal and oil firing involves many technical and economic factors.

It is not possible, in this short article, to do justice to the vast amount of technical information which has been provided by the many papers contributed to the Conference. Readers interested, for example, in the application of the Diesel engine to rail traction, in modern developments in agricultural drying processes, or in any of the other modern applications of liquid fuels in the field already indicated, will be well advised to consult the Conference records; when published, these will constitute a valuable work of reference which will perhaps be the major achievement of the Conference.

F. H. Garner

OBITUARIES

Dr. S. E. Sheppard

Samuel Edward Sheppard died in Rochester, N.Y., on September 29, aged sixty-six. Dr. Sheppard was born in Catford, and was educated at St. Dunstan's College, Catford, and University College, London. There he obtained the degree of B.Sc. by research in 1903, his thesis dealing with the theory of the photographic process and involving a repetition and extension of the earlier work of Hurter and Driffield. This work was greatly extended in his research for the D.Sc. degree, which was granted in 1906 for a thesis which was published in 1907 jointly with that of C. E. K. Mees under the title of "Investigations on the Theory of the Photographic Process". Much of the work had been published in a series of papers in the *Photographic Journal*, the *Transactions of the Chemical Society*, and in the *Proceedings of the Royal Society*.

In 1906 Sheppard was awarded an 1851 Exhibition for two years and went to Marburg, where he worked with Karl Schaum, professor of photo-chemistry and the editor of the *Zeitschrift für Wissenschaftliche Photographie*. Sheppard's work was on the molecular structure of sensitizing dyes and particularly of pinacyanol, the red sensitizer discovered only a short time before by Homolka, of the Hoechst dye-works. The study of the structure and behaviour of dyes like pinacyanol continued to attract Sheppard's attention throughout his entire life. After a year in Germany, Sheppard went to Paris, where he worked with Victor Henri at the Sorbonne on colloid chemistry.

In 1913 Sheppard accepted an invitation to take charge of the sections of physical and colloid chemistry in the Kodak Research Laboratory, which had just been organised under the direction of C. E. K. Mees at Rochester, N.Y.

His early work there dealt principally with the physico-chemical properties of gelatin, and a number of papers were published dealing with the measurement of the viscosity of gelatin solutions, the measurement of the jelly strength and the elastic properties of gelatin jellies, the setting and melting points of gelatins, the drying and swelling of gelatin, and the structure of gelatin in solution, in the jelly, and in the dry state. These early papers deal primarily with the definition of the properties to be measured, with methods of measurement, and with instruments for making the measurements. As soon as the methods were so perfected that reproducibility was possible, it became evident that further progress in the realm of the physical and chemical properties was dependent on the nature of the sample. This work culminated in 1929 in a description of a procedure for making a standard gelatin by methods easily reproduced in the laboratories. A scientifically valuable by-product of this work was the manufacture and consequent availability of such a standard de-ashed gelatin to laboratories in general, biological as well as chemical.

After the First World War, Sheppard began to turn his attention to the structure and properties of silver halide emulsions, and his first work took the form of a study of the distribution of the sizes of the silver halide grains in an emulsion, the intention being to work out the relation between this distribution and the sensitometric properties of the material. Thus began a long series of studies that are not yet completed, though much progress has been made in the last thirty years. At the same time, working with Dr. Ludwik Silberstein and with Mr. A. P. H. Trivelli, Sheppard began to consider the action of light on the halides and the nature of sensitivity, and about 1923 a series of papers was published on the theory of photographic sensitivity and of exposure, which resulted in the presentation of the concentration speck hypothesis, according to which the sensitivity was related to discontinuities in the silver bromide lattice, presumably due to some foreign substance. At the same time, a very notable group of studies was going forward on the measurement of size frequency distribution, which led to the development of microscopic methods by which the grain-size frequency distribution could be measured for practical silver bromide emulsions.

The well-known sensitizing property of gelatin in the photographic process led to a systematic study of the difference between photographic gelatins in their sensitizing power and the nature of the substance in gelatin which conferred sensitivity. By a painstaking series of analyses, it was found that the sensitizer inherent in natural gelatin was concentrated in the liquors obtained by the acid treatment of the raw material after liming; and eventually it was found that the chemical properties of the sensitizer corresponded to those of allyl thiourea, and that therefore the gelatin sensitizer was essentially one which could produce silver sulphide specks in the silver bromide crystals.

This discovery is perhaps the major advance made in Sheppard's scientific career. All further study of the photographic properties of gelatin, of the nature of the sensitivity of silver halides and of the latent image have been conditioned by it. Its publication won for Sheppard instant recognition. He was awarded the Adelsköld Medal of the Swedish Photographic Society in 1929, the Progress Medal of the Royal Photographic Society in 1928, and the honorary fellowship of the Royal Photographic Society in 1926. In 1928 he delivered the Hurter and Driffield Memorial Lecture to the Royal Photographic Society, and in 1930 received the Nichols Medal of the American Chemical Society.

From that time, Sheppard's scientific work covered a prodigious range of knowledge. Besides the work on the latent image, he studied such matters as the photovoltaic effects, that is, the electrical response of silver halide to light, the colloidal structure of film-base materials and their physico-chemical and elastic properties, the nature of development, and particularly the nature of dye sensitizing, the adsorption of sensitizing dyes to silver halides, the structure of the layers which they formed, and their sensitizing effects.

Sheppard realized that the solution of the problem of dye sensitizing would involve not only the coupling of the dye to the silver halide lattice by absorption, but also an understanding of the nature of the absorption of light by the resonance structure of the dye. Thus he studied the absorption spectra of dyes in various solvents, in vapour phases, and when adsorbed to surfaces. This is the field which was chiefly engaging his attention when his health failed.

While never robust, Sheppard enjoyed good health until a few years ago, when he began to have trouble with his eyes, which culminated in the loss of one eye from glaucoma. At the same time, his heart was affected, and continued to fail until in January 1948 he found it necessary to resign from his position with the Kodak Company.

More than any other single worker, Sheppard has been responsible for our present knowledge of the theory of the photographic process. He explored every section of the chemistry of that process, and everywhere his studies brought light.

C. E. K. MEES

Prof. Kornél de Kőrösy

WE regret to announce that Dr. Kornél de Kőrösy, professor of biology in the University of Budapest, died on July 14. Son of the famous Hungarian statistician, Joseph de Kőrösy, he was born at Budapest in 1879. As a student of medicine, he entered the Institute of Physiology in the University of his native city, never to leave it permanently until his death.

Until the First World War he was mainly interested in problems of metabolism, especially in those of resorption, and one of his publications foreshadowed the insulin problem. He spent at that time practically all his summer vacations at some world centre of learning. On one such occasion, in New York, Jaques Loeb invited him to stay at the Rockefeller Institute, where they were working together on osmotic problems; but Kőrösy decided to return to Hungary, which proved fatal for his life and career.

During most part of the First World War and some time after, he was acting director of the Physiological Institute, shouldering an unusual load of teaching in difficult circumstances. Anti-semitic racial prejudice, rising quickly after the War, forced him from this position and practically stopped his experimental work. He turned to genetics and developed a mathematical theory of coupling between genes, published as a long monograph in German. During the last ten years of his life he cleared up important problems on crossing-over interference.

Political terror made him conscious of his Jewish duties, and he soon rose to the presidency of the Hungarian Pro-Palestina Association. The Nazis deported his younger son, who failed to return. The months of terror, the loss of access to his precious library and files, even after the War, hastened his death.

Prof. Kőrösy belonged to those men whose respect for truth and justice was embedded in a nature fond of beauty and full of humanitarian sentiment. He was a well-known figure at physiological congresses in Paris, Budapest, London, Boston, Leningrad, Venice, Edinburgh, and was loved for his kindly, gentle nature by friends and students the world over. Music was his favourite recreation, and he loved to travel, always taking his family with him. His wife, whom he married early in life, and three of his children, survive him.

M. POLANYI

WE regret to announce the following deaths:

Sir Wilfrid Grigson, C.S.I., sometime director-general of revenue in Hyderabad, author of "The Aboriginal Problem in the Central Provinces and Berar" and other anthropological studies, on November 26, aged fifty-two.

Dr. Louis Rapkine, director of the Department of Cell Chemistry, Pasteur Institute, Paris, on December 13.

Dr. Marjory Stephenson, M.B.E., F.R.S., of the Medical Research Council Unit for Chemical Microbiology, on December 12, aged sixty-two.

We are glad to learn from Prof. J. Heyrovský, of the Charles University, Prague, that Dr. F. Běhounek, whose death was announced in *Nature* of December 4, is alive and well.

NEWS and VIEWS

U.S. National Academy of Sciences: Agassiz Medal

THE National Academy of Sciences presented the Alexander Agassiz Gold Medal and honorarium for 1948 to Dr. Thomas Gordon Thompson at the autumn meeting of the Academy held at the University of California, Berkeley, on November 15. Dr. Thompson, professor of chemistry and director of the oceanographic laboratories of the University of Washington at Seattle and Friday Harbor in the State of Washington, has long been a leader in investigations of the complex chemistry of the ocean, with special attention to the waters of the north-east Pacific, Puget Sound, the San Juan Archipelago and the Bering and Chukchi Seas. Under his inspiration and leadership, his associates and students have devised and developed effective methods and techniques for the isolation and the quantitative determination of many of the elements and their compounds which occur in minute concentrations in sea water. Examples of such are iron, lithium, silicon, manganese, aluminium, boron and radium, the fluorides, phosphates and silicates, the isotopes of the elements of water and the dissolved gases, and the ionic ratios of the major constituents of sea water in various parts of the ocean. In organising the oceanographic laboratories at Seattle and Friday Harbor, Dr. Thompson brought together specialists in the fundamental sciences associated with the various departments of a great university, and directed their attention and stimulated their interest in the many problems presented by oceanic phenomena. Dr. Thompson has been chairman of various international committees, particularly the committee of the International Association of Physical Oceanography, appointed for the purpose of establishing standard units and procedures for the promotion of studies of the chemistry of the ocean. Established by Sir John Murray in 1911, the Alexander Agassiz Gold Medal is awarded by the Academy "for original contribution in the science of oceanography to scientific men in any part of the world".

William Davidson of Aberdeen: 1648

A TERCENTENARY Memorial Lecture entitled "William Davidson of Aberdeen: The First Scots Professor of Chemistry" was delivered in Marischal College, Aberdeen, on November 26, 1948, by Dr. John Read, professor of chemistry in the University of St. Andrews. Davidson was a native of Aberdeenshire who graduated at Marischal College in 1617 and then migrated to France. Here he became known as an authority on medicine, pharmacy and chemistry. He gave instruction in medical chemistry of the Paracelsian type, and was appointed a physician to the French king. In 1647 he was nominated to the first chair of chemistry to be founded in France, at the Jardin du Roi in Paris, where he entered upon his duties in 1648. Davidson was one of the three earliest occupants of a chair of chemistry, and the first native of the British Isles to become a professor of chemistry. Owing to religious and medical jealousies, he was forced to resign the chair in 1651; thenceforward, until 1667, he was chief physician to the King of Poland. He died in Paris in 1669. Besides various medical works, Davidson wrote an early text-book of chemistry entitled "Philosophia Pyrotechnica". Although imbued with the ideas of his alchemical predecessors, and given to associating the doctrines of chemistry with religious and metaphysical conceptions, he has claims to be called a chemist rather than an alchemist. Davidson was particularly proud of the blue blood of Scotland that ran in his veins; in 1629 he obtained a patent of nobility from Charles I and thereafter styled himself 'Nobilis Scotus'. To account for his entering the medical profession he told his readers that "professors of medicine were invested with such honour by the kings of Scotland that they enjoyed a title equal to that of earls".

U.S. Scientific Mission to Japan

THE Supreme Commander, Allied Powers ('SCAP') has announced that a United States scientific mission to Japan "is scheduled to arrive in that country on or about November 26 and may be expected to remain until about December 18, 1948". The mission is composed of five distinguished American men of science, selected by the National Academy of Sciences, and includes: Dr. Detlev W. Bronk, chairman of the National Research Council, foreign secretary of the National Academy of Sciences, and president-elect of Johns Hopkins University; Dr. E. C. Stakman, chief of the division of plant pathology and botany, University of Minnesota; Dr. Zay Jeffries, vice-president of the General Electric Company, and general manager of its chemical department; Dr. I. I. Rabi, professor of physics, Columbia University; Dr. Roger Adams, head of the department of chemistry, University of Illinois, and chairman of the scientific advisory group that visited Japan in 1947. Dr. Bronk is chairman of the present mission. The new mission is making the visit at a time when some forty thousand Japanese scientific workers, representing all fields of research, are participating in the election of 210 members for the country's first National Science Council. This election, due on December 20, is considered to be of unusual interest as it is thought to represent the first attempt of scientific workers of any country as a whole to elect members of its supreme scientific organ. The mission is expected to review progress made by Japanese men of science in the development of democratic national organisations for scientific activity. It is expected to bring up to date the report submitted by the previous advisory group; recommendations by that group served as guides to 'SCAP' sections in judging proposals of the Japanese for the reorganisation of national scientific bodies. The group proposes to spend approximately one day each in Sendai, Sapporo, Kyoto and Hiroshima; the remainder of the time will be spent in Tokyo in discussion with 'SCAP' personnel and Japanese scientific workers.

Vacation Work for Technical Students

THE fourteenth annual report for the year ending October 1948 by the Vacation Work Scheme of the Imperial College of Science and Technology has recently been published. The Scheme aims at providing work in Great Britain and abroad for students during their vacation, and it is almost entirely voluntary in nature. During 1948, 829 students participated as compared with 705 in 1947 (this increase being largely due to a greater number of overseas students); and this year's total was made up of 200 overseas students and 629 British, 194 of these latter having worked abroad. The bulk of the British students (591 in actual number) was drawn from the three Colleges which form the Imperial College, namely, the Royal College of Science, Royal School of Mines, and City and Guilds College. In January 1948 an international conference was held in London at the Imperial College to unify the procedure and minimize the correspondence for the exchange of students between different States; ten countries sent representatives and an organisation was founded called the International Association for the Exchange of Students for Technical Experience. During the recent summer vacation this Association has successfully exchanged 950–1,000 students between the participating countries. The next conference of this Association will be held in Copenhagen during January 3–7, 1949. As a result of the establishment of this Association, central organisations have been set up in each country; the governors of the Imperial College have decided to broaden their machinery, coping with international exchange, to include undergraduates from other universities and colleges in Great Britain, and this information has already been communicated. The aim is to make the scheme self-supporting, if possible, through an affiliation fee payable by each college concerned (based on the number of students sent abroad) together with a registration fee payable by the student. Offers of financial assistance have already been made by Messrs. Lever Brothers and Unilever, Ltd., Rolls Royce, Ltd., and the National Oil Refineries, Ltd., and it is anticipated that the scheme will be in operation for the summer of 1949.

Management Abstracts

FOR these days, *Management Abstracts*, the first issue of a series of specialized publications dealing with the different aspects of management to be published by the British Institute of Management (London), seems rather a lavish production. It covers some two hundred British and Overseas publications dealing with current developments in management science, and the abstracts are classified under such headings as general management and organisation; works management; personnel and welfare; financial management; distribution; supplies; transport; statistics; public administration; education and training. *Management Abstracts* will be issued monthly and is intended to cover, eventually, material published in any part of the world; but on its present scale such cover can scarcely be obtained without very considerable expansion on the first two issues. The basis of selection of the abstracts is not apparent, although the more important articles published in Great Britain in recent months appear to be included. For the annual subscription of 30*s*. (or 3*s*. per copy) the business executive may, as it is claimed, save some time; but the production is unlikely to give him much that he cannot readily obtain, and probably earlier, from an efficient firm's library. The publication also includes "Book Notes", which are brief and mainly descriptive. This section might perhaps be expanded with advantage and the length of the abstracts curtailed, particularly if the latter were made purely descriptive and not, as in these two issues, in part critical.

Milk: from Cow to Consumer

WALLACE PRODUCTIONS, LTD., have just finished making a documentary film for the United Dairies, Ltd. This film, which lasts for about half an hour, is called "The Milky Way" and was shown to a small invited audience on November 30 at the British Council Theatre in London. It tells the story of the production, pasteurization and distribution of milk under modern conditions with particular reference to London (the United Dairies, Ltd., being one of the major suppliers of milk in the London area); but the theme is representative of any large town or city where rigid precautions are taken with regard to the safety and purity of milk. The general scientific level of the film has been designed for showing to student-nurses and the senior science forms of secondary schools; but it can be recommended to any intelligent person, scientific or otherwise. The emphasis stressed throughout is on hygiene; but the full account of milk from cow to consumer is amply and well told. The makers and sponsors of this documentary film are to be congratulated on a production which has entertainment value as well as scientific and educational interest.

Information Services Committee

ARISING out of the Scientific Information Conference held last June, the Council of the Royal Society has set up a Standing Committee on Information Services. The terms of reference are: (1) to advise on means of improving existing methods of publishing, abstracting, indexing and distributing scientific information and, in particular, to advise on the implementation of the recommendations of the Royal Society Scientific Information Conference; (2) to report to the Council of the Royal Society.

The following have agreed to serve on the committee: Sir Alfred Egerton (*chairman*); the Treasurer and the Secretaries of the Royal Society; Dr. T. E. Allibone; Prof. J. D. Bernal; Dr. G. L. Brown; Sir David Chadwick; Mr. J. E. Cummins; Dr. G. M. Findlay; Dr. J. E. Holmstrom; Dr. A. King; Dr. J. G. Malloch; and Dr. C. F. A. Pantin.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been announced: J. S. Campbell, agricultural officer, Nigeria; W. Galley, agricultural officer, Uganda; W. Smith, agricultural officer, Gold Coast; E. A. Edmonds, geologist, Gold Coast; N. J. Guest, geologist, Tanganyika; K. Taylor, geologist, Uganda; R. B. Smith, agricultural officer, Trinidad; J. H. Wheelan, assistant conservator of forests, Gold Coast; J. D. Farquhar (assistant conservator of forests, Palestine), assistant conservator of forests, Tanganyika; R. B. McConnell (geologist, Tanganyika), senior geologist, Nigeria. The following have been appointed assistant conservators of forests in the countries mentioned: M. F. H. Abraham (Kenya), M. C. Argyle (Kenya), J. H. Blower (Tanganyika), W. Carmichael (Tanganyika), D. M. Duggie (Gold Coast), W. G. Dyson (Kenya), C. A. Walker (Nigeria), F. Weston (Uganda).

Lectures on Manufactured Foods

THE Nutrition Panel of the Food Group of the Society of Chemical Industry is arranging a series of meetings for discussing the problems affecting manufactured foods in Great Britain. Sausages, soups, ice-creams, cake mixtures, jam, processed cheeses, and the like, form an important part of present-day dietary; but there is still much to be learned about their nutritional significance. The first meeting of this series will be held on Wednesday, January 5, 1949, at Gas Industry House, 1 Grosvenor Place, London, S.W.1, at 6.30 p.m., and the subject will be "The Sausage as Food". The speakers will include Mr. H. P. Blunt, of the Ministry of Food, on "The History of Sausages"; Mr. Osman Jones and Mr. M. G. Read, on the composition of fresh and processed sausages respectively; and Dr. Magnus Pyke on "Sausages and Nutrition".

University of Glasgow

PROF. C. M. YONGE has been re-appointed a director of the Scottish Marine Biological Association. Dr. Angus Macphail has been appointed lecturer in public health, and Dr. W. G. A. Begg an assistant in anatomy. Mr. John Green has resigned from the Departments of Biochemistry and Medicine to become lecturer in clinical chemistry in the University of Aberdeen, and Dr. J. D. Morrison from the Department of Chemistry to take up a post with the Council for Scientific and Industrial Research at Melbourne. Mr. J. C. Gunn, of the Department of Mathematics, University College, London, has been appointed to the Cargill chair of natural philosophy in succession to Prof. T. Alty.

For the current session 266 students have been admitted into the Faculty of Pure Science. Some 144 research students have been registered, including fifty working in the Royal Technical College, nine at the Hannah Institute and three at the Agricultural College.

Announcements

THE Medal of the Royal Society of New South Wales has been awarded to Prof. W. L. Waterhouse, research professor of plant pathology and agricultural botany in the University of Sydney. The award is made for meritorious contributions to the advancement of science: this may include administration and organisation of scientific endeavour. The citation states that this year's award is made to Prof. Waterhouse in recognition of his services to the Society and his valuable contributions to the field agricultural science, particularly with regard t research on cereals.

PROF. R. E. MORTIMER WHEELER, professor archæology in the University of London, formerl director-general of archæology in India, will serve adviser to the Government of Pakistan in setting u a department for the exploration and preservation ancient sites and in forming a museum at Karachi.

PROF. LINDSAY TASMAN RIDE has been appointe vice-chancellor of the University of Hong Kong. A an Australian Rhodes Scholar he graduated i medicine at Oxford, and has been professor physiology at the University of Hong Kong sinc 1928. Prof. Ride had an active military career i China during the Second World War, since when h has been in command of the Hong Kong Volunte Defence Force.

DR. E. J. BOORMAN has been appointed chi chemist of the Anglo-American Oil Co., Ltd. Aft postgraduate research at the Imperial College Science and Technology, London, Dr. Boorma entered the Department of the Government Chemis where he was concerned with petroleum product Soon after the end of the War he joined the staff Esso Development Co., Ltd.

DR. ARTHUR J. BIRCH, of the Dyson Perri Laboratory, Oxford, has been appointed Smithso research fellow of the Royal Society for four yea from January 1, 1949. The fellowship is tenable the University of Cambridge, where Dr. Birch wi continue his researches in organic chemistry.

THE following appointments have been made i the University of London: Dr. B. J. Lloyd-Evan to the Kennedy chair of mechanical engineerin tenable at University College; Dr. W. F. Jepson, t the University readership in applied entomolog tenable at the Imperial College of Science an Technology.

A PROOF copy of Prof. Geitler's revision of th Cyanophyceæ in the "Natürliche Pflanzenfamilien (1 *b*, 1942), most of the copies of which were destroye during the War, has been sent by the author to Pro F. E. Fritsch (at the Botany School, Cambridge). will be loaned for short periods to anyone who interested on application to him.

THE Rationalist Press Association has arrange a course of six lectures under the general title "Intuition and Reason" to be delivered by D Maurice Burton. The lectures will be given eac Monday during January 17–February 21, 1949, the Alliance Hall, Palmer Street, Westminster, Lo don. Tickets for the course cost 12*s*. (9*s*. for R.P. members), and may be obtained from the Rationali Press Association, Ltd., 4–6 Johnson's Court, Fle Street, London, E.C.4.

THE Institution of Naval Architects is offering th Martell Scholarship in Naval Architecture, to be hel at one of the following institutions: Universities Glasgow, Durham (King's College, Newcastle-o Tyne), or Liverpool, or the Royal Naval Colleg Greenwich. It is tenable for three or four years and annual value £175. It is open to British apprentices pupils, less than twenty-three years old, in the roy dockyards or private shipyards. Entries close January 15; full particulars can be obtained from th Secretary, Institution of Naval Architects, 10 Upp Belgrave Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Method for Obtaining Wool Roots for Histochemical Examination

A USEFUL technique has been developed for obtaining moderately large samples of wool roots for histochemical examination. It is hoped that this technique will assist in elucidating the mode of formation of the wool fibre and also facilitate investigations already in progress in this laboratory, which are concerned with developing methods for removal of wool from sheepskins.

Fig. 1

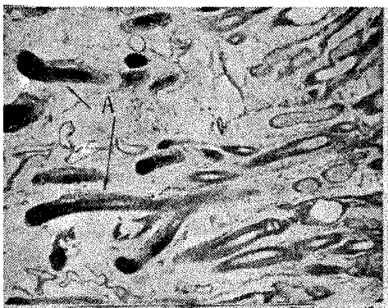
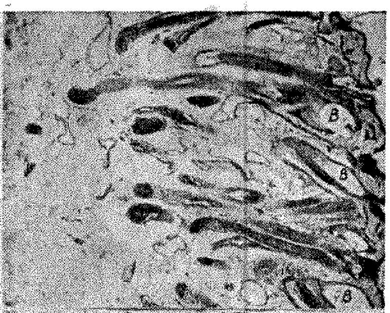


Fig. 2



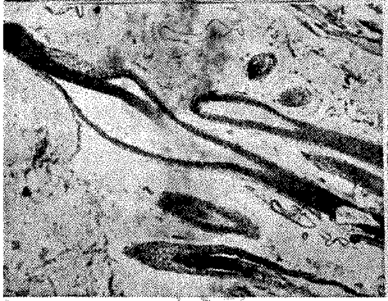


Fig. 3

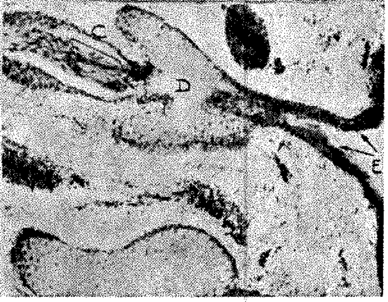


Fig. 4

Formerly, it was possible, by tedious dissection of)ulled staples of wool, to obtain a few milligrams of vool roots; by the new method 0·5–1·0 gm. can)e collected with little effort.

A piece of sheepskin approximately 500 sq. cm. s cut from a fresh skin, most of the wool removed vith scissors, and the remainder clipped to within -3 mm. of the skin. The skin is then placed flat, vith flesh side down, on a piece of plate-glass. A eeswax–rosin mixture (2 : 7 by weight) at about 0° C. is then run over the surface of the skin to a hickness of about 5 mm. When the wax has set, t is lifted with the adhering skin from the glass and he skin peeled away from it gradually, leaving a vax sheet with the wool fibres firmly embedded in t and with the roots exposed. The roots can be arvested readily by clipping with an electric razor, r preferably with a fine animal-hair clipper. The lipping must be done carefully to avoid contamination with particles of wax. By this method it is ossible to obtain material which is all of subpidermal origin.

To ascertain the nature of the tissue thus obtained, sections of the skin have been made before and after removal of the roots. The results of this examination are recorded in the accompanying photomicrographs.

A section of skin is shown in Fig. 1 with the wool roots intact and visible at points marked *A*. In Fig. 2 is seen a section of the same skin after removal of the fibres. Some tissue breakdown is evident; but the lining epithelium and the basal cells are for the most part intact. The vascular areas shown at *B* are probably artefacts and may be due to the removal of sudoriferous glands during sectioning. In Fig. 3 a complete root with shaft is seen *in situ*. The open area around the fibre is, no doubt, an artefact; but it does indicate that there is no strong attachment of the fibre to the follicle lining around the zone of keratinization. Fig. 4 shows the effect of removal of the root on the neighbouring structures. Derangement of the epithelium is evident at *C*; but, as shown at *D*, little or no sebaceous gland tissue has been removed, and the epidermis at *E* is intact.

The yield of roots from the wax sheets is affected by the depth of the root in the skin, and from measurements made on a number of different skins it was found that, whereas a root-length of 0·7–0·8 mm. yielded only 10–20 mgm. per 100 sq. cm. skin, a root length of 1·2–1·3 mm. yielded 200–300 mgm. per 100 sq. cm. skin. If the wool roots are too short for clipping, root extract can be obtained by applying a suitable extractant to the wax sheet and brushing it over the surface.

Roots have been obtained by the same technique from guinea pig skin, and no doubt the method is applicable to any type of skin.

Thanks are due to Miss H. M. Matthews for technical assistance.

WILLIAM J. ELLIS
Biochemistry Section,
Division of Industrial Chemistry,
Council for Scientific and Industrial Research,
Melbourne, Australia.
June 3.

Fine Structure of Cell Walls in Fresh Plant Tissues

THE increasing preoccupation of plant physiological laboratories throughout the world with problems of growth makes it very desirable that the details of structure in the cell wall, in growing tissue, should be known as completely as possible in the condition occurring in the living tissue itself. A good deal of the discussion arising from growth studies centres around the configuration of the cell wall, and the facile generalization of the striking results of X-ray analysis in dried material to cover the condition in fresh

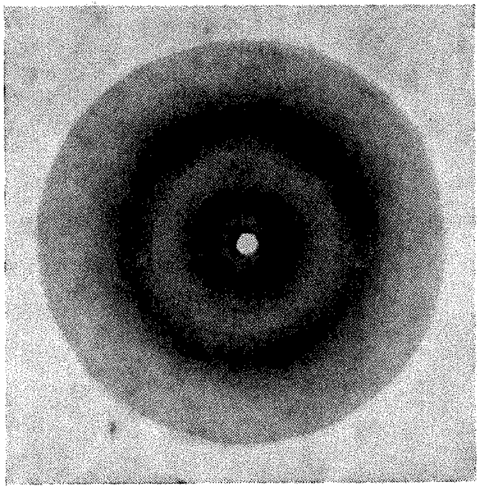


Fig. 1. X-ray diagram of a bundle of parallel filaments of *Rhizoclonium*, beam perpendicular to filament-length. The alga was put in the spectrometer straight from the culture vessel and kept running with water during the exposure. Exposure time 10·5 hr. Note that in addition to the two water haloes there is a diagram of cellulose identical with, though weaker than, that of the dried specimen in Fig. 2

tissue is perhaps not *a priori* legitimate; for it is highly improbable that the dried material, even when rewetted, can be considered with any exactitude as equivalent to the original material fresh from the plant. In point of fact, attention was directed some years ago to the implications of the fact that in bacterial cellulose the planes of 6·1 A.-spacing lie parallel to the surface of the cellulose plate only after drying[1], so that the demonstration of the special orientation of dried walls of *Valonia*[2] and *Cladophora*[3] did not necessarily guarantee a similar orientation in fresh material.

It should, however, be noted that the drying of bacterial cellulose might involve nothing more than a packing of flat plates (from the bacterial capsules) flat on the substrate, and the orientation might, in fact, be present in each plate even in the fresh cellulose.

More recently even the existence of crystalline regions in fresh material has been called into question[4]. It is observed that when fresh cotton hairs are photographed without drying, then the diagram shows merely the water haloes with no sign of a cellulose diagram; this latter appears only after the specimen has dried, but remains present on rewetting.

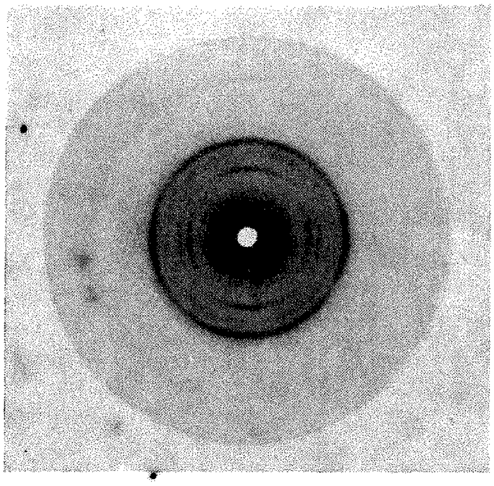


Fig. 2. The same bundle of filaments after drying. The photograph is much stronger but otherwise is identical with the cellulose diagram of Fig. 1

Correspondingly, Berkeley and Kerr regard the cellulose in cotton hairs as existing in the form of single, parallel cellulose chains separated by water molecules. It seemed to us that there were other, more probable, interpretations of these results. First, the water halo in fresh cotton is very intense and could possibly mask the cellulose diagram, the intensity of which might well be reduced by the absorption of X-rays by the water and by an angular dispersion of the crystalline regions caused by the presence of the water between them. Rewetting of dried specimens would not produce the same effects since it is well known that dried cellulose has a lower regain than fresh material, and in any event the lumina do not refill once the cells have dried.

We therefore decided to re-examine the condition of fresh material both for the existence of micelles and for special orientation, and therefore chose as our material an alga, *Rhizoclonium*, which will tolerate abundant water during the exposure in an X-ray spectrometer, and cambial tissue from *Pinus sylvestris* as an example of a rapidly growing tissue.

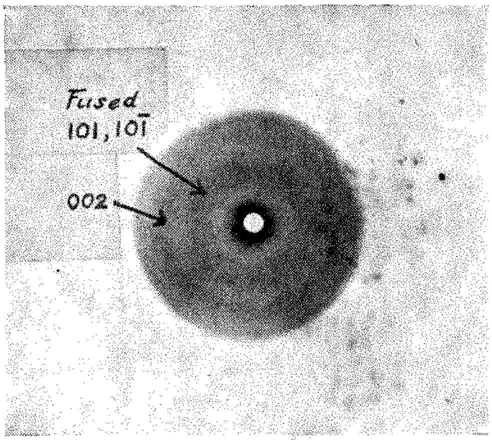


Fig. 3. X-ray diagram of a pellet of fresh cambial tissue maintained in equilibrium with air at 94 per cent relative humidity during the exposure. The 002 and fused 101 and $10\bar{1}$ circles are clearly visible

Both were collected fresh and kept wet during exposure, except that with cambial tissue the water halo had to be reduced in intensity by mounting the tissue in a holder within which the air was maintained at 98 per cent relative humidity. The tissues were then allowed to dry, and X-ray diagrams were taken of this dried material. The resulting photographs are presented in Figs. 1, 2, 3 and 4.

In comparing the two algal photographs it should be remembered that a reduction of apparent intensity in the cellulose diagram of wet material is to be expected both on account of the intense background and of the absorption of X-rays by water. Intensity differences can therefore at the moment be disregarded. In the wet specimen (Fig. 1) the arcs of the cellulose diagram are very apparent and are as sharp as those in the dry material. Further, the disposition of the arcs is the same, and in particular the 6·1 A.-arc is missing along the meridian. Thus in this material, which had never been dried, not only is the cellulose organised into micelles, but also these in turn have already the special orientation

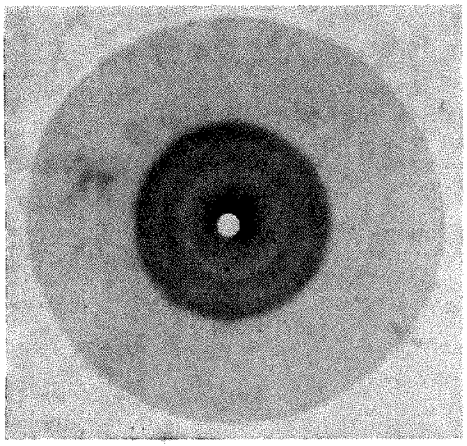


Fig. 4. Comparable photographs of a pellet of dried cambium

demonstrated in dried cells. In cambium, too (Fig. 3), the 3·9 A.-ring and the fused 5·4 and 6·1 can plainly be identified so that here, too, micelles exist in fresh tissue, much as they do in dry material (Fig. 4). In point of fact, it is probable that the 6·1 A. (101) arc is missing in untreated cambium. This point will be discussed elsewhere; it is not of importance to the present discussion, and the inner ring in the cambium diagrams is therefore treated conventionally as a fused 101, 10$\bar{1}$. It is not, of course, clear that the size of the micelles is the same in wet as in dried tissue; but it is certain that in the materials we have used, crystalline regions do exist sufficiently extensive to give rise to X-ray diagrams.

It is therefore reasonably certain that consideration of growth processes in plant cells will need to continue to be made in terms of wall structure substantially similar to that described for dried material.

The senior author is indebted to the Department of Scientific and Industrial Research for a grant to cover in part the expenses of the algal research, from the programme of which some of the present results are drawn.

R. D. PRESTON
A. B. WARDROP*
E. NICOLAI†

Botany Department,
The University, Leeds 2.
Oct. 28.

* An officer of the Council for Scientific and Industrial Research, Melbourne, Australia.

† On leave from the Fibre Research Institute, Delft, Holland.

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Extraction of Bright Coals by Anhydrous Ethylene Diamine

PYRIDINE has long been known as a good solvent for coal[1]. It is effective even at room temperature, and causes marked swelling of the coal substance. Solutions are usually prepared at the boiling point and are recognized to be at least predominantly colloidal. It has recently been found that ethylene diamine is a more rapid and in some respects more powerful solvent, its action being similar in many ways to that of pyridine. A preliminary survey has been made of its interaction with coals. As with pyridine[2], the action of ethylene diamine is retarded by the presence of moisture; commercial diamine containing 40 per cent water has very little effect at room temperature. The solvent used in this work contained less than 1 per cent water.

The process of solution of lower-rank bituminous coals is accompanied by great swelling of the solid and a large heat evolution. Dried pieces of whatever size imbibe finally about 1·2 gm. of diamine per gm. of coal. Irreversible adsorption of the solvent is observed on both residue and recovered extract; when, by a nitrogen balance, allowance is made for this, the total yield of solid products agrees closely with the weight of original coal. The extract solutions have been studied by optical and other methods and found to consist largely of colloidal particles of the order of hundreds of angströms in diameter, together with a background of somewhat smaller material (I am indebted to Dr. L. Kann of these laboratories for this information). The evidence to date does not preclude the presence of small molecules in addition; but the quantity in this form is certainly not great. Osmotic measurements (for example, vapour-pressure lowering) are unreliable because a very small quantity of ammonia is slowly but continuously evolved by coal in contact with ethylene diamine. (The source of the ammonia has not been established; in view of the small quantity produced, and the readiness with which ethylene diamine liberates ammonia on treatment with other substances, its formation may be adventitious.) In many cases, unlike the behaviour of pyridine-coal sols, the solution of extract in the original solvent continues to form a stable colloidal solution when poured into water, although it can readily be flocculated by addition of acid or of multivalent cations. The particles in aqueous solution (at pH $\sim$ 11·5) are negatively charged.

Higher rank (coking and steam) coals yield very much less extract than those of lower rank and show a much smaller degree of swelling. After 48 hours treatment in a Soxhlet apparatus containing nitrogen at atmospheric pressure, typical yields of extract, corrected for solvent, are: coals containing less than 85 per cent carbon (Parr pure coal basis), 35–40 per cent; coals containing more than 88 per cent carbon, 1–5 per cent. Anthracite is not visibly affected and yields no extract. Bovey Tracey lignite yields, in a Soxhlet apparatus, about the same proportion of extract as a low-rank bituminous coal; at room temperature the yield of extract is relatively smaller, though the swelling is much the same as with the coal. 'Humic acids' produced by oxidation of coal and purified by extraction with, and re-precipitation from, an organic solvent dissolve only to a limited extent in ethylene diamine even at the boiling point; on addition of water, however, they dissolve rapidly and completely just as in 10 per cent aqueous sodium hydroxide. Irish dopplerite swells considerably but very slowly in ethylene diamine, and very little extraction (as indicated by colour) takes place even on boiling; it is rather more soluble when water is added. The same sample of dopplerite was only slightly soluble in 10 per cent sodium hydroxide. Spruce lignin (for which I am indebted to Dr. W. G. Campbell, of the Forest Products Research Laboratory, Princes Risborough) and cellulose both swell in ethylene diamine, but yield no appreciable soluble material.

The degree of extraction at room temperature varies in an interesting manner with solvent/coal ratio, successive treatment of the same material, and coal rank. This will form the subject of a further communication. It may be mentioned here, however, that at room temperature the degree of extraction of low-rank coals rapidly approaches a limit (about 10 per cent) as the solvent/coal ratio is increased ; if the sol is then removed by filtration and fresh solvent is added, a further substantial amount of extract (about 5 per cent) is obtained. This can be repeated many times before the amount of extract becomes negligible.

It is now well recognized that coal has a colloidal structure[3]. The type of extraction phenomenon outlined in the last paragraph is characteristic of colloidal systems, although the present case appears to have some unusual features. Swelling in solvents is a normal property of colloidal substances, including polymers. In the case of coal, a thermodynamic treatment must take into account the distribution of colloidal material in appreciable concentration between both phases.

I. G. C. Dryden

Experimental Station,
British Coal Utilisation Research Association,
Leatherhead, Surrey. July 9.

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Properties of Ethylene Diamine

THE properties of ethylene diamine have been summarized by Wilson[1] and by Putnam and Kobe[2]. In the course of recent work with this substance, additional and in part contradictory information has been obtained.

Samples of commercial anhydrous ethylene diamine were refluxed with metallic potassium until the liquid became permanently dark-coloured ; it was then distilled, and redistilled to check the boiling point. At 20° C. the viscosity was found to be 1·52 cp., the density 0·893 gm./c.c. These values are rather lower than previous determinations. The kinematic viscosity is very sensitive to small quantities of water and of carbon dioxide, and its measurement has been found convenient as a rapid test for purity. A striking maximum ($\sim$ 12·7 cp.) occurs in the curve relating dynamic viscosity to water content, at a molecular proportion of approximately 1 diamine : 2 water. The refractive index is not sensibly altered by addition of up to 3 per cent by weight of water. It has also been found that the point of half-neutralization in the potentiometric titration curve can readily be detected, but is not sharp enough to be used for the accurate analysis of ethylene diamine–ammonia mixtures.

The anhydrous diamine is miscible in all proportions not only with water, but also with lower alcohols, ethers and ketones, chloro-methanes and lower benzene homologues. Addition of 2–4 per cent of water by volume has been found to effect sensibly complete separation of ethylene diamine from solution in such liquids as xylene and ether ; it is probable that earlier reports of its limited solubility in some of the above solvents have arisen from the use of insufficiently dried diamine.

Diamine is immiscible with paraffins unless a third component, such as alcohol or chloroform, is added.

So far as we are aware, the unpleasant temporary physiological discomforts which can be caused by ethylene diamine are not well known. The liquid if not washed from the skin causes blistering. One of the authors appears to be allergic to the fumes even in low concentration. The symptoms (acute fits of coughing some hours after exposure) did not in the first instance develop for some weeks.

S. G. Boas-Traube
E. M. Dresel
I. G. C. Dryden

Experimental Station,
British Coal Utilisation Research Association,
Leatherhead, Surrey.
July 9.

[1] Wilson, A. L., *Ind. Eng. Chem.*, **27**, 867 (1935).

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Solubility of Bituminous Coal in Alcoholic Potash

IN the course of some exploratory experiments carried out eighteen months ago when I was a member of the staff of the British Coal Utilisation Research Association, it was observed that appreciable quantities of some bituminous coals were soluble (or dispersible) in alcoholic potash. A Northumberland coal containing 82·6 per cent of carbon and 5·1 per cent of hydrogen (on ash-free basis) was soluble to the extent of 20 per cent. Since its solubility in aqueous potash was quite inappreciable, this coal contained no significant quantity of ulmic material ('humic acids'), such as is formed when coal is oxidized by air exposure. Moreover, the proportion of coal extracted by alcoholic potash at the boiling temperature was unchanged when the experiment was carried out in the complete absence of air.

The extracted material remained dissolved (or dispersed) on diluting the alcoholic solution with water, but—like the so-called 'humic acids' obtained by the slow oxidation of coal—was immediately flocculated to a brown powder on addition of dilute acid. The elementary composition of this material was close to that of the parent coal (both being reduced to the pure coal basis), but it contained a somewhat higher proportion of oxygen (determined 'by difference').

The presence of small quantities of water in the alcohol (or the coal) slowed down the rate of extraction somewhat, but appeared to have but little influence on the proportion of extract finally obtained.

In further experiments the same parent coal was first separated into α-(pyridine-insoluble), β-(pyridine-soluble, chloroform-insoluble) and γ-(chloroform-soluble) fractions. The γ-fraction was found to be almost completely soluble in hot alcoholic potash, the β-fraction soluble to the extent of *c.* 50 per cent and a small portion of the α-fraction was also soluble. The extracts from all three fractions were similar in their behaviour.

A South Wales 'coking' coal (containing 89·7 per cent carbon and 5·0 per cent hydrogen on the ash-free basis) was soluble only to the extent of about 5 per cent in alcoholic potash. The extract showed similar behaviour to that from the Northumberland coal. While these experiments with only two coals afford insufficient data for generalization, a decreasing degree of solubility with increase of rank is for several reasons to be expected.

One possible interpretation of the behaviour described is that the alcoholic potash effects an ester hydrolysis, and that part of the coal substance consists of 'humic humates'.

N. BERKOWITZ

Department of Chemistry,
Constantine Technical College,
Middlesbrough. July 9.

Membrane Electrophoresis in Relation to Bioelectrical Polarization Effects

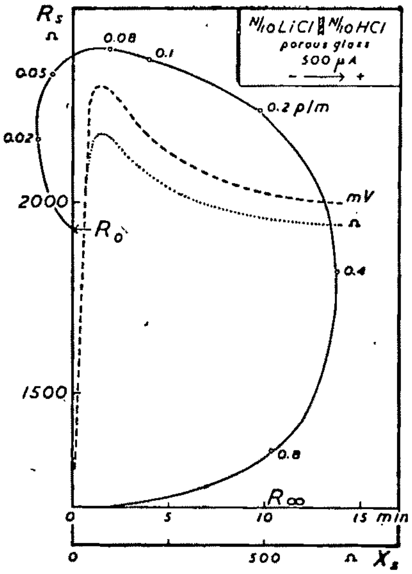
IN electrophysiology the term 'polarization' often has an ambiguous meaning. Here it will be used in the physical sense as an overall definition to include changes in the 'resting potential' of the object (membrane, nerve, skin, etc.), as well as the appearance of rectification, capacity and inductivity effects under the influence of an externally applied current. The potential changes and the rectification effects have mostly been interpreted in a qualitative manner in terms of selective ion permeability, and the capacity as 'double layers', 'dielectrics', etc.[1,2,3]. Cole[4] has recently made the unexpected observation of an inductance component in the squid axon, which he seems inclined to explain as analogous to piezo-electric behaviour. Lorente de Nó[5] prefers more unspecific concepts implying also chemical reactions.

A very simple system, which can display the characteristic features of polarization, is:

Homogeneous mass (1)	Porous membrane	Homogeneous mass (2)
A^+R^-	$A^+R^- + B^+R^-$	B^+R^-

If the mobility of the ion constituent B^+ is greater than that of A^+, then the application of direct current, with the direction (1) anode and (2) cathode, will decrease the conductivity within the membrane. A reversed current direction will increase it; thus the 'rectification' may be easy enough to understand. The membrane behaves as a non-linear circuit element. Obviously this type of electrolyte system is closely related to the well-known 'moving boundary' systems. Theories[6-11] and experiments[12,13] show that the transition layer between masses (1) and (2) under appropriate conditions can be segregated in successive layers with different ionic compositions, which can *move* in either direction. These concepts can easily make understandable the fact that a membrane, supporting electrolytes, can change its longitudinal conductivity in a non-linear fashion. A great variety of patterns of the interrelations between direction, density and duration of the applied current and the resulting conductivity can be anticipated. The changes of the conductivity (and membrane potential proper) may lead to voltage *vs.* time curves similar to those known from the transient responses on rectangular D.C. pulses, applied to circuits containing resistances, capacities and inductivities.

The accompanying graph provides an example taken from a preliminary study. A system 0·1 *N* lithium chloride (stirred)/porous glass membrane/ 0·1 *N* hydrochloric acid (stirred) was subject to constant current flow with the cathode on the hydrochloric acid side. The change of the total membrane voltage with time exhibits an 'overshooting' (see the dashed curve, *mV*) well known from certain RLC (or RC) circuits. The parallel course of the high-frequency resistance of the membrane layer (dotted curve, Ω) indicates that the temporal variation of the potential is, in the main, caused by changes of the electrolyte content within the membrane (the membrane potential proper, that is, the 'back-E.M.F.', plays a minor part here). The voltage-time curve has also been transformed into an A.C. 'impedance locus diagram' by the aid of 'square wave analysis'[14]. The locus curve (full line) of the impedance at different A.C. frequencies is of the shape regarded as typical for a resistance–capacitance–inductance circuit (cf. ref. 15).



In conclusion, it may be stated that a purely aqueous electrolyte system may exhibit effects formally similar to rectification, capacity and inductivity. Changes of the 'resting potential' or 'back E.M.F.' can also be demonstrated, especially with charged membranes. All phenomena are due to ionic redistributions within the membrane, initiated by the flowing current. These observations may have bearings on discussions on the nature of biological polarization phenomena. More experimentation under well-controlled conditions seems desirable. Theories of electrolytic migration also require extension to include the effects of diffusion, membrane dimension, membrane charge, solvent movement, etc. Investigations in these directions are being made in this laboratory.

This type of moving-boundary can obviously be utilized as an electrophoresis method for separation purposes, particularly if a superposed counter-flow of the solvent is employed.

An extended report of this work will be published elsewhere.

TORSTEN TEORELL

Physiological Institute,
University of Uppsala,
Uppsala. Aug. 3.

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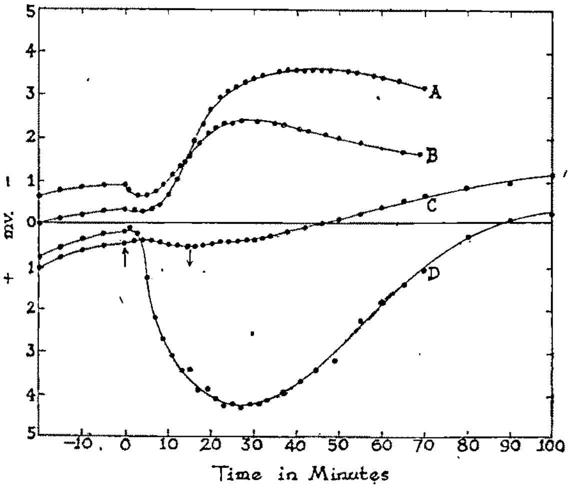
Electrical Potential Change Accompanying the Development of Rigor in Iodoacetate-Poisoned Muscle

No *a priori* answer can be given to the question whether the development of rigor in muscle poisoned by iodoacetate is accompanied by electrical depolarization, though it may be expected that the muscle after developing rigor will eventually become depolarized. The present work was an attempt to find an experimental answer to this question.

The sartorius muscle of the toad prepared with its nerve for stimulation was employed. The preparation was poisoned by soaking for 30–60 min. in 1/10,000–1/20,000 iodoacetate solution, sometimes with the addition of sodium cyanide to the concentration of $M/1,000$–2,000. Rigor of the poisoned muscle was induced in the usual way by stimulation, at the rate of one shock every 5 sec. in most experiments. A rough indication that the development of rigor was not accompanied by any considerable depolarization was first obtained by showing that the muscle, soon after the development of rigor, gave demarcation potential of the usual magnitude on crushing or on application of isotonic potassium chloride.



Time-course of electrical potential change of poisoned half of muscle relative to normal half. Stimulation, one shock every 5 sec. between arrows. See text for other explanation

A closer examination was then made by poisoning one half of the muscle and measuring the potential of this half against the normal half at short intervals during and after the onset of rigor. In such experiments the muscle was naturally mounted in air and the results regularly showed a slowly developing depolarization, beginning shortly after the start of stimulation and reaching a maximum in 30–40 min., roughly paralleling the course of the development of rigor. Both the course and the magnitude of the depolarization, however, depended on the temperature. The results of an experiment at 10–11° C. are reproduced in the accompanying graph, curves *A* and *B*, given by two symmetrical muscles. A comparison of pairs of curves such as these revealed the influence of an apparently insignificant difference in the experimental condition. When two strands of cotton-wool were used for connecting the muscle to the calomel half-cells used as leads (curve *A*), the depolarization was regularly greater than when two troughs about 8 mm. wide filled with Ringer solution served as contacts (curve *B*). The only obvious difference was that, if there was anything liberated by the muscle, it would be partially washed away from the segments of the muscle lying on the troughs.

We therefore tested the effect of deliberate washing. It was found that the depolarization of the poisoned half relative to the normal half observed when the muscle was mounted and stimulated in air disappeared more or less completely when the whole muscle was afterwards washed in stirred normal Ringer solution. We then attempted to determine the time-course of the electrical potential change accompanying the development of rigor while the whole muscle, one half of which was previously poisoned, was continually washed except during the short times required for potential measurements. Curve *C* represents the result when the washing solution was normal Ringer. It is seen that the depolarization of the poisoned half normally occurring during the first 30–40 min. after the beginning of stimulation was completely suppressed.

There is thus a strong indication that the initial depolarization accompanying the development of rigor was due to the release of some depolarizing substance by the muscle when developing rigor. In all probability this substance was potassium. Dean[1] has previously reported that iodoacetate-poisoned muscle, after the onset of rigor, lost a large amount of potassium. The use of potassium-free Ringer solution as a possibly more efficient washing solution then suggested itself, and the result was as shown in curve *D*, the two curves *C* and *D* being given by a symmetrical pair of muscles at 23° C. treated in identical manner except for the composition of the washing solution, and therefore directly comparable.

It is seen that, under the conditions of continuous washing with potassium-free Ringer solution, the initial phase of depolarization may be not only completely suppressed, but even actually replaced by a phase of large positive variation. That the half of the muscle subjected to rigor under these conditions contained less potassium than the normal half had been ascertained by separate potassium analysis of the two halves. A mere smaller potassium content of that half, however, could not account for its relative positivity. We had soaked half the muscle in potassium-free Ringer solution overnight, and then washed the whole muscle in potassium-free Ringer for half to one hour. The end which had previously been soaked in potassium-free Ringer solution overnight, while containing less potassium as afterwards determined by analysis, showed no relative positivity.

It may be concluded that when secondary change resulting from the release of potassium is eliminated, the development of rigor in iodoacetate-poisoned muscle is not accompanied by depolarization. Indeed, the primary event might even be an increase of polarization.

Y. M. Liu
C. H. Hsu
T. P. Feng

Institute of Medicine,
Academia Sinica,
Shanghai.
June 24.

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Nervous Mechanism in Tunicata

DESPITE the contributions of Lorleberg[1], Hilton[2], Hecht[3], Cate[4], Bacq[5] and Das[6], the picture of tunicate nervous relations is still incomplete. Although the central nervous system consists of only one compact intersiphonal ganglion and the peripheral system of a few nerves emanating from the former, the extreme sensitivity of monascidians to touch, vibrations, etc., is astounding. A person walking about in a room where expanded *Ciona*, *Ascidiella*, or *Styelopsis* are lying in a jar on a table is enough to make some of the ascidians contract. Lorleberg[1] stated that *Styelopsis* had free nerve terminations, whereas Das[6] found in *Herdmania* an extensive nerve supply, not only to the organs lying inside the mantle, but also to receptor cells of the test as well. I have now found these nerve fibres, ramifying into the mantle, the test, and ending in the receptor organs, in *Ciona*, *Ascidiella* as well as *Styelopsis*. Free nerve terminations have been found in *Styelopsis* and *Ascidiella* and probably occur in all Tunicata.

The nerves arising from the intersiphonal ganglion have both afferent and efferent fibres in them; and as they branch and subdivide to supply the muscles and the receptors, the afferent and efferent fibrils are separated to form the peripheral nerves. It has also been established that, in crossed reflexes, nerve impulses pass directly from one siphon to the other by way of the ganglion. Removal of the ganglion not only prevents crossed reflexes but also affects the threshold of sensitivity and rate of recovery.

A complete account of the nervous mechanism in the Tunicata is being published elsewhere.

S. M. DAS

Department of Zoology,
University, Lucknow.
June 30.

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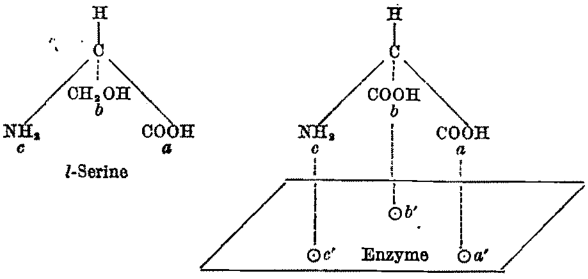
Interpretation of Experiments on Metabolic Processes, using Isotopic Tracer Elements

IN two instances, the distribution of isotopic carbon in the product of a metabolic process has been used to infer that a symmetrical intermediate compound is not involved. Wood *et al.*[1] showed that isotopic carbon, introduced as carbon dioxide together with pyruvate, led to the formation of ketoglutarate which contained isotopic carbon only in the carboxy group next to the keto group; on these grounds, they excluded citrate as an intermediate. Shemin[2] found that when glycine is formed from serine, containing isotopic nitrogen and isotopic carbon in its carboxy group, the relative abundance of nitrogen-15 and carbon-13 in the glycine was the same as in the serine; he argued that amino-malonic acid is therefore not an intermediate in this process.

These conclusions seem to arise from the fallacy that, because symmetrical products arising from the *d*- or *l*-form of an optically active precursor cannot be distinguished, therefore the two identical groups of a symmetrical product formed from one optical antipode cannot be distinguished. On the contrary, it is possible that an asymmetric enzyme which attacks a symmetrical compound can distinguish between its identical groups. This power of distinction is illustrated for the case of amino-malonic acid in the accompanying formulæ. a', b', c' represent points in the enzyme which specifically combine with the groups a, b, c of the substrate. Evidently, decarboxylation could occur at a' but not at b', or *vice versa*. The same conclusion follows if any three of the groups of the substrate specifically combine with the enzyme. If decarboxylation occurs only at b', then all the isotopic carbon in the carboxy group of serine will appear in the glycine. The case of the formation of ketoglutarate from citrate is exactly parallel.



l-Serine

Amino-malonic acid

This argument depends on two conditions: (*a*) that the sites a' and b' are catalytically different; (*b*) that three-point combination occurs between the symmetrical substrate and the enzyme; such combination is, of course, necessary wherever a single optical antipode is formed enzymatically from an inactive precursor. Since neither is unlikely, it follows that the asymmetrical occurrence of isotope in a product cannot be taken as conclusive evidence against its arising from a symmetrical precursor.

A. G. OGSTON

Department of Biochemistry,
Oxford.
July 12.

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Cultivation of *Trypanosoma cruzi* in the Developing Chick Embryo

ALTHOUGH *Trypanosoma cruzi*, the causative agent of Chagas' disease in South America, has been successfully cultivated in the embryonic tissues of the chick, attempts at growing this parasite in the developing chick embryo have hitherto led to inconclusive results. Roubaud and Romana[1] inoculated *T. cruzi* into the chorio-allantoic membrane of chick embryos from (*a*) a rich culture; (*b*) drops of liquid excreta of *Rhodinus prolixus* containing metacyclic forms; and (*c*) citrated blood of an infected guinea pig containing numerous large and active trypanosomes. The results were negative, and no infection was observed, except that in one embryo inoculated with the citrated blood a single trypanosome was found to have persisted on the membrane a week after inoculation. Rodhain and van den Berghe[2] inoculated a dozen eggs with a strain of *T. cruzi* cultured in Novy–MacNeal–Nicolle medium. Three of the embryos became 'infected'; but attempts to effect a second passage in embryos did not succeed, and sections of the membrane of an 'infected' embryo did not show any trace of an invasion of the membrane or intracellular developmental stages. Rodhain and van den Berghe concluded that a true infection had not been established and that, probably, cellular invasion of the chick embryo does not occur, but that, as the parasite grows readily in tissue cultures of the chick embryo, the results need verification.

Recently I have succeeded in producing infection in chick embryos with both cultural and blood forms of *T. cruzi*.

The strain of *T. cruzi* was obtained from Dr. D. G. Davey, Imperial Chemical Industries, Manchester, on February 4, 1943, and since has been maintained in this Institute in mice. The inocula were composed of (*a*) equal parts of heart blood (drawn aseptically) from infected mice and sterile citrate-saline solution; and (*b*) a rich culture on Novy–MacNeal–Nicolle medium. The eggs were used after 10–14 days incubation, and the inoculations were made on to the chorio-allantoic membrane by the standard technique described by Beveridge and Burnet[3]. The eggs were opened from the third day onwards after inoculation, the membrane was fixed for sectioning, and heart blood from the embryo was examined for trypanosomes.

Twenty-four embryos were inoculated, twelve with culture and twelve with the citrated blood. Six were found dead on opening, and were discarded. All the others were infected and showed characteristic macroscopic lesions on the membrane which, on microscopic examination of the sections, are seen to be produced by the invasion of the membrane by the parasite and its active intracellular multiplication. All the stages of intracellular development characteristic of the parasite in the vertebrate host have been found in the membrane. The free extracellular trypanosomes appear in the blood of the embryo on the fifth day after inoculation. None of the inoculated embryos has so far survived to hatch out.

Macroscopically, the lesions appear as whitish opaque granulations scattered over the entire inoculated area of the membrane (Fig. 1). In some cases a tendency for the lesions to concentrate into groups was observed. The membrane as a rule is thickened and rigid, and the blood vessels tend to dilate. The lesions are evident on the third day after inoculation and become very numerous and highly specific on the fifth day.

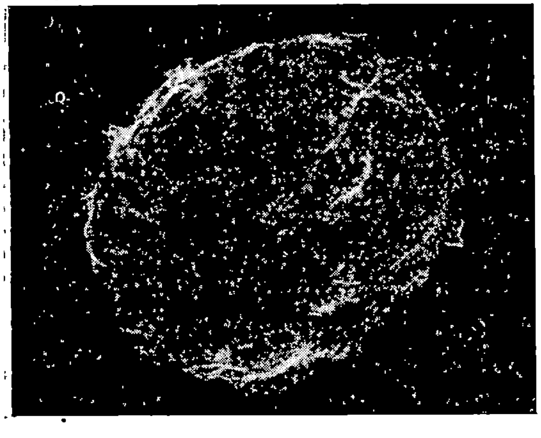

Fig. 1. Photograph (approximately one and a half times natural size) of chorio-allantoic membrane showing typical specific lesions produced by *T. cruzi* five days after inoculation with a culture in Novy–MacNeal–Nicolle medium

Sections of the infected membrane show numerous 'cysts' on the surface of the ectoderm or deeper down in the same layer. These 'cysts' enclose large numbers of leishmania stages of *T. cruzi*. Apparently the individual trypanosomes from the inoculum invade ectodermal cells and round up into leishmania stages which then undergo repeated divisions. The infected cell is ultimately reduced to a bag or membrane surrounding the parasites, and this gives rise to the characteristic 'cyst-like' appearance. The host cell is very much hypertrophied and its nucleus large and degenerate. The ectodermal cells around the invaded cell proliferate actively and the whole area gets considerably thickened, thus forming the characteristic lesion. It is usual to find several such groups of leishmania stages inside one lesion (Fig. 2). The crithidial forms have been observed in sections of membrane fixed five days after inoculation. The proliferation of the ectoderm cells is accompanied by cornification and necrosis. The mesoderm layer is unaffected, except for the presence of large numbers of eosinophil leucocytes and for slight œdema. Red blood cells and leucocytes are frequently seen below the ectoderm. The endoderm does not appear to be affected in any way.

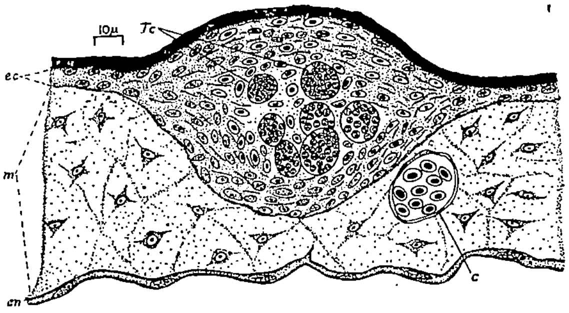

Fig. 2. Section of chorio-allantoic membrane showing a lesion containing leishmania stages of *T. cruzi* three days after inoculation with citrated blood of an infected mouse: *c*, capillary; *ec*, ectoderm; *en*, endoderm; *m*, mesoderm; *Tc*, Leishmania stages of *T. cruzi*

Thus, contrary to the results obtained by previous workers, it has been found that chick embryos, of 10–14 days incubation, may be infected readily with either cultural or blood forms of *T. cruzi*, and that characteristic lesions are developed in the chorio-allantoic membrane of the infected embryos. The cultivation of *T. cruzi* in chick embryos opens up a promising field for studies on the action of drugs on the intracellular stages of this trypanosome. Further experiments are in progress, and a fuller account of the intracellular development of *T. cruzi* and the histopathological changes in the host will be published elsewhere.

My thanks are due to Dr. P. Tate for supplying infected mouse blood for the above experiments.

P. N. Gaṅapati

Molteno Institute,
Cambridge.
Aug. 28.

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Phosphorylation of Myosin by Adenosine Triphosphate

THE study of the interaction between actomyosin and adenosine triphosphate has hitherto given evidence of physical changes in the protein and of its enzymic activity. Very little was known, however, of chemical changes in the protein molecule accompanying the physical effects. Phosphorylation of the protein[1] and formation of an adenosine triphosphate-protein compound[2] have been suggested as alternative possibilities, but conclusive experimental evidence has not yet been presented.

Content in phosphate and adenine (μgm./gm. threads)

Temperature			0° C.						37° C.						
	Substances applied	No. of experiments	P_0	P_7	P_T	P_7—P_0	P_T—P_7	A	No. of experiments	P_0	P_7	P_T	P_7—P_0	P_T—P_7	A
Actomyosin	Water	22	1·20	2·35	4·20	1·15	1·85	11·35	15	0·95	2·25	4·10	1·30	1·85	10·20
	Water	5	1·00	2·35	4·35	1·35	2·00	11·30	2	1·30	2·30	5·55	1·00	3·25	11·00
	ATP*	9	2·85	5·50	7·80	2·65	2·35	14·40	13	4·80	8·65	12·10	3·85	3·45	17·05
Actin-free myosin	Water	4	1·15	1·90	2·85	0·75	0·95	9·20	4	1·60	2·35	3·95	0·75	1·60	10·55
	ATP*	10	6·25	9·35	13·95	3·10	4·60	18·15	8	9·20	12·30	17·10	3·10	4·80	20·30
Actomyosin with low adenosine triphosphatase activity	Water	1	1·40	2·15	4·00	0·75	1·85								
	ATP*	2	5·50	7·85	12·55	2·35	4·70		2	6·75	9·00	16·75	2·25	7·75	
	ATP + KCl + $MgCl_2$†	2	11·45	13·10	20·40	1·65	7·30								

* 2 × 10^{-6} mol./ml. adenosine triphosphate.

† 2 × 10^{-6} mol./ml. adenosine triphosphate + 1 × 10^{4} mol./ml. potassium chloride + 1 × 10^{-5} mol./ml. magnesium chloride.

Actomyosin and actin-free myosin threads contain appreciable amounts of adenine, ribose and phosphorus which cannot be removed by repeated washing, but are extractable after denaturation. In the protein-free extracts the phosphorus is present as orthophosphate (P_0), readily hydrolysable phosphate (P_7—P_0) and difficultly hydrolysable phosphate (P_T—P_7).

Treatment with adenosine triphosphate causes a considerable increase in adenine, ribose and the different phosphate fractions, not removable by repeated washing (see table). The ratio of readily hydrolysable phosphate and phosphate hydrolysable with difficulty to adenine corresponds roughly to the ratio calculated for adenosine diphosphate.

The uptake of adenine, ribose and phosphate can be observed only after the application of adenosine triphosphate. No uptake of either nucleotide or phosphate follows treatment of the protein with adenosine diphosphate, adenylic acid, orthophosphate or pyrophosphate. The effect of adenosine triphosphate is independent of the adenosine triphosphatase activity of the protein, as threads from preparations with high and low enzymic activity give the same results. Inosine triphosphate and inorganic triphosphate, which are both split by adenosine triphosphatase, produce neither an uptake of nucleotide nor of phosphate. Furthermore, an increase in temperature from 0° C. to 37° C. is accompanied by a much higher increase in enzymic activity than in nucleotide and phosphate uptake.

The orthophosphate found in the protein-free extract must originate from highly labile phosphate bound to the protein, that is, it is the expression of a phosphorylation of the protein. It can scarcely be present as orthophosphate before denaturation, because orthophosphate is quantitatively removed by the washing preceding denaturation.

While phosphorylation and nucleotide uptake are independent of the enzymic activity of the protein, a close correlation exists between chemical effects and constriction of volume. Both phenomena require the presence of adenosine triphosphate, which is highly specific for both reactions. In increasing concentrations adenosine triphosphate causes increasing phosphorylation and nucleotide uptake as well as increasing volume constriction. Addition of magnesium salts, which enhances the latter effect, also increases phosphorylation.

Adenosine triphosphate causes phosphate and nucleotide uptake both in threads of actomyosin and actin-free myosin, whereas the constriction of volume occurs only in the presence of actin. Hence, the chemical changes must be localized in the myosin moiety of the protein.

FRITZ BUCHTHAL
ADAM DEUTSCH
GUSTAV G. KNAPPEIS
AGNETE MUNCH-PETERSEN

Institute of Neurophysiology,
University of Copenhagen.
Institute of Chemistry,
University of Lund.

June 24.

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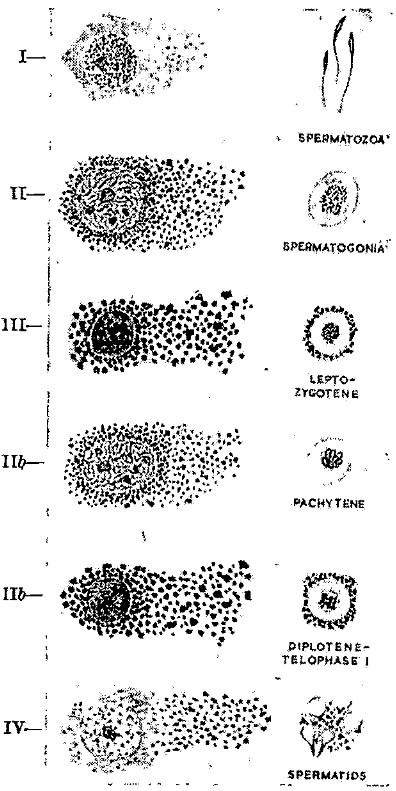
Ribonucleic Acid Supply and Phosphatase Distribution during the Spermatogenesis of *Asellus aquaticus*

STUDIES on the spermatogenesis of *Asellus aquaticus* L.[1] directed attention to the polyploid cells surrounding each testicular lobe. It has been found that these cells show cyclic variations of morphological characters both in nucleus and in cytoplasm which correspond to different phases of spermatocytic evolution. The latter is almost synchronous in each lobe, and a small bunch of spermatogonia remains in the basal portion of the lobe, to ensure the next spermatogenetic wave.

The nuclei of the surrounding cells are polyploid of the *Gerris* type[2], that is, with chromosomes



preserving their individuality. No large chromocentre is present. The cytoplasm may be more or less filled with basophil granules, which tested by Brachet's method (Unna–Pappenheim stain and control by pretreatment with ribonuclease) appear to be very rich in ribonucleic acid, perhaps entirely formed of this substance.

The variations may be summarized as follows. Stage I corresponds with fully formed spermatozoa. Nucleus large, chromatin of each chromosome much contracted. Cytoplasm devoid of granules. Stage II corresponds with spermatogonia. Nucleus larger, chromatin much more dispersed and chromosomes threadlike. Cytoplasm with a few granules, especially abundant around the nuclear membrane. A few granules are found excreted between the spermatogonia. The spermatogonial cytoplasm stains pink with pyronin. Stage III corresponds with spermatocytes in lepto-zygotene. Nucleus small, very contracted, chromatin more diffuse. Cytoplasm heavily charged with large granules of ribonucleic acid, which are excreted into the interstices between the spermatocytes. Spermatocyte cytoplasm stains a brilliant pink. Stage II *b*. At pachytene the follicular cells are again in stage II, and the germ cells appear to have exhausted their supply of ribonucleic acid in cytoplasm. Stage III *b*. At diplotene to telophase I, the follicular cells are again in stage III, while the cytoplasm of the germ cells stains red (especially so at metaphase I). Stage IV corresponds with telophase II to spermatids. Chromatin resumes the granular form (that is, contracted chromosomes). The cytoplasm is vacuolated and devoid of granules. Some of them are still present outside the cells and between the young spermatids, the majority of which have their tails oriented toward the clots of granules.

There are one or two nucleoli in every stage except stage II, in which three to six supplementary nucleoli appear. In every stage nucleoli stain faint pink, except in stage III, in which the main nucleoli stain deep red.

With Gomori's technique for phosphatases, using as substrate either sodium glycerophosphate β or polymerized desoxyribonucleic acid or ribonucleic acid, the following results have been obtained. (*a*) The monophosphatases and diphosphatases are present in the nuclei, both of follicular cells and germ cells; they are localized on chromatin and nucleoli (see below). They are probably absent from the cytoplasm and certainly from the granules. (*b*) Mono- and diphosphatases are present in the main nucleolus at every stage. In stage II they are present together in two or three of the supplementary nucleoli, while in the remainder only monophosphatases are present. Since it is probable that phosphatases are concerned with the metabolism of nucleic acids[3-5], we are inclined to think that the metabolism of ribonucleic acid occurs only at two points, namely, (i) the polyploid nucleus as the starting point, and (ii) the germ cell nucleus as the end point. Moreover, it appears that the highest charge in phosphatases corresponds to stage III, so that probably this is the phase with the greatest production of ribonucleic acid.

From the observations it follows that: (*a*) The follicular cells elaborate and secrete ribonucleic acid, which is supplied to the germ cells. (*b*) The nucleus takes part in the secretory activity of the cell and shows evident structural changes. (*c*) During a spermatogenetic cycle the polyploid cells undergo two waves of secretion, with two peaks corresponding respectively to lepto-zygotene and diplotene-telophase I. (*d*) Spermatocytes absorb and utilize ribonucleic acid, which is supplied in this way by the follicular cells.

The mechanism of feeding nucleic acids to the male germ cells of *Asellus* thus differs slightly from that found by Painter and Reindorp[6] in the oocytes of *Drosophila* and by Painter[7] in the anthers of *Rhœo.*

GIOVANNA VITAGLIANO
MARINA DE NICOLA
Istituto di Genetica,
e Centro di Citogenetica del C.N.R.,
Università di Napoli.
June 28.

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Electrical Resistance of Wires with Large Strains

SOME time ago, K. H. Swainger[1] directed attention to the remarkable linearity of the electrical resistance of 'Minalpha' wires with large strains, optically measured. As this observation has important consequences on strain measurements, it seemed worth while to examine wires of other materials for the effect. Preliminary experiments showed that for all materials tested the specific increase of the electrical resistance was approximately equal to twice the specific elongation of the wire, if well above the yield point. This result made it obvious that the change of the electrical resistance is mostly a geometrical property, and was not due to a change of the resistivity of the material.

Thus, with the two assumptions that the resistivity of the material and the volume of the wire remain unchanged at large strains, it is easy to see that the resistance R with its initial value R_0 is connected to the actual length L of a uniformly strained wire of initial length L_0, by the expression :

$$\frac{R}{R_0} = \left(\frac{L}{L_0}\right)^2;$$

which for small values of $\Delta L/L_0$ may be written

$$\frac{\Delta R}{R_0} = 2 \cdot \frac{\Delta L}{L_0}.$$

'Copel', a copper–nickel alloy from the Hoskins Manufacturing Company, Detroit, has shown the largest elongation, with the remarkable value of about 35 per cent, but we have in some cases found values as high as 60 per cent. As may be seen from Table 1, the two basic assumptions are excellently verified for this material.

Table 1. Static test on 'Copel' wire. $L_0 = 125$ mm.; diameter, 0·45 mm.

ΔL (mm.)	R (ohm)	R/R_0	$(L/L_0)^2$
0	0·376	1·000	1·000
6·25	0·414	1·101	1·102
12·50	0·455	1·210	1·210
18·75	0·497	1·322	1·322
25·00	0·542	1·442	1·440
31·25	0·588	1·564	1·562
37·50	0·635	1·689	1·690

Wires of other materials showed resistances a little less (0·5–1 per cent) than the calculated values, probably due to the elastic part of the strain.

As the electrical resistance is determined by the dimensions of the wire only, it seemed plausible that the rate of strain would not affect the resistance-strain relation, though it affects strongly the stress-strain curve.

In order to confirm this, the wire was rapidly stretched by releasing a spring, between which and the wire a plate provided with slits at 2-mm. intervals was inserted. The resistance-time curve was taken as an oscillogram, on which every 2 mm. of elongation were marked using a photocell guided by these slits. The results are shown in Table 2, where v denotes the velocity of the moving end of the wire.

Table 2. Dynamic test on 'Copel' wire. $L_0 = 101$ mm.; diameter, 0·45 mm.

v (m./s.)	ΔL (mm.)	R (ohm)	R/R_0	$(L/L_0)^2$
0	0	0·303	1·000	1·000
1·8	2·1	0·316	1·043	1·042
2·6	4·1	0·328	1·082	1·083
3·1	6·1	0·342	1·129	1·124
3·5	8·1	0·354	1·168	1·167
3·9	10·1	0·367	1·211	1·210
4·4	14·1	0·394	1·300	1·299
4·8	18·1	0·422	1·393	1·391
5·2	22·1	0·451	1·488	1·485
5·6	26·1	0·477	1·574	1·584
5·9	30·1	0·509	1·680	1·685
6·2	34·1	0·541	1·785	1·789

Similar results have been obtained with a 200-mm. wire. The differences between the two last columns lie within the errors of observation.

We have found it possible to use these plastic strain gauges with advantage to measure the extremely rapid increase of diameter of detonating shells and the like.

W. Weibull

Aktiebolaget Bofors,
Sweden.
June 30.

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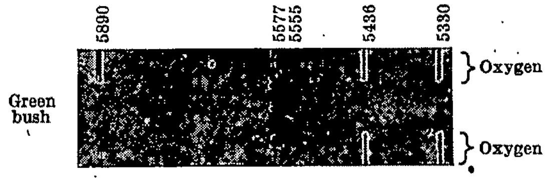
The Green Auroral Line as an Initiator of Phosphorescence in Condensed Systems

In 1924 one of us (L. V.)[1] detected a number of phosphorescent bands produced when solidified mixtures of nitrogen with inert gases (argon or neon) were exposed to the bombardment of cathode rays. One of these bands, called N_1, was situated in the region of the green auroral line. With diminishing nitrogen concentration the width of the line diminished and in pure neon it took the shape of a diffuse line with a wave-length 5577·4 A., which within the limit of error was identical with that[2] of the auroral line 5577·35. From this result, Vegard concluded that he was actually observing the green auroral line, which, however, under certain conditions took the form of a phosphorescent band, due to the action of Van der Waals' forces[3] between the molecules of the condensed system.

After McLennan and collaborators had shown that the green auroral line originated from transitions between the metastable ground-states $^1S_0$ and $^1D_2$ of the normal oxygen atoms, Vegard[4] expressed the view that the coincidence between the auroral line and the N_1-band observed in solidified inert gases and in their mixtures with nitrogen was not likely to be accidental, and that further studies of the phosphorescent band might show some relationships ; in other words, that the band was initiated by traces of oxygen, which act as nuclei of the phosphorescence. Now we have recently been able to study a most interesting luminescence effect which strongly supports this view.

In connexion with the production of inert gases undertaken by the Norwegian firm "Norsk Hydro-Elektrisk Kvaelstofaktieselskab", J. Nordhagen recently found that a sample of purified argon, when tested at atmospheric pressure by a Tesla transformer, showed a green bush of luminescence not previously found by similar tests of other samples. It was therefore of importance to find the origin of the phenomenon in order to make sure that it was not due to impurities of some sort. We were consulted on the matter and asked to undertake a spectral analysis of the luminescence.



The spectrograms showed that the green bush consists of a single green band dominated by a somewhat diffuse line with continuous light on both sides. The wave-length of the line was measured and found to be 5577. Thus within the limits of error, the wave-length is equal to that of the auroral line 5577·35 A. A spectrogram was also taken with a comparison spectrum obtained from an oxygen discharge tube which gave the green auroral line. As seen from the reproduced spectrogram, the line in the phosphorescent band from argon coincides exactly with the auroral line. The spectrograph had at this wave-length the fairly large dispersion of 50 A./mm. Towards longer wave-lengths the continuous light extends to 5585 ; and towards short wave-lengths to about 5400.

The reason for the different behaviour of the old and new samples was found to be that the latter contained less oxygen. When the oxygen concentration of the new sample was increased to that of the previous ones, the green phosphorescence disappeared. Thus the essential condition for the appearance of the phosphorescent band initiated by the green auroral line is that oxygen is present in extremely small concentrations. The green luminescence showed an afterglow, sometimes lasting for a few seconds.

In the experiments with the *solidified* gases, previously referred to, the solid layers unavoidably contained traces of oxygen, and it is therefore very likely that the green N_1-band, which in neon had the wave-length 5577·4, is a phosphorescence phenomenon initiated by the green auroral line. In solidified systems a red band N_3 (6320) was observed, which might be initiated by the red auroral O I-doublet (6300·3, 6364).

In the case of gaseous argon we have not yet observed a red band corresponding to the red O I-doublet.

Investigations into the nature of this phosphorescence phenomenon, detected by Mr. Nordhagen in gaseous argon containing traces of oxygen, will be continued.

L. Vegard
G. Kvifte

Physical Institute,
University. Oslo.
July 9.

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Some New Ferromagnetic Manganese Alloys

The ferromagnetic beta phases in the systems copper–manganese–aluminium and copper–manganese–tin have been shown to have an ordered body-centred cubic structure, and the compositions of alloys showing maximum magnetizations correspond to atomic proportions[1,2] Cu_2MnAl and Cu_2MnSn. Valentiner has recently reported that ferromagnetic alloys exist in the system copper–manganese–indium. The highest intensity of magnetization is shown by the composition Cu_2MnIn, and the structure is analogous to that[3] of Cu_2MnAl and Cu_2MnSn.

The position of gallium in the periodic table relative to aluminium, indium and tin, and the similarity of the equilibrium diagrams of the binary systems copper–aluminium, copper–tin, copper–indium and copper–gallium suggest that a ferromagnetic beta phase might exist in the ternary system copper–manganese–gallium.

We have investigated three copper–manganese–gallium alloys having the following compositions (Table 1).

Table 1

Alloy designation	Weight per cent Cu	Mn	Ga
*G*1	49·5	21·6	28·9
*G*2	62·3	13·0	24·7
*G*3	57·8	16·0	26·2

Specimens of alloy *G*1 quenched from temperatures between 500° C. and 750° C. all showed a two-phase structure under the microscope, and were very feebly magnetic. The highest intensity of magnetization was shown by a specimen quenched from 650° C. This specimen had a saturation magnetization at room temperature of about 2½ per cent of that of nickel. This value was doubled on ageing the specimen at 100° C. for 110 hours. The composition of alloy *G*1 corresponds to atomic proportions $Cu_{1\cdot97}Mn_{1\cdot00}Ga_{1\cdot05}$.

Alloys *G*2 and *G*3 were quite strongly magnetic after being quenched from 750° C., and under the microscope had an acicular appearance like martensite. Alloy *G*3 had a saturation intensity of magnetization at room temperature about seven-tenths of that of nickel. Cooled slowly from 750° C., this alloy became non-magnetic, and microscopic examination showed that a transformation had taken place. Ageing of alloy *G*3 at 100° C. and 200° C., following quenching from 750° C., caused a reduction in saturation magnetization; but no transformation was apparent under the microscope.

Table 2. X-ray diffraction data for alloy *G*3 (quenched from 750° C.)

Radiation	Intensity	*d*	Radiation	Intensity	*d*
FeKα	ww	2·446	FeKβ	ww	1·328
β	ww	2·294	α	m	1·335
α	m	2·286	β	ww	1·292
β	ww	2·122	α	s	1·295
α	s	2·127	α	s	1·207
β	m	2·019	α	w	1·148
α	ss	2·018	α	m	1·135
α	m	1·968	α	ss	1·108
α	m	1·556	α	m	1·076
α	m	1·532	β	w	1·062
α	m	1·371	α	m	1·067
			α	w	1·011

X-ray diffraction photographs were taken at room temperature of powder specimens, quenched from 750° C., of alloys *G*2 and *G*3. Both patterns were of the same type, and the data for alloy *G*3 are listed in Table 2. A satisfactory interpretation of these data could not be made. The lines observed cannot be reconciled with those to be expected from the beta structure, ordered or unordered. Weibke states that the beta copper–gallium alloys resemble beta copper–aluminium alloys in that the structure of quenched alloys depends upon the cooling velocity[4]. The same behaviour was noted by Hume-Rothery and Raynor[5]. The martensitic structures observed in quenched alloys could possibly be derived from the beta phase, stable at high temperature, but not retained by quenching.

Preliminary experiments have shown that ferromagnetic phases exist in the binary systems manganese–germanium and manganese–indium, and in the ternary system copper–manganese–germanium. Investigation of these systems is being extended with the view of identifying the ferromagnetic carriers. It is also suggested that ferromagnetic phases might exist in the binary system manganese–gallium.

F. A. Hames
D. S. Eppelsheimer

School of Mines and Metallurgy,
University of Missouri,
Rolla, Missouri.
July 2.

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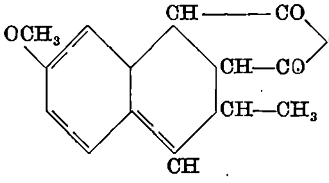
Addition of Maleic Anhydride to Anethole

In a communication bearing this title, and when referring to our papers[1] on the uncrystallizable compound (m.p. 311–312°) formed during the course of the reaction which takes place between anethole and maleic anhydride, Bruckner and Kovács[2] state that we have not recognized that this compound was a heteropolymer. In a series of other reports on the same subject published later, the heteropolymer character of the compound was established and, furthermore, its molecular weight was determined[3] with the help of the *cis*-hexahydro-*para*-aminobenzoic acid lactam[4]. The product which is obtained first under Bruckner's working conditions and our own, when refluxed with chloroform, yields two compounds, one of them soluble (m.p. 245° decomp.), with a molecular weight equal to 738 (theoretical for 3 : 3·735), and the other insoluble (m.p. 310° decomp.), with a molecular weight equal to 1,010 (theoretical for 4 : 4·980).



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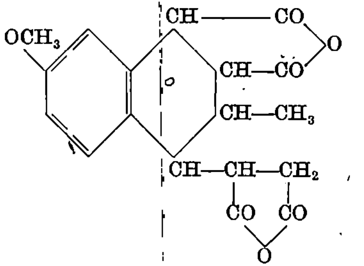

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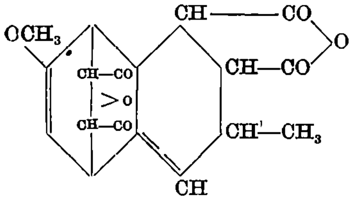
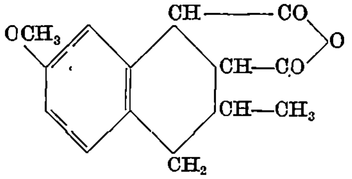
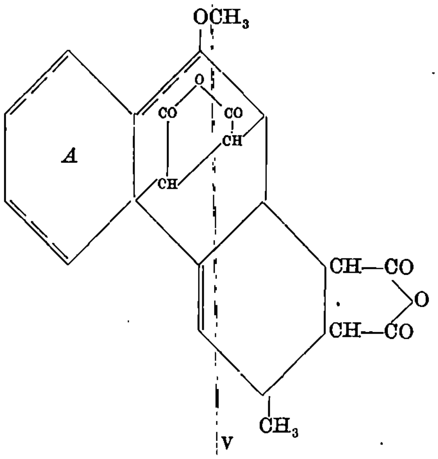


II



III



V

Bruckner and Kovács refer to the structure of the crystalline compound (m.p. 241°) formed by one mole of anethole and two moles of maleic anhydride, obtained by Bruckner in small quantities[5], and which he now obtains with a 60 per cent yield when a small amount of dimethylaniline is added.

We have found a crystalline compound (m.p. 232°) in this ratio of 1 : 2 with a yield of 30 per cent, when the condensation is carried out in the presence of hydroquinone, which acts as an inhibiting agent towards polymerization[3]; and, moreover, we have characterized crystalline products with the same molar ratio in the condensation of maleic anhydride with *o*-metoxypropenylbenzene (m.p. 241°)[6] and 1-4-metoxypropenylnaphthalene (m.p. 256–257°)[7].

Concerning the structure of the compound formed, Bruckner considers that, from the point of view of diene synthesis, anethole behaves as a conjugated tetraene which would react successively as shown by I and II. Though we do not deny this possibility, we have directed attention to the possibility that the reaction takes place in the form indicated in III and IV, where the second molecule of maleic anhydride would react, following a process of substitution addition already mentioned by Adler[8] as coincident with the diene synthesis.

The ultra-violet absorption spectra of these compounds are of the same type as that found for tetraline. When heated with selenium to 220°, characterization of the corresponding methyl-oxy-dicarboxylic acids, formed through loss of the second maleic anhydride molecule, is accomplished. With Bruckner's structure this may evidently take place due to the tendency of the nucleus to become aromatic; with our own, through elimination of the lateral chains, in this case of succinic acid, a process usually accompanying the hydrogenation reactions. On the other hand, in the case of 1-4-metoxypropenylnaphthalene it would be necessary to make allowance, following Bruckner, for the entrance of a second molecule as shown in V, and furthermore for the possibility of a new molecule adding itself to the conjugation in *A*; but we have found no compounds in the ratio of 1 : 3.

We are studying now the possibility of a reaction of substitution addition with the allylic isomers of these diene compounds which, taking place in these cases with transposition[9], gives rise to a conjugation capable of reacting, in the form of a diene synthesis, and producing compounds showing a structure which can be compared to that of those under consideration. The results and details of these investigations will be published elsewhere.

M. Lora-Tamayo

Department of Organic Chemistry,
"Alonso Barba" Institute of Chemistry,
Madrid.

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Interpretation of Data from Electrical Resistivity Geophysical Surveys

In connexion with the note by J. M. Hough on work by himself and Prof. L. S. Palmer of University College, Hull[1], I should like to direct attention to a method I described briefly in 1934, and which I have been practising since that date[2].

It will be noticed that I use the ratio ρ_a/ρ_1 for application to standard curves, of which I have sets in many forms. In all cases I obtain solutions by superposition of field curves on transparent paper, having long ago calculated sufficient values for complete sets of curves.

In the solution of multilayer problems I have used proportional compasses and thereby obtain four or five similar curves for superposition on standard curves, from which the 'scale', that is, the effective value of ρ_1, is obtained. I am grateful for the suggestion of using logarithmic plots, which are similar in shape and result merely in a shift of the axes according to 'scale'.

Finally, I would like to suggest to Prof. Palmer and Mr. Hough that a day in the field using my method will convince them of the advantages of my lay-out, in which a is fixed and α varied. A small handbook is now in the press giving details of the method and standard curves for the use of Survey officers.

Incidentally, there is a printer's error in the formula in my paper[2] at the foot of p. 276, owing to my not being able to check the proofs; it should read:

$$\frac{\rho_a}{\rho_1} = 1 + 2f(f+1)$$

$$\sum_{n=1}^{n=\infty} k^n \left[\frac{1}{(f^2 + 4\lambda^2 n^2)^{1/2}} - \frac{1}{((f+1)^2 + 4\lambda^2 n^2)^{1/2}}\right]$$

W. G. G. COOPER

Geological Survey Department,
Zomba, Nyasaland.

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[1] *Nature*, **161**, 812 (1948).

[2] *Mining Mag.* (Nov. 1934).

The comparison of field curves with sets of standard curves, as suggested by Mr. W. G. G. Cooper, is one method of interpreting results. This method requires a large number of standard curves even for the two-layer case, as there are two variables, namely, the depth of the surface layer and the ratio of the resistivities of the two layers. The number of standard curves is reduced to a single set when logarithmic curves are used, as suggested by Whitehead and Radley[1] and in my original letter[2]. Mr. Cooper agrees with me that for multi-layer curves the use of logarithmic curves is a definite advantage.

Mr. Cooper's method for field-work has obvious advantages over our method in needing a smaller operating team. When α is small, the potential difference between the potential electrodes is small, and this may cause the method to be insensitive for these readings. Although the usual electrode-layout is that due to Wenner, there are many other possibilities, and we hope to make an investigation into some of these in the near future. We expect that the most suitable electrode arrangement will depend upon the particular geological structure to be investigated.

J. M. HOUGH

University College, Hull.

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[1] Whitehead, S., and Radley, W. G., *Proc. Phys. Soc.*, **47**, 589 (1935).

[2] Hough, J. M., *Nature*, **161**, 812 (1948).

Blinking

In recent discussions on blinking[1], it has been taken for granted that, in a physical experiment, an object cannot be kept under continuous observation. The difficulty, however, is easily overcome. It is easy to acquire the habit of blinking the eyes alternately and, provided the period is made slightly shorter than that associated with normal blinking, no discomfort results.

I have used this technique in the laboratory for more than twenty years, and have always assumed that it was generally known; but this, apparently, is not the case.

R. E. D. CLARK

St. John's College,
Cambridge.

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[1] Lawson, R. W., *Nature*, **161**, 154 (1948); **162**, 531 (1948).

DR. CLARK'S interesting and novel method of avoiding the interruption of vision due to blinking assumes that blinking is suppressed when the subject 'winks' periodically with alternate eyes. After repeated trials, I doubt whether this assumption is justified. Moreover, few people are aware of their normal rate of blinking.

Almost the whole of the lid movement during blinking is performed by the upper lid, and the two lids meet roughly at the level of the base of the iris. The period of blackout during blinking is made up of two parts: the time taken by the upper lid to traverse in both directions the lower iris, and the time during which the lids are in contact. In general, the vision is 'mobile' during the whole of the blink, and for a short time afterwards (Lawson, *l.c.*). Both blackout and mobile vision become serious only at relatively high rates of blinking.

In 'winking', on the other hand, the lid movement is shared about equally by the upper and lower lids, and contact is established in general over the pupil. The period of blackout for each eye is consequently restricted to the time of contact of the lids, and is thus shorter than the blackout due to blinking. The vision of the winking eye is, however, mobile during the whole of the wink, owing to the development of a mobile diplopia caused apparently by refraction in the superficial corneal fluid as the lids approach each other. The existence of this diplopia in binocular vision during winking can readily be demonstrated by holding the wink, when two images are clearly visible. For myself it amounts to about 1° in the field of vision, the direction of displacement varying from subject to subject. On the other hand, the mobile vision due to eyeball rotation associated with blinking amounts to only $\frac{1}{2}$° in the field of vision (*l.c.*).

Thus, although the effect of blackout is largely eliminated by the process of 'winking' alternately in binocular vision, mobile vision is enhanced and becomes much more disturbing. The 'cure' seems to be worse than the 'disease', and I am not clear how it can be applied to observations through a 'monocular' microscope.

ROBERT W. LAWSON

Department of Physics,
University,
Sheffield 10.

GEOLOGY AND MINERAL RESOURCES OF AFRICA

AT the eighteenth session of the International Geological Congress held in London during August last, the Association of African Geological Surveys held a series of four meetings at which recent advances in the geology of Africa were announced, and discussions of special interest took place. The meetings were of truly international character, and the great interest they aroused is clear from the large attendances and the very considerable number of papers that were presented. Indeed, in many cases only the briefest time could be given to the reading of the papers, but the discussions on the important problems dealt with were of special value. The meetings bore striking testimony to the results already obtained by international co-operation in the whole field of African geology, and in addition indicated the means by which this co-operation could be fruitfully extended.

An important part of the activities of the Association was the presentation of new sheets of the International Geological Map of Africa, together with the co-ordinated description of natural regions; there were also discussions on general and special problems of African geology, and personal contributions on territorial problems.

A full account of the proceedings of the Association has been given by M. F. Blondel, secretary of the Association and director of the Bureau d'Études géologiques et minières coloniales, Paris, in *Chronique des Mines Coloniales* (Numéro Spécial, No. 147, Sept. 15, 1948), a journal well known to African geologists, and it will appear also in due course in the *Comptes rendus* of the International Geological Congress.

Recent advances in the geology and mineral resources of the British African Colonies were summarized in a paper by the directorate of Colonial Geological Surveys, which was based on descriptions by the directors of the British African Geological Surveys, most of which were given in the form of lectures at the Imperial Institute during the preceding year. These lectures and associated papers are shortly to be issued by the Imperial Institute in one volume, which will provide a most useful summary of the present position regarding the geology and mineral resources of these important Colonies.

This was the second session of the Association, the first having been held at the previous session of the International Congress in Moscow in 1937. The formation of the Association arose largely from the need for discussing various problems connected with the preparation of the International Geological Map of Africa; it was found, too, that there were many other problems of an international character that could usefully be discussed at periodical meetings, and the Association was accordingly formed to meet at the same time as the International Geological Congress. The next meeting of the Congress at Algiers in 1952 will be of special interest to all interested in African geology.

At the first meeting of the present session of the Association, Sir Edward Bailey was elected honorary president, Dr. F. Dixey president, and M. Blondel was re-elected secretary; Dr. Dixey then took the chair. All the African Geological Surveys were represented, and during the meetings fifty papers were presented with a view to inclusion in the *Comptes rendus* of the International Geological Congress, and there were also 109 contributions to the discussions.

M. Blondel reported on the work of the Commission of the International Geological Map of Africa. The Commission, which was formed at the International Geological Congress in Brussels in 1922, had as its object the preparation of a geological map of Africa on the scale of 1/5,000,000; M. A. Lacroix was elected president, and M. de Margerie secretary-general. For various reasons progress was at first slow, and in 1934 the task of preparation was taken over by the Bureau d'Études géologiques et minières coloniales, Paris, of which the director, M. Blondel, became the deputy secretary-general of the Commission. Owing to the magnitude of the task it was soon apparent that it would have to be carried out by an international body, and the Association of African Geological Surveys was formed very largely with the object of assisting the work of the Commission. It is none the less important not to overlook the fact that the immense task of compilation, drafting and publication has been performed at the Bureau d'Études géologiques et minières coloniales by M. Blondel and his staff; and the progress made with the map since 1937, in spite of the devastation of the intervening war years, reflects the highest possible credit on these collaborators, to whom all interested in the geology of Africa owe a great debt of gratitude.

In presenting the report of the Commission to the Association, M. Blondel referred to the death of M. A. Lacroix, who had been president of the Commission since its inception. M. de Margerie, who had greatly facilitated the work in its earlier stages, was elected president in his place, Sir Edward Bailey and Prof. Fourmarier were elected vice-presidents, and M. Blondel secretary-general; and it was agreed that the Commission should comprise the heads of the various African Geological Surveys, and certain eminent geologists with special knowledge of Africa.

M. Blondel showed that, of the nine sheets into which the map was divided, the first (No. 1, North-West) was published in May 1936, and presented to the Congress in Moscow; but owing to the loss of the stock of prints during the War, a reprint was made in 1946. Sheet No. 2 (Centre, North) was published in 1948, and No. 3 (North-East) in 1947; No. 4 (West) was presented in proof to the Congress in London; No. 5 (Centre) and No. 9 (South-East) were presented in manuscript form for discussion; and No. 7 (South-West) is reserved for the legend. There remain only No. 8 (South Africa) and No. 6 (East Africa), which are in active preparation, and there is good prospect that the work of the Commission will be wholly completed by the next Congress.

This great work has been financed very largely by France and the French African territories, and by Belgium and the Belgian Congo; Uganda, Southern Rhodesia and Egypt have also assisted. Considerable additional funds are urgently required for the completion of the work. Too large a share has clearly fallen on some countries and too little on others, and it is of the greatest importance that the British Colonies, among others, who stand to benefit so largely by this work, should in the future take a far greater share in the financial burden than they have in the past.

Following the submission of M. Blondel's report, Dr. N. R. Junner proposed that a tectonic and mineralogical map of Africa should be prepared, and M. Blondel, on being asked, generously undertook this additional task, which should fulfil a want long felt by many African geologists.

Prior to the meeting, the Association had invited the various geological services in Africa to prepare descriptions of the regions for which they were responsible, and in almost all cases this invitation was accepted. During the meeting brief summaries of these contributions were given, covering the following extensive territories: French Morocco, Sahara, Libya, Egypt, French West Africa, Portuguese Guinea, the British Colonies, French Equatorial Africa, Western Belgian Congo, the Katanga, Angola, Northern and Southern Rhodesia, the Union of South Africa and South-West Africa, Madagascar. These papers present an excellent review of African geology in 1948, and it is hoped that they will all appear in due course in the *Comptes rendus* of the Congress.

A geological bibliography of Central Africa, with additions to 1944, recently published by Belgium and the Belgian Congo, was presented to the Association.

The Association had proposed for discussion a number of general subjects, most of which concerned the correlation of the older formations for the purposes of the International Map. A discussion on the Pre-Cambrian formations was opened by Prof. A. Holmes, who, on the basis of recent researches on the age determination of rocks by radioactive methods, and of the disposition of the different orogenic zones, suggested a number of correlations, which in some cases were at variance with those generally accepted. These views stimulated a most interesting discussion, in which many members of the Association took part.

There followed a discussion on the correlation of the Karagwe-Ankolean, Kavirondian, and Nyanzian formations of East and Central Africa, which again elicited much interesting information from many speakers. It was finally agreed that on the International Map these three formations should be shown by the same colour, but with different symbols. The correlation of the Akwapimian, Birrimian and Buem formations was vigorously discussed by West African geologists, and it was finally agreed that the legend should show the upward succession long adopted by the Gold Coast Geological Survey, namely, Birrimian, Tarkwaian, Akwapimian, but with a note that certain French geologists would place the Akwapimian much lower. The Buem was to be shown as Upper Pre-Cambrian, but with the reservation that it might be Cambrian.

Following a discussion on the age and correlation of the Upper Kundulungu and the Waterberg-Matsap, it was agreed that, on the map, these formations should be represented by one colour, and that in the legend the age should be left open, with the observation that the ages suggested by various geologists ranged from pre-Silurian to Devonian and even Carboniferous.

The value of African tillites for correlation purposes was discussed, as was also the importance of *Stromatolites* and comparable organisms in determining the age and relations of the older formations. It was at length agreed that owing to the lack of knowledge of the structure of these algal forms, they should be the subject of study by specialists; and on the motion of M. A. Jamotte, it was resolved that the International Palæontological Union should be invited to undertake a special study of them.

An extra meeting was devoted wholly to the problem of rift valleys, and following papers by Prof. R. M. Shackleton, Dr. R. B. McConnell and Mr. A. M. Quennell, a valuable and interesting discussion took place, in which many members participated.

A long discussion was devoted to the terminology of the African Pleistocene, and it was finally agreed to recommend the adoption of the resolution on this question by the African Pre-History Conference held at Nairobi in January 1947. A resolution was also passed recommending the formation of a sub-commission to study the distribution and correlation of the Kalahari Sands.

The question of the distribution, ages and origin of the African carbonatites also gave rise to a useful discussion.

Finally, during the last meeting of the Association, thirty-three personal contributions on the geology of the various territories of Northern, Central, Eastern and Southern Africa were noted, and certain of them briefly discussed.

It may be of interest to add that at a Specialist Geological Conference arranged in September by the British Commonwealth Scientific Organisation, in consequence of the presence in London of the delegates to the International Geological Congress, a discussion took place on the question of the formation of regional bureaux for the study of long-term fundamental research on African geological problems on a regional as distinct from a territorial basis.

This session of the Association of African Geological Surveys not only enabled many old personal contacts among African geologists to be renewed, but also led to many new ones; and the papers and discussions were of great interest and value not only because of the new observations revealed by them, but also on account of the stimulus they gave to international co-operation in the realms of geology and to a regional approach to many fundamental problems.

The Association recorded its appreciation of the invaluable services of its secretary, M. Blondel, not only in the successful organisation of the session, but also in co-ordinating the activities of the Association during the interval between the sessions of the Congress.

POWER SUPPLY AND THE ELECTRICAL ENGINEER

THE title "Means and Ends" given to the presidential address of Mr. T. J. N. Haldane to the Institution of Electrical Engineers on October 7 expressed at once the twofold character and the unity of his subject. An eloquent reaffirmation of the faith of the engineer in the ultimate value of his calling was made by Mr. Haldane in the second part of an address which in the factual sphere concerned itself with the position of electricity power supply in Great Britain and Western Europe.

Pointing out that as early as the beginning of the seventeenth century Francis Bacon had indicated that man's mental and material progress are inseparably linked with one another, Mr. Haldane said, "At present it is all too painfully obvious that for most of the world we are very far from having achieved even that modest level of material prosperity such as would provide reasonable conditions for widespread spiritual development, which must, I believe, be regarded as our ultimate objective. So there remains a vast task for the scientist and engineer, whose work should receive whole-hearted approval, provided the raising of standards of life is regarded as a means rather than an end in itself." It was against this philosophic background that Mr. Haldane reviewed the position of electricity supply in Great Britain and in Western Europe.

Referring first to the nationalization of this industry in Britain, and remarking that we might well be proud of the way in which the change to public ownership had been accepted, Mr. Haldane expressed satisfaction at the new British Electricity Authority's keen awareness of the special problems resulting from the unification of this great undertaking. The twenty years of successful operation of the Central Electricity Board engendered confidence in the future of the new Authority.

Mr. Haldane first gave a brief review of the broad economic position, in which he referred to the importance to the electrical export trade of co-operation of the British Electricity Authority with manufacturers so as to ensure that plant developed for home use should also be suitable and competitive for export, and he also mentioned the not inconsiderable part played by the independent consulting engineer in fostering British trade abroad. He then gave detailed consideration to power resources, drawing a clear distinction between the requirements for power and requirements for energy. Mr. Haldane commented on the important contribution which could be made by water-power schemes towards the meeting of peak loads. Any given water-power scheme will be limited to a certain average annual output of kilowatt-hours; but it is possible to install a large amount of plant and make a correspondingly large contribution to the peak-load problem at the expense of a reduced annual load factor. One of the existing hydro-electric schemes, the Galloway development, was designed for an annual load factor of about 20 per cent; and for the new Sloy station on Loch Lomond the designed load factor was only 10 per cent. Tidal schemes and large-scale wind-generation, because of the intermittent character of their supplies, could make little contribution towards meeting peak loads but could add appreciably to the total output of energy. "Intermediate between the two extremes of pure kilowatts and pure kilowatt-hours," he said, "comes the gas-turbine, burning oil, whose importance is mainly as regards kilowatts, with a contribution to kilowatt-hours limited by economic considerations. Gas-turbines permit the cheap provision of kilowatts, but, until coal can be used in place of oil, cannot be justified for load factors above about 10 per cent or 15 per cent. No doubt, nuclear fission, if and when used for power production, will also have special circumstances attached to its use, such as, perhaps, development only on a large scale in remote regions at a very high load factor. Our main source of both kilowatts and kilowatt-hours must, however, continue to be coal, whose use we can hope to improve by a further increase in operational economy and by limiting, where possible, transport of this fuel particularly by rail." Referring further to the gas-turbine, Mr. Haldane stated that several large gas-turbine sets of the order of 15,000-kW. capacity were at present under construction for use as peak-load plant. It might seem surprising that active consideration was being given to the possible large-scale use of wind power. "The renewed interest in the subject is due mainly to three factors: the existence of extensive grid systems into which intermittent supplies of energy, wherever produced, can be fed; the increased knowledge of aerodynamics; and the shortage of coal." The western shores of the British Isles are well suited to the large-scale development of wind power, and this source of energy deserves more attention than it has received in the past.

Referring to the siting of generating stations, Mr. Haldane said that there were, broadly speaking, three choices: at the load centre, at or near the pithead, or on an estuary site to which coal could be delivered by sea. Estuary sites far removed from the load centre were unlikely to compare favourably with generation at or near the pithead. An economic comparison relating to the London area showed that, once all the available estuary sites had been used, it would be advantageous to place the bulk of future generating stations near the coalfields, with high-voltage transmission to the load centre. Peak-load plant at the load centre might well consist largely of gas-turbines.

Second only in importance to the actual generation of the required amount of electric power came the provision of adequate transmission and interconnexion facilities. This function had been served in Great Britain up to the present by the 132-kV. grid; but consideration had been given to the desirability of providing an additional national busbar operating at a higher voltage. We were about to experiment with the use of 275 kV., which was regarded as adequate for the distances over which we had to transmit and was, incidentally, considered to be the highest voltage for which underground cables could be built at the present time. The highest voltage A.C. system in Europe was at present under construction in Sweden, where a large block of power would be transmitted a distance of about 600 miles at 380 kV. "It may well be desirable," said Mr. Haldane, "to proceed as soon as possible with the construction of such a very high voltage system superimposed on the existing 132-kV. grid."

Turning to the power problems of Western Europe, which are even more acute than those of Great Britain, Mr. Haldane showed on a map the distribution of energy resources. It had long been hoped, he said, that some day all the Western European countries would be interconnected so as to make better use of the available resources. "Technically it should be possible to have high capacity interconnexion extending eventually from Scandinavia in the north to France in the south, with further interconnexion to Austria, Switzerland and Italy. Economically it seems likely that this would be highly beneficial. In fact, few measures could be expected to be more beneficial to European economic life than such integration of power resources, meeting as it would one of the most urgent of Europe's problems and helping towards unification." In this connexion, the question arose of the desirability of a connexion between the British system and that of the Continent. Technically, an interconnecting link between, say, London and Paris by high-voltage cable across the Channel appeared practicable. The question was whether the expenditure would be justified by saving in plant and interchange of energy.

The second part of Mr. Haldane's address was concerned with the philosophical implications of the activities of the engineer and the reaction of present-day conditions on his outlook. "As engineers concerned with applied science," said Mr. Haldane, "we occupy a position intermediate between that of pure science and that of the branches of knowledge concerned with human affairs. We are very definitely concerned both with the advancement of scientific knowledge and with the problem of how this knowledge can best be applied to meet human needs. The latter function makes it particularly important that the general educational background of engineering training should be as wide as possible and should not exclude those branches of knowledge generally known as the humanities.

"The present difficulties due to the huge content of knowledge and consequent tendency towards excessive specialization have led to the disappearance at an early stage in education of any general study of religion or philosophy, so that at the age when young people are becoming able to think on such subjects the great majority proceed to concentrate on mastering the means of life and remain indifferent to, and almost oblivious of, its ends.

"Future generations may well be amazed at our acceptance of such a state of affairs, the existence of which I feel to be one of the strongest arguments in favour of the higher education of engineers being centred in the universities rather than in mono-technic colleges. Although even in the best of our universities there may be too much concentration on means and too little thought about ends, the engineering undergraduate does at least get and give the immense advantage of mixing with those who are studying totally different branches of knowledge. The whole atmosphere of a university engineering education can be influenced by contacts with the other faculties, including the humanities, and consequently study can be on a much broader basis than is possible in colleges or institutions dealing with one subject or group of subjects."

In summing up, Mr. Haldane remarked, "In providing the conditions in which the things of the spirit can come to full fruition we undertake a vital as well as a noble task in which we can have the utmost pride. But let us fully understand the nature of our task, and let us spend more time than we now do in considering the ends to which our work is directed."

MODERN DEVELOPMENTS IN FORESTRY

IN *Forestry Abstracts* (Commonwealth Forestry Bureau, vol. 10, No. 1 Abstracts (1)—(849), September 1948, Commonwealth Forestry Bureau, Oxford), Mr. J. J. MacGregor, of the Imperial Forestry Institute, Oxford, has an interesting paper on "Some Improved Techniques in Nurseries and on Planting Sites". There are many influences, he says, compelling foresters all over the world to revise time-worn practices. These influences are part of the general economic environment in which rising wages and relative shortages of labour are, perhaps, most significant. They have directly stimulated the search for more economic methods, machines and techniques. In a general way, current and recent developments have proceeded along the two main lines of 'rationalization' and the application of new techniques to specific operations. The latter, which includes the adoption of mechanization, improved processes with new tools and new treatments, forms the basis of the article.

In using the term 'rationalization' the author means it to be applied to the administration of staff, the training of subordinate workers, housing and amenities, the execution and close inspection of all work, and the provision of tools; on this last point of tools one might add that, until recently in ordinary forest work, they were few, simple and no different from those in existence during what may be called the pre-mechanized times. In the modern study of these methods Sweden has given the lead and has been in the position, during the past ten years, when so many were otherwise engaged, to make considerable progress; and mention must be made of Swedish reorganisation of piece-work rates, which require to be both flexible and easily understood. Both in North America and in Germany forestry experts have been making similar studies. One form of 'rationalization' has been the suggested centralization of forest nurseries, since it is held, and rightly so, that the efficient raising of large stocks requires highly skilled and experienced supervision. Whether, however, the small nursery on the private estate should be regarded as obsolete is a matter which is open to considerable argument. The big battalions are by no means the safest in a matter of this kind, for many reasons.

On the side of technical mechanical developments, North America takes the lead. In agriculture, the application of labour-saving devices has gone a long way, and a few have been adapted for forestry purposes. But it is felt that special investigations, which are indeed being carried out by those conversant with forest nursery and other wider forestry problems, will have a greater chance of giving the forester new mechanical implements suitable to his particular type of work. The article also deals with the transfer of planting stock (storage and packing), preparation of sites, stump removal, plough and cultivators (the Forestry Commission has had a considerable success based on experiments with heavy ploughs), sowing and planting, planting methods and machines.

LABORATORY GLASSWARE PRODUCTION

THE expression 'E-MIL' may not be quite so well known as some others which have become quite commonplace; but it is likely to become a mark of quality standard in future. Messrs. H. J. Elliott, Ltd., Treforest Trading Estate, Nr. Pontypridd, Glam., whose trade mark it is, already enjoy a reputation for high-quality glassware for quantitative work; but they laudably seek to enhance that reputation by aiming at still higher standards and by offering unconditional guarantees concerning their products, as well as improvements in the character and packaging of the articles.

In the first place, their volumetric glassware will be designated 'E-Mil Green Line' in the case of that which complies with National Physical Laboratory grade *A* specifications, and 'E-Mil Gold Line' for that of the grade *B* standard, the graduations of these varieties being filled respectively with insoluble green and yellow enamels. The pigments appear to be somewhat fluorescent, for they are easily visible in poor lighting, even with coloured solutions. Furthermore, the markings, which are fused into the glass, seem to be irremovable except by such chemicals as those which corrode the glass itself.

Stoppers in graduated flasks and cylinders have always tended to be troublesome owing to a propensity for 'seizing'. The new 'E-MIL' stopper is a valuable accessory. Accurately moulded from an almost inert plastic, it provides a gas-tight and liquid-tight closure to an orifice of British Standards Institution specification taper (although it is not of B.S.I. specification dimensions), but does not bind or seize up irremovably. It is understood that patent protection is being sought for this attractive article.

Nor is this all, for the firm has introduced another innovation. It feels that the old style of crating a number of items amid masses of wood-wool, straw, sawdust and the like is not good enough for precision equipment; the packing material might be dusty and soil the articles, even if paper wrappings are used in addition, and by no means does it ensure safe transport unless an expert is employed to pack and another to unpack. Even with this system, overhead costs can easily be inflated by 'on-the-floor' losses in transferring the goods to storage bins, then to shelves and counters and finally with, or sometimes without, further packing, to the possession of the ultimate user. The firm feels that it can reduce these losses by sealing each article into its own specially fitting carton, which will be unreturnable and will doubtless be retained by many a technician as it provides a convenient pigeon-hole for the safe storage of the article in his locker. It is obvious that the extra expenses of this carton packing will be offset by dispensing with crates, etc., and with the trouble of their recovery as returned empties, not forgetting the overhead expenses and office work associated with the latter.

This programme could not be so courageously planned by the management had it not the wholehearted loyalty of its employees, to whom it gives very strong incentives to produce not only quantity but also quality in whatever they are making. The result is not a mere 'master and man' condition but the development of what may be described as a happy family, some members of which are miners who can no longer follow their former employment because of the dreaded silicosis, some are ex-Service men whose injuries limit their capabilities in the way of earning a living, and others are women and young people with a flair for delicate manipulation. It is good to see them working with a will, and everywhere there is evidence—sometimes resonant—of happy and contented folk.

R. SUTCLIFFE

EDUCATION IN HAITI

THE U.S. Office of Education has undertaken the preparation of a series of basic studies in education in a number of Central and South American countries. This series of studies is part of a programme to promote understanding of educational conditions in the American countries and to encourage co-operation in the field of inter-American education. The project, part of a government-wide programme of cultural co-operation under the auspices of the U.S. Department of State, was begun in the autumn of 1943. It involves travel by Office of Education specialists in the various countries in order to gather information at first hand on their educational systems and to prepare reports for publication.

"Education in Haiti" (Washington, D.C.: Gov. Printing Office. 25 cents) is based on data collected by Prof. Mercer Cook during a twenty-two months stay in which, as supervisor of an English-teaching project which was initially sponsored by the U.S. Office of Education, he was able to make use of authoritative sources of information.

The total area of the Republic of Haiti is about 10,700 square miles, more than two-thirds of which is covered by highlands. This complicates the construction of roads and renders many villages practically inaccessible to commerce and to education. The high rate of illiteracy—estimated at about 92 per cent by some observers—should thus be attributed in some part to topography. No scientific attempt has ever been made to count the total number of Haitians, but an estimate made in 1937 puts the total population at about three millions. Of these, nine-tenths live in rural areas and, as in other Latin-American countries, the fundamental educational problem is that of the rural school. Already, in the words of a contemporary Haitian novelist, erosion has "bled the earth to the bone", and the problem of this agricultural country is to try to intensify its agricultural effort by educating the peasant in modern methods of cultivation and soil conservation. Until this problem of rural education is satisfactorily solved, Haiti seems destined to remain a desperately poor country. The converse is equally true. Progress has been made in recent years; but the deplorable facts remain that four out of five peasant children never attend school; that teachers' salaries are inadequate; that many school buildings are hopelessly unsatisfactory; that equipment and textbooks are often unobtainable; that malaria, yaws, syphilis, tuberculosis and hookworm have undermined the health of the Haitian; that, as one Haitian physician states, "the diet of the Haitian peasant has not changed since slavery days"; and that education has been tied up too closely with politics.

The language problem is also a considerable source of difficulty to Haitian educationists. The official language of the republic is French, while "not one peasant out of a 100 can even guess what is being said in that language"; all Haitians understand Creole and most of them speak it. From Prof. Cook's observations it is apparent that poverty, ill-health, politics and linguistics are the basic ills that beset the Haitian school teacher, and the greatest of these is poverty. "On less than the average income of a first-class American university, the Haitians must provide and maintain elementary, secondary, professional, rural and vocational schools for a population of approximately three millions."

Despite these and other obstacles, however, the Haitians, through their own efforts and with some aid from foreigners, principally French and North American, have, during the last twenty years, progressed along the road to enlightenment. Their schools are no longer entirely literary or classical, teachers are better trained and somewhat better paid; printed regulations are less frequently disregarded. Yet, as Prof. Cook has shown, much remains to be done, and his report will prove invaluable in concentrating attention on the state of education in Haiti.

T. H. HAWKINS

FORTHCOMING EVENT

Monday, December 20

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. E. G. R. Taylor and Prof. W. M. Smart, F.R.S.: "The Navigator's Story".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST (non-medical)—The Director of the Pathological Laboratory, General Hospital, Middlesbrough (December 25).

PRINCIPAL SCIENTIFIC OFFICER (with a First or Second Class Honours Degree in Mathematics or an equivalent qualification, and ability to apply mathematics to tidal movements, etc.) in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2336 (December 30).

PRINCIPAL SCIENTIFIC OFFICERS in the Headquarters Office in London of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2335 (December 30).

HORTICULTURAL OFFICER in Grade II of the National Agricultural Advisory Service—The Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, London, N.W.1, endorsed N.A.A.S. (December 31).

SENIOR RESEARCH OFFICER in the Organic Chemistry Section of the National Chemical Research Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (December 31).

PHYSICISTS and MATHEMATICIANS (for unestablished posts in the Experimental Officer class) in Ministry of Supply research and development establishments in Southern England and South Midlands, for duties concerned with aerodynamics, armaments, ballistics, crystallography, fuels, heat, jet propulsion, radio and radar, and X-rays—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.398/48A (December 31).

SENIOR SCIENTIFIC OFFICER (Ref. A.403/48A) to lead a group of physicists and engineers studying effect of tropical conditions on Service materials and equipment, and a SCIENTIFIC OFFICER (Ref. F.429/48A) to work in analytical or biochemical investigations into deterioration of equipment under tropical conditions, at the Tropical Testing Establishment, Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (January 3).

DEMONSTRATOR IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (January 8).

READERSHIP IN DEMOGRAPHY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 20).

POSTGRADUATE STUDENTSHIPS in preparation for research into stored products entomology in the Colonial Empire—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (April 30).

CHEMISTS IN THE JOINT DEPARTMENT OF CHEMISTRY, Federation of Malaya—The Director of Recruitment, Colonial Service, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1.

RESEARCH ASSISTANT in the field of Organic Chemistry—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

SENIOR LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Secretary, Royal Technical College, Glasgow.

PHYSICAL CHEMISTS as Scientific Officers at a Ministry of Supply research and development establishment near London for duties in (*a*) high temperature refractories, (*b*) crystallography and practical microscopy, (*c*) spectrography and (*d*) plant development—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1025/48A.

CHEMICAL ENGINEER IN THE DIVISION OF ATOMIC ENERGY (Production), Risley, to assist in the design and operation of a prototype plant with a view to helping in the design and construction of a large production plant—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ASSISTANT EDITOR of *Science Abstracts*—The Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Building Studies. Bulletin No. 1: Clay Building Bricks, their Manufacture, Properties and Testing; with Notes on the Efficiency of Brickwork. By B. Butterworth. Pp. iv+24+9 plates. (London: H.M. Stationery Office, 1948.) 1*s*. net. [98

Progress in Leather Science, 1920–1945. Issued in commemoration of the Twenty-fifth Anniversary of the formation of the British Leather Manufacturers' Research Association. Vol. 1. Pp. viii+220. Vol. 2. Pp. xi+221–486. Vol. 3. Pp. xii+487–705. (London: British Leather Manufacturers' Research Association, 1946–1948.) [118

Ovaltine Research Laboratories. Annual Report, 1947. Pp. 8. (London: A. Wander, Ltd., 1948.) [118

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 830, Vol. 241: The Growth-Inhibitory and Carcinogenic Properties of 4-Aminostilbene and Derivatives. By A. Haddow, R. J. C. Harris, G. A. R. Kon and Edna M. F. Roe. Pp. 147–196. 15*s*. No. 831, Vol. 241: The Sensitiveness of Explosives. By J. L. Copp, S. E. Napier, T. Nash, W. J. Powell, H. Skelly, A. R. Ubbelohde and P. Woodward. Pp. 197–296. 30*s*. No. 832, Vol. 241: The First Spectrum of Copper (Cu 1). By A. G. Shenstone. Pp. 297–322. 6*s*. (London: Cambridge University Press, 1948.) [168

A Descriptive Guide to the Libraries of the University of Leeds. By Dr. Richard Offor. Pp. 134+6 plates. (Leeds: Brotherton Library, The University, 1947.) 6*s*. 6*d*. [168

The British Council. Report for 1947–1948. Pp. 88. (London: British Council, 1948.) [168

Physical Society. Reports on Progress in Physics. Vol. 11 (1946–47). Pp. iv+462+11 plates. (London: Physical Society, 1948.) 42*s*. net; to Fellows, 25*s*. net. [168

Lambeth Conference 1948: The Encyclical Letter from the Bishops, together with Resolutions and Reports. Pp. v+53+iv+120. (London: S.P.C.K., 1948.) 5*s*. [178

National Building Studies. Special Report No. 1: Structural Requirements for Houses. By Dr. F. G. Thomas. Pp. iv+9+11 plates. (London: H.M. Stationery Office, 1948.) 9*d*. net. [178

Diamond Tool Patents, 2: Diamond Abrasive Wheels. Edited by P. Grodzinski. Pp. 52. (London: Industrial Diamond Information Bureau, 1948.) 10*s*. [178

Report of a Conference on Strength of Solids held at the H. H. Wills Physical Laboratory, University of Bristol, on 7–9 July 1947. Pp. iv+162. (London: Physical Society, 1948.) 25*s*. [178

National Building Studies. Special Report No. 2: Plumbing in America; a Report on a Visit to U.S.A. and Canada on Plumbing. By F. L. Barrow. Pp. iv+24. (London: H.M. Stationery Office, 1948.) 6*d*. net. [188

Imperial Agricultural Bureaux. Joint Publication No. 12: Phenothiazine in Veterinary Medicine; a Review of the Literature of 1942–46, by J. Tweedale Edwards; Bibliography of Phenothiazine as an Anthelmintic, 1942–46, by the Imperial Bureau of Agricultural Parasitology. Pp. 36. (Weybridge: Imperial Bureau of Animal Health; St. Albans: Imperial Bureau of Agricultural Parasitology, 1947.) 4*s*. [198

Economic Thought and Industrial Policy: an Inaugural Lecture delivered at University College, London, on March 4th, 1948. By Prof. G. C. Allen. Pp. ii+18. (London: H. K. Lewis and Co., Ltd., 1948.) 2*s*. 6*d*. net. [198

Other Countries

Bernice P. Bishop Museum. Bulletin 193: Specialized Studies in Polynesian Anthropology. By Katharine Luomala, Felix M. Keesing, Marie Keesing, Ernest Beaglehole and E. G. Burrows. Pp. iv+88. Bulletin 194: Report of the Director for 1947. By Peter H. Buck (Te Rangi Hiroa). Pp. 40. (Honolulu: Bernice P. Bishop Museum. 1947–1948.) [38

Western Australia Geological Survey. Bulletin No. 101: The Mining Groups of the Yilgarn Goldfield north of the Great Eastern Railway. By R. S. Matheson; with Three Appendices by Dr. K. R. Miles. Pp. 242+ix. (Perth: Government Printer, 1947.) [48

Smithsonian Institution: Bureau of American Ethnology. Bulletin 143: Handbook of South American Indians. Edited by Julian H. Steward. Vol. 4: The Circum-Caribbean Tribes. Pp. xx+609+98 plates. (Washington, D.C.: Government Printing Office, 1948.) [98

Smithsonian Institution: United States National Museum. Bulletin 195: Life Histories of North American Nuthatches, Wrens, Thrashers and their Allies; Order Passeriformes. By Arthur Cleveland Bent. Pp. xi+475+90 plates. (Washington, D.C.: Government Printing Office, 1948.) 1.75 dollars. [98

Conseil International des Unions scientifiques. Sixième rapport de la Commission pour l'étude des Relations entre les phénomènes solaires et terrestres. Pp. 215. (Orléans: Imprimerie Nouvelle, 1948.) [98

Smithsonian Institution: Institute of Social Anthropology. Publication No. 8: Sierra Popoluca Speech. By Mary L. Foster and George M. Foster. Pp. iii+45. (Washington, D.C.: Government Printing Office, 1948.) 40 cents. [98

Twenty-eighth Annual Report of the Research Council of Alberta, 1947. (Report No. 51.) Pp. 28. (Edmonton: King's Printer, 1948.) [118

South African Institute for Medical Research. Annual Report for the Year 1947. Pp. 67. (Johannesburg: South African Institute for Medical Research, 1948.) [118

Chicago Natural History Museum. Report of the Director to the Board of Trustrees for the Year 1947. Pp. 144. (Chicago: Chicago Natural History Museum, 1948.) 1 dollar. [128

Illinois Natural History Survey. Bulletin, Vol. 24, Article 2: The Leafhoppers, or Cicadellidae, of Illinois (Eurymelinae-Balcluthinae). By D. M. DeLong. Pp. 91–376. (Urbana: Illinois Natural History Survey, 1948.) [168

Handbook of Scientific and Technical Societies and Institutions of the United States and Canada. (Bulletin of the National Research Council, No. 115.) Fifth edition. Pp. 371. (Washington, D.C.: National Academy of Sciences, 1948.) 5 dollars. [178

Smithsonian Miscellaneous Collections. Vol. 108: Compendio y descripción de las Indias occidentales. Por Antonio Vazquez de Espinosa. Transcrito del manuscrito original por Charles Upson Clark. (Publication 3898.) Pp. xii+801. (Washington, D.C.: Smithsonian Institution, 1948.) [198

Catalogues

Maps and Atlases of the British Isles from the 16th to 19th Century. (Catalogue No. 692.) Pp. 78. (London: Francis Edwards, Ltd., 1948.)

The Tilgate Story. Pp. 20. (London: F. W. Berk and Co., Ltd., 1948.)

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ACADEMIC AND PROFESSIONAL INCENTIVES

IN its report on "University Finance in Great Britain", dated July 1943, the British Association Committee on Post-War University Education recorded the view that the question of university salaries was the essence of the situation and should be given priority over almost everything else. The salaries of university staffs of all grades were, in the opinion of that Committee, hopelessly inadequate in competition with the world outside, and in the lower ranges, in some universities, inadequate to afford a reasonable standard of life under prevailing social conditions. In the older universities, the salaries of the non-professorial staff were considered not inadequate in the lower ranks, except for the few who devote themselves almost wholly to research. At the provincial universities, however, the average salary of the non-professorial staff was not more than £450–475 a year, as against £600–1,000 for Cambridge (omitting demonstrators and faculty assistant lecturers).

The British Association Committee asserted bluntly that we can expect neither to attract to the university staffs the pick of their graduates nor to have a satisfactory standard of performance on such salaries ; and it recommended an adequate number of senior lectureships and readerships carrying salaries of £700–1,000 a year. Beyond this, however, it was of the firm opinion that in the existing organisation of our society, all whole-time professors in all British universities should receive at least £1,500 a year at 1938 values. "The reputation of our universities," it was urged, "depends more on the quality of their professors than on any other single factor. For the sake of university teaching and research we should make it more easy to retain our very best men, and to attract outstanding men back from the outside world when they are still at the height of their powers."

Somewhat similar proposals were advanced by the Association of University Teachers in a report on "University Developments, 1944", adopted by the Council of the Association in December 1943, namely, a basic salary of £1,500 for professors, and salaries in the range £800–1,100 for senior lecturers and readers. These proposals were afterwards criticized by Bruce Truscot in "Redbrick and these Vital Days", who suggested that the basic salary of £1,500 for a professor was too low though not necessarily at the beginning, and that the British Association Committee's own recommendation implies a basic figure of £1,800. The general level of lecturers' salaries proposed by the Association, however, he regarded as too high ; and he urged that the principle of a salary scale for the professor is of vital importance and one which will be of real service in dealing with the difficulty that in certain subjects such as medicine, and possibly engineering, it may be necessary to pay considerably higher salaries in view of outside competition.

It is true that outside competition should not be the sole factor to be considered in determining professorial salaries; but it is from this point of view that some recent observations of Dr. C. E. Raven in addressing the Senate of the University of Cambridge, on resigning the office of vice-chancellor on October 1, have received publicity which has somewhat distorted them. Dr. Raven recalled that, when putting forward proposals for the stipends of its professors, the University was warned by the University Grants Committee that £1,450 was the maximum professorial salary which the Treasury would recognize. Dr. Raven said that it seemed plain that if the maximum income in academic life was so seriously below that obtainable not only in medicine and at the Bar, but also in the Civil Service and indeed almost all other professions, the universities could scarcely expect to induce men of the highest abilities to stay with them.

This, however, was not all. If professors were limited to such a rate, and there was to be any ladder of promotion, junior teaching officers could be given scarcely a living wage—certainly not a wage on which to marry and bring up a family. Dr. Raven referred particularly to the position of men who, after six or more years in national service, had gained fellowships or been elected to junior teaching posts, and who at the age of thirty were receiving salaries little different from those offered in 1939 to men of twenty-three. In view of the cost of living, it seemed inevitable that unless the university could improve its scales of pay, it would lose an increasing number of men.

That view, of course, ignores the other incentives which induce men and women to take up an academic life; but such incentives can scarcely operate if the salaries offered in the early years of academic life do not enable men and women to sustain modest standards of living such as those laid down by the Association of University Teachers in the memorandum issued before the War, which presented reasoned arguments for a minimum stipend of £500 for a married teaching officer to do his whole duty by a university and its students. The disparity between such academic salaries and those offered in industry is considerable and may well lead to untoward distribution of man-power if uncorrected. Dr. Raven, indeed, directs attention to one specific example of disparity which was obviously in the mind of the British Association Committee when its report was written; the findings of the Spens Report on the Remuneration of Consultants and Specialists, to which Dr. Raven refers, accentuate this disparity. As Dr. Raven suggests, it is on the face of it absurd that whereas the stipends of the majority of Cambridge professors do not rise above £1,550, a specialist appointed to the staff of a hospital is to be guaranteed a salary rising to £2,500 at the 1939 value of money. If the salaries of university teachers of medicine are raised to the figures specified in the Spens Report, the resulting anomalies in the scientific departments of a university will be intolerable as well as absurd.

The universities are clearly facing something of a dilemma, even if the terms may not be precisely as Dr. Raven suggests. The disparity between the pay of chemists in industry and in the universities is well known, and the professorial limit of £1,450 is a good deal less than a man of the highest ability could expect to earn, even if more laboriously or precariously, in the Civil Service or at the Bar, quite apart from industry or medicine. It has been made abundantly clear in discussions on scientific man-power and on scientific and industrial research during the last decade that any policy which denuded any one sector of national life, whether the universities, the Government service or industry, of its proper proportion of the new talent leaving the universities, would have untoward repercussions on the well-being of the nation as a whole.

The problem or dilemma is thus not one for the universities alone, and it must be considered against a much broader background than that of finance. As regards the latter, it should be noted, moreover, that in a written answer to a question in the House of Commons on November 4, Mr. Glenvil Hall stated that in assessing grants to the universities, the University Grants Committee recognizes certain standard rates of salary for professors (other than clinical professors). Allowances are, however, made to enable institutions to pay higher rates of salary where the institution considers the rate of salary should for any reason be above the standard. The distribution of this additional remuneration is left entirely to the institution concerned.

These arrangements, Mr. Glenvil Hall added, were made after consultation with the Treasury, and they seem to leave the universities rather freer than Dr. Raven implies to compete with the non-academic world on its own terms. It does not follow, however, that the universities are bound to do so, unless there is real evidence that first-class men are deserting the universities in significant numbers to earn high salaries elsewhere. So far as chemists are concerned, the evidence suggests that even the offer of considerably higher salaries is not attracting to industry all the men needed for research or production. Moreover, Dr. Raven's statement that £1,450 is the maximum salary has been challenged elsewhere; in the civic universities, it is stated that the typical range of professorial salaries is £1,450 to £1,750, apart from the full-time clinical professors, who receive £2,500. Even this range of salaries is not much inducement for a highly trained man with great influence in the community at the peak of his career; and it must be admitted that in spite of the rise in the salaries of university teachers since 1939, neither in leisure nor in money are they, and particularly the professors, as well off as they were before the War. Nevertheless, it is reasonable to ask whether the universities actually know of men who would have taken their more important posts had it been possible to offer another two hundred pounds or so. Such evidence is imperative before the universities take any steps to restore the balance between clinical professors and non-teaching specialists, or between clinical and non-clinical professors, which the recommendations of the Spens Report so obviously upset.

Whatever course the universities adopt, even if they fall back on a general upgrading of all professorial salaries, the repercussions are likely to be far-reaching. Admittedly, comparison between academic salaries and those current in the medical profession is invidious and a poor basis for framing policy. It illustrates, indeed, the embarrassments that may arise from bringing, without careful preparation and forethought, hitherto unplanned and uncoordinated parts of the economy under the ægis of the State. Quite apart from the rise in salaries in a profession already comparatively highly paid given by the institution of the National Health Service, there has simultaneously been a considerable retardation of the operation of the economic factors which would normally restore the balance. Meanwhile, the nation may well find itself in the near future with a plethora of medical and a great scarcity of the scientific workers, technicians and administrators upon whose services industrial productivity and development depend.

The financial incentive is, of course, not the only one. It is often not the most important motive that influences a man or woman in choosing between an academic life or a career in industry, medicine or another profession; but it is essential that at the lower levels, where a difference of two hundred pounds or less may be a decisive factor, the minimum salaries must be such as enable the maintenance of a standard of living compatible with the full discharge of academic responsibilities. The sense of vocation is not entirely lost, and the idea of rendering public service can still influence the choice of profession. Part at least of the immediate task is to dispel the misconceptions which have, for example, made young scientific workers reluctant to enter industry; for few who have gone into modern industry on the research, production or management side have been unable to find satisfaction for their ideal of public service as much as in academic life, the Civil Service or in independent professional practice.

Adequate salaries at the lower levels should be a first consideration in any national policy. If the universities can be satisfied that at those levels there is no longer the risk of some promising scientific worker, for example, who would fill a professorial post with great distinction in a couple of decades if he remained in academic life, being attracted to another career solely on financial grounds, the most important step towards safeguarding the future will have been taken. Nor is the question one for the universities alone. It should also have the attention of the professional bodies, for it is bound up with that question of mobility of staff and the interchange of workers which is now generally recognized as fruitful for creative work. The question of incentives and conditions of work in one particular profession or occupation cannot be considered entirely without reference to those which prevail elsewhere.

These questions need to be examined from a broader angle than has often been done in the past. In a stimulating discussion on the large laboratory in nuclear research at the Princeton Bicentenary conferences, Prof. E. P. Wigner suggested that one important advantage which the university possesses over other institutions is the constant influx of new people to whom the basis of each idea has to be explained and by whom it may be challenged. A comparatively rapid turnover at both the top and the lower levels of at least a part of the staff in a large laboratory or institution might, he suggested, have a vitalizing effect and help to avoid the stagnation which tends to infect such institutions.

Such migration and interchange is, of course, greatly hindered by existing disparities in salary scales, apart from the new tensions which the Spens Report threatens to introduce. Discussions on superannuation schemes have already emphasized the same point, and there are other obstacles such as housing difficulties which are partly financial and partly material. The time is ripe for a broad approach to the whole question from a national point of view. The subject well merits a considered statement by such a body as Nuffield College, giving due weight to the altruism which often determines the choice of profession, as well as to the financial and other material incentives. Such a statement might well be a most important contribution to the solution of the long-term problem of the distribution of the nation's trained man-power in ways which at once afford satisfaction to the idealism and sense of vocation of the individual, and the needs of the community for service in specific fields.

LARGE-SCALE EVOLUTION

Neuere Probleme der Abstammungslehre

Die Transspezifische Evolution. Von Prof. Dr. Bernhard Rensch. Pp. vii + 407. (Stuttgart: Ferdinand Enke, 1947.) 26.20 R. marks.

DR. JULIAN HUXLEY has already directed attention to this book in a short comment published in *Nature* of October 9, p. 562. It is, as he pointed out, a worthy companion of the series of monographs by Dobzhansky, Simpson, Mayr and Huxley himself, which have in the last few years elevated evolutionary theory to a new plane of precision and completeness. It is particularly interesting to be presented at this time with a general discussion which was written in Germany during the War, when communication with English-speaking men of science was at a minimum. The general similarity between Dr. Bernhard Rensch's conclusions and those of the books mentioned above is very striking, and demonstrates that there is a wide consensus of agreement on the new advances in our understanding.

Rensch's work is mainly devoted to that part of evolutionary theory which has always presented the greatest difficulties of interpretation in the past, namely, the large-scale evolutionary changes which relate widely differing species, genera or families. The argument advanced is that, so far as our present knowledge goes, these can be adequately explained by the three main factors—mutation, selection and chance—which produce the minor diversities within species. The book is introduced by a short summary of the evidence for the action of these factors within species and of the nature of the intra-specific differentiation which they bring about. It then passes on to a discussion of the nature of major evolutionary change, which is classified into two broad categories: kladogenesis, or the branching of evolutionary lineages so as to give rise to new types; and anagenesis, or progressive evolution within a lineage.

Rensch's main argument can, perhaps, be summarized in two conclusions: first, that nearly all conceivable types of organisation seem actually to have occurred, which is evidence that the processes are fundamentally under the influence of chance mutation; and secondly, that the individuals which undergo evolution are developmental systems possessing an organisation which conditions the types of change that can arise. These theses are supported by a wide selection of facts drawn from a detailed knowledge of systematics—both of recent and fossil forms—and of many branches of genetics and experimental biology. The reader is left in no doubt that the study of evolution remains, as it was in Darwin's day, the prime field of biology, demanding a universality of knowledge and a power of synthesis which must greatly transcend the narrow limits within which too many biologists are content to be confined.

In the last three chapters, Rensch ventures into even wider fields, and enters on a discussion of the origin of life, and of the evolution of consciousness. The arguments advanced here may not meet with so much general acceptance; but the topic is one to which biologists should more often attempt to contribute. Many of the classical problems of epistemology derive from the elementary knowledge of human sensory physiology which was all that was available to authors such as Hume, and they are bound to appear somewhat differently when seen in the light of our present knowledge of the faculties of man's ancestors.

C. H. WADDINGTON

ELEMENTARY ZOOLOGY IN THE UNITED STATES

Laboratory Guide in Animal Biology

By Robert H. Wolcott and Asst. Prof. Eugene F. Powell. (McGraw-Hill Publications in the Zoological Sciences.) Second edition. Pp. ix+113. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 9*s*.

An Introduction to Vertebrate Anatomy

By Harold Madison Messer. Revised edition. Pp. xxi+475. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 24*s*. net.

A Concise Comparative Anatomy

By William Henry Atwood. Pp. 413. (St. Louis, Mo.: C. V. Mosby Company; London: Henry Kimpton, 1947.) 20*s*. net.

Textbook of Zoology

By Prof. George Edwin Potter. Second edition. Pp. 948. (St. Louis, Mo.: C. V. Mosby Co.; London: Henry Kimpton, 1947.) 25*s*. net.

THESE four text-books for elementary students illustrate the trends in the teaching of zoology in the United States. As three of them are second editions they have obviously proved successful in their own spheres. The "Comparative Anatomy" by Atwood, although in its first edition, is based on the author's "Introduction to Vertebrate Anatomy", and in some degree, therefore, is not entirely new.

Wolcott and Powell's "Laboratory Guide" is similar to the schedules that most university teachers produce as the result of their experience in dealing with large practical classes. It proceeds by the 'types method', using protozoa, a sponge, cœlenterates, flatworms, a roundworm, a starfish, a mussel, annelids, the crayfish, grasshopper and frog, and treats them in a very elementary way, supplemented by observation of the living animal. The only figure in the book is that of a microscope. Since the student must be taught not only to observe and to dissect, but also to sketch what he sees, a few sample drawings, fully labelled, would be helpful. The book is clearly printed and well bound.

Messer's "Introduction to Vertebrate Anatomy" and Atwood's "Concise Comparative Anatomy" adopt the 'systemic method'. This has the advantage of evolutionary sequence, but the disadvantage that the animal is not appreciated as a whole, and such a method *does* require the study of a single animal to give it balance. The authors have recognized this by adding, for further study, a list of books, many of which are monographs. The preparation of a second edition tempts an author to add new figures, and unless he is careful, the correlation of these with the text and with one another will be neglected. To take an example, Messer figures the arteries and veins of various vertebrates. In the dogfish the arteries are black and the veins white, in *Necturus* and the turtle both are white, in the bird both are striped, and in the mammal they are white. Why could not they be represented similarly in the different classes? Most of the diagrams, however, are clear and well printed; but the blocks of animals in the classification scheme are very much worn. No magnification is given, so that the field mouse appears to be larger than the jack rabbit, and the coney than the dugong. Each chapter ends with a summary, and there is a good glossary. Atwood's book has many diagrams of exceptional merit, but suffers from the same lack of correlation. The English portion of the text is satisfactory; but the Latin terminology is full of errors, for example, corpus restiformus, saccus vasculosis, corpora quadrigemini, and cæcums and appendices!

Potter's general "Textbook of Zoology" was written for rather more advanced students, but is not detailed enough for a British general degree course, although it contains an account of all the phyla. Of the forty-six chapters, eighteen were contributed by collaborators. The types method is used, and the various organs are printed in heavy type so that the paragraphs dealing with them can be easily found. The whole animal kingdom takes up about two-thirds of the book (650 pages) and the remainder has chapters of general interest, such as abnormalities, the endocrine glands, ecology, parasitism, marine zoology, wild-life conservation, genetics and eugenics, embryology, phylogeny and the theory of evolution. A glossary and an exhaustive bibliography are added. The book is thus both informative and interesting, and the author has attempted a compromise between a comprehensive study of the animal kingdom for the student who will proceed no further with the subject, and the necessity for providing the more enterprising and advanced student with the means of extending his knowledge, while stressing for both groups the importance of work in the field and in the laboratory. On the whole, these aims are fulfilled very well. Underlying it the author has in mind the understanding of scientific principles and training in scientific method.

Collaboration has resulted in a lack of uniformity in the standard of the work and in the figures. The section on the frog is unnecessarily elementary, following the more advanced chapters on the vertebrate animal and the two chapters on fishes. In general the line blocks are good, the half-tone blocks so poor that they are sometimes unrecognizable, for example, the bull frog (Fig. 272), Linnæus (Fig. 12), and *Perophora* (Fig. 407). The text has been brought up to date, especially as regards recent work on hormones and vitamins; but here and there a statement causes a shock to the reader, such as this from the chapter on *Amphioxus*: "Ciliated nephridia similar to those of the earthworm lead from the dorsal portion of the coelom to the atrial cavity".

The production is pleasing, and the price (25*s.*) is not exorbitant. N. B. EALES

EARTH HISTORY

The Formation of the Continents by Convection

By G. F. S. Hills. Pp. vi + 102. (London: Edward Arnold and Co., 1947.) 7*s.* 6*d.* net.

THE discontinuous sialic continents floating in the continuous simatic layer and the folded belts of the crust present two of the grandest problems of geology. In this essay, the solutions advanced are these. First, in the early liquid stage of the earth, crystallization began with the sinking of heavy olivine and the floating of light felspar; these floating crystals were carried by convection to the poles to form clumps which, as the liquid magma became more viscous and convection ceased, were then moved to the equator by the Eötvös force. During these operations, radioactive substances, concentrated in the felspathic material, heated the underlying olivine-layer which, thus expanded, elevated this material above the oceans to make the Laurasia and Gondwanaland of the palæogeographer.

The second problem is solved as a consequence of this expansion; the continental masses, pegged down to the Pacific rim, are domed up by uprise of basaltic material which, finding its own level, escapes around the rim, creasing up the continental and geosynclinal margins into the fold belts and, spreading over the floor of the present Pacific, carries with it fragments of continental material that formed, for example, New Guinea, Fiji and other islands. This gigantic basalt flow was responsible for the Cenomanian Transgression and a variety of other events.

With these two mechanisms in mind, the author discusses the Atlantic rift, the roots of mountains, the origins of fiords, the cause of the Quaternary glaciation, the salt in the sea and the absence of fossils in the Pre-Cambrian rocks, and finds many of the hard problems connected with these diverse topics more amenable.

Inquiries such as these into the mechanisms of the earth are naturally of interest to the geologist, who is usually not qualified to make them—he leaves it to the mathematician or geophysicist. The author views a great many geological operations in a different way from the geologist. His conception of the crystallization of magma, the formation of granite, the production of gneissose texture, the history of the fold-belts—to name a few special points—and his general use of the geological time-scale, are not those of the geologist dealing with the detailed anatomy of the crust. But still the author's proposals must be considered alongside those of Daly and Sir George Darwin, when the geologist comes to contemplate the bearing of his mass of detail on the grand problems of earth-history. H. H. READ

FRUIT GROWING AND STORAGE

Harvesting and Storing Garden Fruit

By Raymond Bush. Pp. 162+16 plates. (London: Faber and Faber, Ltd., 1947.) 12*s.* 6*d.* net.

WHEN Mr. Raymond Bush sits down to write a book or an article, one may be sure that the result will be well worth the gardener's reading. There is always much wisdom, not untinged by humour, much of a life-time's accumulated experience and, usually, something at least to make one doubt or even disagree. His new book is no exception; no fruit-grower could read it without enjoyment and without learning a great deal; but some at least would feel a sense of disappointment. The book was obviously intended originally for the amateur fruit-grower—its title alone leaves no doubt on that point; but the author's enthusiasm for his subject carries him outside his field, and some of his suggestions would be beyond the means or the needs of all but the wealthiest of amateurs. The suggestion, for example, that quick-freezing of fruits and vegetables could be practised in the home is surely misleading, to say the least, when one considers that for satisfactory preservation an initial temperature of about − 30° F. is necessary. On this subject, details of the method of processing seem of little value or interest to the public for whom the book is intended, while for anyone seriously considering factory-production the information would be hopelessly meagre.

Taken by and large, it is a curiously compounded volume; one is left with the feeling that the author set out to write a book specifically to the title, and then, having found that it was of insufficient size, added five chapters at the beginning containing random dissertations on soils and climates for fruit-growing, manuring, pollination and other cultivational problems, all full of good advice and wise comment but having little direct bearing on the real subject.

On the central matter of storage, one cannot again help but feel a sense of disappointment. The storage of fruits has been a matter of such intensive scientific research, research which is not so difficult to 'put over' to the layman, that some attempt might be made to explain the physiological principles involved. The meaning and significance of the 'climacteric' in fruit ripening and storage is surely worth more than two paragraphs of explanation. Again, if the description of the quick-freezing process was worth inclusion, something might have been said of gas-storage, even if only to make the layman aware of the possibilities and limitations of the process.

At the end, the author again adds four chapters, which one would not expect from the title, on jam-making, bottling and canning, wines and fruit-juices. Here, at least, is a field in which the amateur can practise, and if the book stimulates a revival of the old art of home cider-making it will, on that alone, achieve much. The descriptions of home-made fruit wines fill one with the desire to start without delay on one's own 'brewery'; but further reading discloses the need for impossible quantities of that rare commodity, sugar, and regretfully one abandons hope until more spacious times come back.

Despite the criticisms which have been made, the book, as has been said, is one which all interested in fruit-growing can read with profit and enjoyment.

R. H. STOUGHTON

ELECTRONIC APPLICATIONS OF GERMANIUM

CRYSTAL rectifiers, the essential constituents of which are a metal and semiconductor in contact, are of two types, large-area contact rectifiers, such as copper oxide or selenium rectifiers, and point-contact ones, such as the germanium or silicon type. In both types the semi-conductor, which contains certain impurities, is in the form of a slab making contact on both top and bottom with the metal. For large-area contact rectifiers, rectification is obtained by making the intrinsic rectifications of the two metal-semiconductor contacts of different values, and for the point-contact rectifiers by making the area of one contact, usually the upper one and consisting of a small point at the end of a wire of metal such as tungsten ('cat's whisker'), very much smaller than the area of the other contact, the base electrode.

Germanium High Back-voltage Rectifiers

With the extension of radio communication to ultra-high frequencies, the use of point-contact crystal rectifiers in telecommunication circuits has become an established practice. The silicon rectifier, which is most suitable for ultra-high frequencies, is limited in that it can withstand only a small inverse voltage. The germanium crystal rectifier, in a form which has recently been developed[1,2,3], is less liable to overload. It can withstand a peak inverse voltage of 80 volts and deliver a maximum continuous current of 50 milliamperes; and although its frequency response is inferior to that of silicon, it is greatly superior to that of the metal-oxide rectifier. Its small weight and size (¼ inch diameter and ⅝ inch long) makes it particularly useful as a component in portable or miniature electrical equipment. As a detector or rectifier it can replace the vacuum diode, with the considerable advantage that, being a non-heating device, A.C. hum, noise, and thermal delay, from which all hot-cathode devices of the vacuum type suffer, are absent.

The germanium crystals used in these high back-voltage crystal rectifiers are excess (n-type) semiconductors, and are obtained from ingots formed *in vacuo* and slowly cooled. They require to be lapped in order to introduce large flow forces, which probably change the surface layers, and to be etched, the action of which is not clearly understood but which is said to improve the back voltage.

The Transistor

It is with germanium prepared in this fashion that J. Bardeen and W. H. Brattain, of the Bell Telephone Laboratories, in the course of a general investigation, initiated and directed by W. H. Shockley, on the properties of semiconductors, have developed a new three-element electronic device, called by them a 'transistor' (transfer-resistor) or 'semi-conductor triode'. This can be employed as an amplifier or oscillator and can replace the vacuum triode in most electronic circuits. The device, which consists of a metal cylinder, about an inch long and of the thickness of a pencil, containing the germanium and its three electrodes, was demonstrated with great success recently at a Press conference in New York. The transistor was used to amplify telephone and television signals, and a standard-model radio receiver, with transistors in place of the ordinary radio valves, operated quite satisfactorily. A standard frequency note generated by an oscillatory circuit employing transistors was also produced.

The construction and basic principles of operation of the transistor have been described by its discoverers in two letters communicated by them to the *Physical Review*[4]. In place of the single 'cat's whisker' of the crystal rectifier, two fine wires (both tungsten and phosphor-bronze have been used) make contact with the upper surface of the germanium block. These electrodes, the emitter and collector, are about 0·005–0·025 cm. apart. The third electrode, which is a large-area low-resistance contact, makes contact with the base of the block. Both the emitter and collector, when connected separately with the base, have characteristics similar to that of the high back-voltage rectifier. With a suitable positive bias on the emitter and negative bias on the collector relative to the base electrode, a signal introduced between the emitter and the base appears in amplified form between the collector and the base. Amplifications up to 100 times, that is to say, a gain of 20 decibels, have been obtained.

The transistor uses less power than a vacuum tube, has an output of 25 milliwatts and can operate at frequencies up to 10 megacycles per second. The collector has a high impedance and can therefore be matched to a high-impedance load. Being an excess (n-type) semiconductor, the main body of the germanium conducts electricity by excess electrons; but, as tests described in the second of two letters confirm, there is a thin layer next to the upper surface of the germanium which is of defect (p-type) positive-hole conductivity. Thus a current of positive-holes flows from the emitter and spreads over the surface of the semiconductor. Since the sign of the collector bias is such as to attract the positive-holes, a large part of the emitter current flows to and enters the collector. The collector has a high impedance for the flow of electrons into the semiconductor, but little or no impedance to the flow of positive-holes, so that for a signal voltage which varies the emitter current, there is a corresponding larger variation in collector current, producing the observed amplification.

The nature of the excess conductivity of the surface layer was investigated by means of probe measurements of the potential in the vicinity of a point contact on the plane surface of a thick block of germanium. Various surface treatments, in addition to the etch usually employed for crystal rectifiers, were used in different tests. The existence of the (p-type) conducting layer at the surface was confirmed, but the conditions very close to the point contact (within 0·01 cm.) were found to be complicated.

The transistor is not yet in production, but its simplicity, small size, performance, long life, and probably low cost when mass-produced, should find many applications in all forms of electronic equipment.

Non-rectifying Germanium

Following closely on the announcement of the transistor with its (p-type) defect surface layer, W. E. Dunlap and E. F. Hennelly, of the General Electric Company research laboratories, New York, report[5] the preparation of germanium of rather unique properties, of which the most striking is the almost complete absence of surface rectification at the germanium–metal contact. The germanium ingots were prepared by melting germanium powder under a pressure of less than 10^{-4} mm. of mercury, and ten-point, plane-welded contact rectifiers were made from one ingot. The units were weakly (n-type) excess semiconductors at room temperature, where their average rectification ratio for 20 volts was 3·54, and (p-type) defect semi-conductors at −196° C., where the corresponding ratio was 1·22. For small voltages the rectification was negligible at both 25° and −196° C.; but for 20–100 volts the rectification factor increased to the order of 2. This is attributed not to a true rectification but to possible heating and consequent inhomogeneity in the germanium. Hall-effect measurements showed that the transition from n to p takes place at 70° C. The room-temperature resistivity, 17·8 ohm. cm., was increased by some 20 per cent by the application of a magnetic field of several thousand gauss, and the Hall coefficient, 514,000 E.M.U., decreased by about 30 per cent for an increase of field of approximately 10,000 gauss. The high magneto-resistance and variation of Hall coefficient with magnetic field, in spite of the apparently high degree of homogeneity of the germanium, is the second point of interest. It is suggested that these effects are intrinsic or else the inhomogeneity is on a scale small compared with the dimensions, about 0·0002 inch, of the point-contact, and further work is in progress to test these ideas.

[1] *G.E.C. Rev.*, **51**, 13 (1948).

[2] *J. Sci. Instr. and Phys. Ind.*, **25**, 247 (1948).

[3] *Electronic Eng.*. **20**, 232 (1948).

[4] *Phys. Rev.*, **74**. 230, 231 (1948).

[5] *Phys. Rev.*, **74**, 976 (1948).

NEW LIGHT ON THE ORIGIN OF MONEY

By DR. PAUL EINZIG

MATERIAL produced by recent ethnological research calls for a revision of the hitherto generally accepted 'classical' conception of the origin and early evolution of money. That conception may be briefly summarized as follows: Barter developed as and when original communism (tribal ownership of the means of production) gave way to private property, and self-sufficiency of economic units gave way to division of labour. Money developed after the progress of division of labour and the growing complexity of the economic system had reduced barter to absurdity. The primitive forms of money originally adopted were gradually replaced by more advanced forms. Eventually, the functioning of advanced money economy led to the development of credit economy.

This conception is all but universally endorsed by economists, and is expressed briefly and superficially in most text-books on money. Yet in the light of ethnological and historical research it must be denounced as fundamentally false. Paradoxical as it may seem, it is nevertheless a fact that barter existed before the development of division of labour and private property in the generally accepted sense of these terms; that money originated long before the complexities of progressing economies had reduced barter to absurdity; that the origin of money was due to a large extent to non-commercial factors; and that credit existed already before money came into being.

According to the classical conception of economic history, foreign trade existed before home trade; barter first developed between tribes specializing in different cultures, while within the tribes themselves it only developed after the adoption of a certain degree of division of labour. This conception is entirely erroneous. There was ample scope for barter within a pastoral, agricultural, hunting or fishing tribe. As has been ascertained, members or households of a tribe specializing in one single culture are, in fact, in the habit of exchanging systematically their products against each other. For one thing, even though the entire tribe may be pastoral, that does not necessarily mean that they breed the same kinds of animals. Even if they do, there is, in any event, ample scope for exchanging young animals against old ones, good quality stock against inferior stock, etc. Likewise in an agricultural community there is ample scope for exchanging various agricultural products against each other.

There is ethnological evidence also for the existence of barter in communities where means of production constitute tribal property. Once the proceeds of production are distributed they become private property, and there may be occasion for bartering the products against each other. When the chief of a warrior tribe distributed among the tribesmen the proceeds of a successful raid or the tribute paid by subject tribes, the objects thus distributed became the private property of the recipients and provided occasion for barter among each other long before the development of private ownership of the means of production. In particular the enslaved captives provided material for systematic barter.

The conception that money came to be adopted as and when progress of division of labour had made it intolerably inconvenient to trade by means of barter is regarded as axiomatic by the overwhelming majority of economists. Yet there is ample ethnological evidence to prove that in a large number of communities barter continued long after the adoption of some form of standardized means of payment for non-commercial purposes. In many primitive communities in the Pacific area or Africa, internal trade is, or was until quite recently, conducted almost entirely by means of barter even though standardized means of payment were in use for certain non-commercial purposes, such as payment of bride price, contributions to religious sacrifices, subscriptions to secret societies, payment of tribute, ransom, blood money, etc. While it is known to ethnologists, it is not realized by the overwhelming majority of economists that, in primitive communities, such non-commercial payments are incomparably more important than commercial transactions proper. They wrongly believe that a community at an early stage of its economic evolution does not feel the necessity for the adoption of money unless and until barter has become too inconvenient owing to the growing variety of goods and services to be exchanged against each other.

In reality, barter is not nearly so inconvenient a system in a primitive community as is assumed by economists who look upon it through modern eyes. The instances quoted by economists to illustrate the difficulties that were eventually supposed to have led to the adoption of money are usually taken not from the internal life of primitive tribes but from the experience of European travellers in dealing with them. There was the much-quoted experience of Cameron who, in order to be able to acquire an urgently needed boat in Tanganyika, had to exchange his brass wire against cloth, then cloth against ivory and finally ivory against the boat. There was also the well-known experience in Indonesia of Wallace, who had to do without dinner whenever vendors of food did not happen to want his goods. Mademoiselle Zélie, of the Théâtre Lyrique, Paris, complained in a much-quoted letter that her fee for a concert on one of the Society Islands, consisting of three pigs, twenty-three turkeys, forty-four chickens, five thousand coconuts and considerable quantities of bananas, lemons and oranges, was of little use to her. All these and many other instances may appear to the modern reader as a convincing proof that barter is an impossible system. Yet these instances only illustrate the difficulties and anomalies that are apt to arise through contact between two different civilizations. The natives of the communities visited by Cameron, Wallace and Mademoiselle Zélie were quite capable of making their own arrangements to ensure the smooth working of a system which, though far from ideal, suited their primitive requirements tolerably well. The fact that even culturally advanced communities with relatively developed economies, such as Ancient India and Ancient Egypt, conducted their trade mostly by barter shows that the inconveniences of that system have been grossly exaggerated by modern writers.

The development of some form of standardized means of payment must have preceded in most communities the achievement of a stage in the progress of division of labour when barter became impracticable. Long before that stage was reached, there already existed some form of money used regularly for non-commercial purposes. Nevertheless, the communities concerned continued to barter, not because they knew no better, but because they preferred to exchange goods and services against each other rather than against money. It was largely because the non-commercial purposes for which money was employed ensured a steady demand for the monetary objects that they gradually became favourite media of barter and ended by becoming media of exchange. It seems reasonable to assume, therefore, that money first developed to serve matrimonial, political or religious payments and was only later adopted gradually for commercial purposes. Possibly it was adopted as commercial means of payment even before division of labour made barter impossible.

Long before this stage was reached, an advanced credit economy developed in many primitive communities. During recent years ethnologists have described many communities in which trade was transacted mostly by barter, but which possessed, nevertheless, a highly involved credit system arising from the non-commercial use of some standardized means of payment. Thus in the New Hebrides there is a most elaborate and extensive credit system in terms of pigs, arising from the sacrificial use of the animals[1]. Shell strings required for subscriptions in secret societies formed the basis of a veritable inverted pyramid of credit system on the Banks Islands[2]. Payments in connexion with marriages resulted in a highly involved system of indebtedness in dogs' teeth currency among the Manus of the Admiralty Islands[3]. On Alor, in Indonesia, everybody is both a creditor and a debtor in a complicated system of reciprocal indebtedness in terms of bronze drums and gongs which form an indispensable part of the bride price[4].

The existence of a highly developed credit system in Babylonia many centuries before the adoption of coinage, during a period when the currency consisted of barley and uncoined silver, is an instance of the evolution of credit prior to the evolution of modern money.

Barter, by its nature, gave rise to a credit system before the adoption of money. This was not realized by some economists, who, however distinguished in their own lines, were unacquainted with the elements of anthropology. John Stuart Mill's picture of the tailor on the verge of starvation trying frantically to find a baker who happened to be in need of a jacket, in order to secure his daily bread in exchange for it, is a characteristic instance in this respect[5]. Fortunately for themselves and for the progress of mankind, primitive man had enough common sense to overcome the difficulty, which existed in Mill's imagination, that the tailor would not want as much bread at a time as would be worth the coat and that the coat could not be divided. In fact, the tailor could easily make arrangements with the baker to secure the supply of bread over a period in return for the sale of the coat. This is what is done regularly in present-day primitive communities. According to ethnological evidence, blacksmiths and other artisans are paid after harvest for goods and services supplied between harvests.

To some extent the development of primitive money actually does away with the necessity for credit system that was indispensable in a barter economy owing to the discrepancies between the value of the objects exchanged and the time-lag between their delivery. Thanks to the adoption of some object for monetary use, blacksmiths can now collect payment immediately instead of having to wait until the next harvest; and John Stuart Mill's imaginary tailor would have been able to sell his coat to the baker against cash payment instead of granting credit in terms of loaves.

Many of the above facts and conclusions may appear elementary to ethnologists. They are ignored, however, by the overwhelming majority of economists. It is of the utmost importance to establish closer co-operation between the two branches of learning for the benefit of both. It is to the interest of monetary economists to study more closely the origin and early phases in the evolution of money, instead of accepting as axiomatic the vague and out-of-date observations on the subject in Adam Smith's "Wealth of Nations". They have to become acquainted with the material produced by ethnologists. The latter, in turn, are in need of better acquaintance with the theoretical rules of monetary economics. In the absence of such knowledge, they are unable to make adequate use of their opportunities to study on the spot such primitive monetary systems as still exist. Their findings are apt to be exasperatingly vague. While asserting in general terms that certain material serves as the currency of a certain community, they very often fail to state precisely which monetary functions the material in question performs and to what extent. Above all, they are not qualified to ascertain if, and to what extent, the behaviour of primitive money conforms to the accepted rules of monetary theory. As primitive monetary systems are disappearing fast, it is of the utmost importance that ethnologists engaged in field-work should equip themselves with the necessary knowledge of monetary theory while there is still a possibility of investigating the functioning of the primitive monetary systems which have survived to our day.

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[1] Layard, G., "Stone Men of Malekula" (London, 1937), pp. 252–3; Harrison, T., "Savage Civilization" (London, 1937), pp. 26–28.

[2] Codrington, R. H., "The Melanesians" (Oxford, 1881), p. 236.

[3] Mead, Margaret, "Growing Up in New Guinea" (London, 1931), p. 218; Fortune, R. F., "Manus' Religion and Ethnological Study of the Manus Natives of the Admiralty Islands" (Philadelphia, 1936), pp. 49–50.

[4] Du Bois, Cora, "The People of Alor" (Minneapolis, 1944), pp. 143–5.

[5] Mill, John Stuart, "Principles of Political Economy" (London, 1878), p. 4.

VITAMINS AND ANTI-VITAMINS

AN interesting discussion on "Anti-vitamins in Food", arranged by the Nutrition Society, took place on October 23 at the Royal Society of Arts. Sir Edward Mellanby, who might justly claim to be the originator of the modern concept of anti-vitamins, was chairman. In his introductory remarks he pointed out that the 'anti-vitamin' or 'toxamin' theory is now some twenty years old, although his early claims that cereals must contain substances which antagonize vitamin D had not been immediately accepted. Later work, however, in identifying phytic acid as an anti-calcifying factor, had placed the existence of anti-vitamins beyond dispute. Considerable progress is now being made towards an understanding of the general principles underlying the mode of action of the anti-vitamins, and both their significance as dietary factors and their potentialities as therapeutic agents are clearly recognized.

Natural and Artificial Anti-vitamins

Dr. L. J. Harris recalled that Eijkmann, who shared a Nobel Prize with the late Sir Frederick Gowland Hopkins for the discovery of vitamins, resorted to what amounted to an 'anti-vitamin' theory to explain the results of his experiments on avian polyneuritis. Since a diet of polished rice caused polyneuritis, while rice polishings cured this condition, he assumed that the rice contained a toxin and the polishings an antidote. Hopkins, on the other hand, proved the reality of 'deficiency diseases', in which injury is caused simply by the absence of a vitamin from the diet, and not by failure of the vitamin to neutralize a dietary toxin. While Hopkins' conclusions have proved substantially correct, it is now realized that the adequacy or inadequacy of a diet in regard to a particular vitamin may often be influenced by the other constituents of the diet. Since the requirement of the organism for vitamin B_1 has been found to be proportional to the carbohydrate intake, we may regard the starch present in Eijkmann's polished rice as being antagonistic to the vitamin B_1 present in the polishings. In this limited sense, therefore, it may be considered a toxic substance.

The important work of Mellanby on the rachitogenic properties of cereal products, however, indicated that some foods contain substances, other than their major components, which antagonize the action of vitamins. Another important advance resulted from the demonstration by Fildes and Woods that the sulphonamide drugs owe their bacteriostatic action to their biological competition with *p*-amino-benzoic acid, a compound with a similar chemical structure which has since been recognized as a vitamin. The sulphonamides may therefore be regarded as artificial anti-vitamins, and, on the same principle, analogues inhibiting the action of most of the other vitamins have now been synthesized. Although it was not intentionally chosen as an anti-vitamin, the familiar insecticide 'Gammexane', or hexa-chloro-benzene, presumably owes its activity to its competition with the vitamin inositol, the corresponding hexa-hydroxy compound.

In estimations of vitamins in foodstuffs by biological tests, the results obtained will depend not only on the amounts of vitamin present but also on the amounts of anti-vitamin, as well as on the presence of substances which assist the vitamin in its absorption and utilization, and many other factors. Chemical tests, on the other hand, tell us how much vitamin is present, without enlightening us as to its degree of availability to the animal. Since both chemical and biological methods give results which are perfectly correct, within the limitations recognized in each case, it is obviously essential that in quoting vitamin values for foodstuffs the method used should be clearly stated.

Anti-B-vitamins

The numerous B-vitamins in themselves present a very complicated picture, which is made even more complex when we extend our studies to the corresponding anti-vitamins. Many B-vitamins, moreover, are synthesized by the intestinal bacteria, in amounts which differ widely in different animals, with the result that anti-vitamins may either affect the organism directly or through the agency of the intestinal flora. Altogether, Dr. E. Kodicek has enumerated five ways in which the action of B-vitamins may be inhibited, including (1) failure of intestinal absorption, (2) the destruction or inactivation of the vitamin by toxic substances or bacteria, (3) the inhibition of bacteria producing the vitamin by antagonists or the absence of an essential metabolite, (4) the displacement of the vitamin from the tissues by analogues, and (5) exposure of the organism to special-stresses, such as infections, pregnancy, and a bad balance of the major components of the diet.

Various types of 'toxamins' may oppose the action of B-vitamins, but the term 'anti-vitamin' is perhaps best reserved for the structural analogues, which have already been synthesized in relation to aneurin, nicotinic amide, riboflavin, vitamin B_6, pteroyl glutamic acid, pantothenic acid, biotin, choline and inositol. Several natural toxamins have also been reported, including the thiaminase in live yeast which destroys vitamin B_1, a factor in maize which antagonizes nicotinic amide, the avidin of raw egg white which inactivates biotin, and the lycomarasmin of wilted tomato plants which antagonizes the bacterial growth-factor, streptogenin.

Rachitogenic and Hæmorrhagenic Toxamins

Phytic acid, a phosphorylated derivative of inositol, is the best known anti-calcifying agent in foodstuffs. Prof. R. A. McCance pointed out that evidence of the rachitogenic properties of cereal products was advanced by Mellanby in 1920; but it was not until about ten years later that Bruce and Callow found that phytic acid interferes with the absorption of calcium. Harrison and Mellanby then demonstrated that this substance had the same effect as cereals in causing rickets in dogs, while

McCance and his colleagues found in human feeding trials that the absorption of calcium was less efficient with wholemeal bread than with white bread as the main constituent of the diet. The addition of calcium to National flour was therefore undertaken in order to compensate for the increased amounts of phytic acid which resulted from the higher extraction-rate.

Unidentified rachitogenic agents have also been encountered in animal feeding-stuffs. Yeast is a valuable source of proteins and B-vitamins for pigs; but Dr. S. K. Kon and his colleagues have found that it causes rickets unless cod-liver oil, or some other source of vitamin D, is also given. Dr. T. K. Ewer has observed rickets in sheep reared in the southern island of New Zealand, where young green cereals are used as fodder. The condition responds to treatment with vitamin D; exposure to sunlight, however, is not effective, the tendency to rickets being greatest when good weather causes a rapid growth of the fodder.

Fatal hæmorrhages, associated with a prolonged blood-clotting time, have long been known to occur in cattle fed upon defectively cured sweet-clover, and Link and his colleagues identified the toxic agent as dicoumarin. Since full protection against the action of this substance may be secured by the administration of vitamin K, it may be regarded as a typical toxamin in the sense implied by Mellanby. Dr. P. Meunier, of Lyons, has studied the quantitative balance between hæmorrhagenic agents and vitamin K in the rabbit. Several synthetic analogues, including phenyl indanedione, have been found to cause increased clotting times, although they are generally less active than dicoumarin.

Imbalance of Fat-soluble Vitamins

Under this heading, Dr. T. Moore discussed the effects of toxic overdosing with one vitamin, and also the effects of deficiency or excess of various nutrients on the activity of the fat-soluble vitamins. Thus, massive overdosage with vitamin A leads in rats to skeletal fractures and hæmorrhages which are reminiscent of scurvy, while this disease has also been diagnosed in an American child given absurdly large doses of vitamin A. It has been reported that vitamin A deficiency causes a secondary deficiency of vitamin C in rats and silver foxes; but the significance of this vitamin in both deficiency and excess of vitamin A remains undecided. Hypervitaminosis A in rats, however, undoubtedly leads to a prolonged blood-clotting time which can be corrected by giving vitamin K.

The demands of the organism for carotene or vitamin A may be influenced by many factors. Extensive animal experiments have indicated that vitamin E, a powerful antioxidant, protects vitamin A from destruction in foodstuffs during storage, in the products of their partial digestion passing through the intestinal tract, and in the tissues of the consumer. In the human subject the habitual use of medicinal paraffin may seriously interfere with the absorption of carotene. Early work by Mellanby indicated that certain cereal products, and also ergot of rye, may emphasize the effect of vitamin A deficiency in causing nervous lesions, which his later work has associated with disordered growth of bone.

Massive overdosage with vitamin D causes excessive calcification, and doses approaching the toxic level have been found by Charpy and by Dowling to be valuable in the treatment of cutaneous tuberculosis.

Deficiency of vitamin E in experimental animals causes not only reproductive failure but also many other lesions including muscular dystrophy, brown pigmentation of the uterus and adipose tissues, exudative diathesis, encephalomalacia, renal abnormalities and dental depigmentation. Most of these lesions are increased in severity by an inadequate protein allowance, and by the inclusion in the diet of cod-liver oil or other highly unsaturated fats. Conversely, the lesions may be avoided or reduced in severity by removing fats from the diet, and by including adequate amounts of protein, choline, methionine and inositol. In general, therefore, liability to the effects of vitamin E deficiency is increased by the consumption of readily oxidizable fats, and decreased by adequate dietary supplies of the lipotropic factors which facilitate the mobilization and transference of fats.

Mr. A. L. Bacharach summarized the day's proceedings, and expresssed his satisfaction in the success of the meeting in bringing together a mass of information on an interesting and important subject.

OBITUARY

Sir John Fryer, K.B.E., F.R.S.

AGRICULTURAL science has suffered a severe loss by the death on November 22 of Sir John Fryer, secretary of the Agricultural Research Council, at the age of sixty-two. The news came as a great shock to his many friends both in scientific and administrative circles.

John Claud Fortescue Fryer was born on August 13, 1886. His family had been farmers in Cambridgeshire and Huntingdonshire for generations, and his early years were spent at Chatteris in the fenlands; he was always happy to return to the East Anglian countryside. He was at school at Rugby and went on to Gonville and Caius College, Cambridge, where he took a first class in the Natural Sciences Tripos and a little later was elected a fellow of the College. He already had a good knowledge of British insects and, like his father and grandfather before him, was a keen collector and field naturalist. Some years abroad followed. He joined the Percy Sladen Expedition to Aldabra Island, in the Indian Ocean, and wrote a valuable account of the natural history of the island; he also spent some time in Ceylon where he worked on the genetics of the butterfly *Papilio polytes*. On returning to England, Fryer was appointed entomologist to the Ministry (then Board) of Agriculture, and devoted himself to the study of insects of economic importance in agriculture and horticulture. It was a new post and he started work in an office in Northumberland Avenue without laboratory accommodation or equipment. After a pioneering period, a small staff of entomologists and plant pathologists was recruited and the Ministry's Plant Pathology Laboratory established. Accommodation was found for a time at Kew, and in 1920 a move was made to permanent quarters at Harpenden, where Fryer made his home. As director of the Laboratory, he took a leading part in dealing with a great variety of problems and inquiries concerning insect and other pests of crops, in fostering and initiating research on control measures, and in establishing an efficient advisory service in these subjects throughout Great Britain. One of his major problems was the continually increasing threat of the introduction into Britain of the Colorado beetle after its establishment on the Continent of Europe.

In 1941, the Ministry formed the Agricultural Improvement Council to act as a bridge between science and practice in agriculture, and Fryer became its first secretary. His work for some years had involved close contacts with the Agricultural Research Council, and in 1944, following the death of Dr. W. W. C. Topley, he accepted appointment as secretary of the Council. It was with some misgiving that he undertook this onerous task, for it meant continuous office-work in London, and he knew that there would be little or no time for his entomological interests.

In addition to his scientific attainments, Fryer possessed high administrative ability, and his appointment was quickly justified. His practical knowledge of farming, acquired in his early days, combined with a long experience of the application of scientific method in agriculture, admirably fitted him for the work. Moreover, he had, to a rare degree, the capacity to see and state clearly and succinctly the essential points of any problem, and many who sought his advice could testify to his clear-sighted, logical and helpful discussion of their difficulties. He was especially good in committee, where his sure grasp of essentials and his tactful guidance often brought a rambling discussion to a point.

Fryer was a real countryman and naturalist and a keen fisherman. He was at his best on a collecting expedition in some remote part of the country, and the briefest holiday was spent, if possible, where he could search for specially interesting or rare insects. He had fine collections of British Lepidoptera, Coleoptera and Hemiptera–Heteroptera and was an expert on the Microlepidoptera. He took great interest in the conservation of the British fauna and flora and was an active member of the Society for the Promotion of Nature Reserves and of various committees of the National Trust. He served as president of the Association of Applied Biologists and of the Royal Entomological Society; he was elected a fellow of the Royal Society in 1948. His official services were recognized by a knighthood in 1946.

In 1919, he married Constance Joan Denny-Cooke, of Bergh Apton, near Norwich, who, with a son and daughter, survives him. He was buried at Bergh Apton.

C. T. GIMINGHAM

NEWS and VIEWS

The National Physical Laboratory, Light Division: Mr. T. Smith, F.R.S.

On his retirement last July, Mr. T. Smith completed a period of forty-one years service at the National Physical Laboratory, where he was in charge first of the Optics Section of the Physics Department and later of the newly created Light Division. The long series of investigations on geometrical optics which have established Mr. Smith as a leading authority in the subject were begun a few years after he entered the Laboratory with a paper to the Optical Society entitled "Practical Optical Calculations". This was the key for much of his later work. His outstanding contributions have been to the theory of algebraic, as distinct from trigonometric, methods of optical design, and in the development of methods of computation based on the use of calculating machines. A feature of many of his later papers has been the masterly application of matrix methods to optical problems. As is so often the case when alternatives to old-established procedures are offered, the adoption of Mr. Smith's design methods in the industry has been slow; but there are now signs that their value is being appreciated. Mr. Smith's work was recognized by his election to the Royal Society in 1932, and he has held the office of president both of the earlier Optical Society and the Physical Society. The younger workers in his subject recall with appreciation the care he always took that they should have the fullest opportunity to develop their views however unorthodox or immature. It is appropriate that the council of the Physical Society should have invited Mr. Smith to deliver the sixteenth Thomas Young Oration; this he has agreed to do in June 1949.

Dr. L. A. Sayce

Dr. L. A. Sayce, who has succeeded Mr. T. Smith as superintendent of the Light Division at the National Physical Laboratory, is fifty years of age. After serving in the Honourable Artillery Company in the First World War, he went to the University of Durham to study chemistry, taking honours in 1922, when he was awarded the Saville Shaw Medal. He remained at Durham carrying out research in inorganic chemistry, was awarded his Ph.D., and in 1927 was appointed University lecturer in chemistry. He remained at Durham until 1940, carrying out during this period considerable fundamental work in inorganic chemistry, instrument design, chemical kinetics and photography.

In 1940 Dr. Sayce joined the Ministry of Home Security to initiate a research group in connexion with camouflage, where he did excellent work until 1943. He was then transferred to the Ministry of Supply to take charge of alginate research. Unfortunately, he fell seriously ill soon after receiving this appointment and was away from active work for a year. On recovery he was appointed to the Scientific Research Department of the Admiralty as a principal experimental officer, and in this capacity he was responsible for considerable advances in the development of all kinds of instruments for laboratory use in the Admiralty experimental establishments. In particular he did excellent work in the applications of high-speed photography for laboratory purposes. On the re-organisation of the Admiralty Scientific Service in 1946, he was appointed assistant director of physical research. Dr. Sayce has earned a very high reputation in a wide field of science, and he brings to his new appointment a keen appreciation of the value of fundamental research and an exceptional ability to plan and supervise it.

Zoological Society of London: Mr. G. S. Cansdale

Mr. G. S. Cansdale has been appointed superintendent of the Zoological Society's Gardens in Regent's Park, London, in succession to Dr. G. M. Vevers, who retired on December 15 (see *Nature*, November 6, p. 727). Mr. Cansdale was educated at

St. Edmund's Hall, Oxford; he graduated in forestry and afterwards obtained a research degree for work on black poplars and their hybrids. He was appointed to the Colonial Forest Service in 1934 and served in the Gold Coast from then until 1948. During these years he took full advantage of the opportunities of studying the local fauna and made large collections of reptiles, birds and small mammals for the London Zoo, many of which were new to the collection; in addition, he made extensive collections for the British Museum (Natural History). He has published various popular articles dealing especially with small mammals and their ecology, and is the author of "Animals of West Africa", a general account of the more common mammals and reptiles of that region. In addition to being a keen naturalist, Mr. Cansdale has the advantage of practical experience in keeping live animals, for he and his wife maintained a private collection in Africa and were successful in the rearing and maintenance of a wide range of species, including some which are very difficult to adapt to a life in captivity, with the necessary dietary modifications involved. This experience will be of value in dealing with the many problems which arise in connexion with the maintenance of such a varied collection of animals as that in Regent's Park.

Physics To-day

THE avowed purpose of the American Institute of Physics is "the advancement and diffusion of physics and its applications to human welfare". For the research worker, the teacher, the theoretical or experimental physicist, and the investigator engaged in pure or applied science, the Institute or its member societies publish eight journals of very high merit. They are the well-known *Physical Review, Review of Modern Physics, Journal of the Optical Society of America, Journal of the Acoustical Society of America, American Journal of Physics, Review of Scientific Instruments, Journal of Chemical Physics* and the *Journal of Applied Physics*. To these, in order to fulfil an ever-growing demand for a medium for relatively non-technical surveys of physics progress, there has recently been added *Physics Today*. This new monthly magazine (published by the New York American Institute, May 1948; 50 cents) is described as "a general-interest journal on physics", and its editor is Dr. D. A. Katcher.

The first four numbers of *Physics Today* are very well produced and contain some excellent articles, besides regular features such as book reviews, Institute and Journal notes, and notes from abroad giving details of physics progress in Italy, Great Britain, Scandinavia and elsewhere. Of the articles, "A Newsman Looks at Physicists", by Stephen White, in the May issue is highly to be commended. It is packed with sound advice to the physicist who is called upon either to write for the general Press or to describe his work to some enterprising reporter. Of particular interest to British readers will be a brief but informative report in the May issue by D. L. MacAdam on the 1947 International Conference on Colour Vision held at Cambridge, England, and an illustrated account in the July issue, by the general secretary of the Royal Institution, T. Martin, of the Royal Institution Christmas Lectures. Other articles include: "Trends in American Science", by Vannevar. Bush; "The Reality of Neutrinos", by Prof. G. Gamow; "Detecting Atomic Particles", by Prof. S. A. Korff; and "Helium, the Unruly Liquid", by Prof. L. Tisza. Perhaps the best way to summarize the scope and policy of the magazine, which assuredly has come to stay, is to quote from the editorial of the first number. " 'Physics Today' is for the physicist, to inform him in comfortable, everyday language of what goes on and why and who goes where. But it is also for the chemist, the biologist, and the engineer, to tell them of the science towards which they are driven by so many of their investigations; it is for the student, the teacher, the lawyer, the doctor, and all who are curious about physics; it is for the administrative officials who deal with research; it is for editors and writers whose profession puts them midway between what is done and how it should be reported".

World Power Conference: 1950 Meeting in London

As already announced (see *Nature*, June 26, p. 1,005), the Fourth World Power Conference will be held in the building of the Institution of Civil Engineers, London, during July 10–15, 1950, and the theme of the Conference will be "World Energy Resources and the Production of Power". Sir Harold Hartley will be chairman of the Conference. The technical programme of the Conference has just been published, and copies may be obtained on application to the General Secretary, Fourth World Power Conference, 201–2 Grand Buildings, Trafalgar Square, London, W.C.2. It will be seen that the programme falls into three divisions. Division 1 will contain single reports, from each national committee, to include: (*a*) a survey of the energy resources of the country; (*b*) a historical record of the development of the resources of the country and of prime movers for utilizing them, covering the period since the First World Power Conference in 1924. Division 2 will consist of individual papers, dealing comprehensively with the preparation of fuel of every kind. Division 3, which is perhaps the most important, is headed "Production of Power". In addition to the traditional sources of power, papers will be included on gas turbines, jet engines, hot-air engines, tidal power, wind power, solar energy, terrestrial heat, thermal energy derived from the sea, and atomic energy. It is hoped that, despite the manifold difficulties surrounding the preparation of papers on atomic energy, some valuable contributions will be forthcoming. Although the technical programme does not contain a separate division on utilization, the hope is expressed that papers will be presented dealing with the design and relative advantages of different types of prime movers for specific purposes, for example, aviation, land transport and marine propulsion. Unesco has recently made a grant towards the statistical work carried out by the World Power Conference.

Arctic Ice

THE publication of the *Year-Book of the State of the Ice in the Arctic Sea* issued by the Danske Meteorologiske Institut, which was suspended in 1940, has been resumed on the traditional lines with charts for the spring and summer months. The Institute is trying to collect material for the years 1940–45 to make possible the publication of a report for that time. The present issue is for 1946. In that year the Barents Sea had rather less ice than usual. Details from the Kara Sea are lacking. Spitsbergen was open on the west for most of the summer, and in the north for longer than usual; but in the east, including Storfjord, there was continuous pack-ice until late in

August. In the Greenland Sea ice was less than usual, and parts of the coast of Greenland had periods of accessibility. Twice during May the East Greenland pack touched the north-west coast of Iceland. In Davis Strait the amount of ice was rather less than usual; but its late culmination was an unusual feature. There seems to be no data available for Bering Strait and the Beaufort Sea. In the North Atlantic there was an abnormally easterly distribution of icebergs; very few bergs followed the less important western branch of the Labrador current that flows along the Avalon Peninsula of Newfoundland. But the total amount of ice in the Newfoundland area was about the usual.

Fair Isle Bird Observatory

LYING directly between Orkney and Shetland, Fair Isle has been well known as a bird migration station since Dr. Eagle Clark began his observations there in 1905. Since the Second World War, and largely through the efforts of George Waterston, Ian Pitman and Arthur Duncan, the Fair Isle Bird Observatory Trust has been formed in order to develop the use of the island as one of Europe's premier bird observatories. Already a full-time director has been appointed and a certain amount of equipment installed; but much more support will be needed before the natural ornithological advantages of the island can be investigated. Copies of an attractive booklet describing the Fair Isle Bird Observatory can be obtained from 48 Castle Street, Edinburgh.

Kangaroos

THE ordinary person probably regards the kangaroo as the most characteristic of the native animals of Australia, and the Macropodidæ is the family with the largest number of species and contains the largest animals. Considerable work has been done on this group; but nevertheless the review of the family given by G. H. H. Tate (*Bull. Amer. Mus. Nat. Hist.*, 91; 1948) is timely. The review falls into two parts, one on the anatomy and phylogeny, and the other on the taxonomy. It is suggested that phylogenetically two basal stocks, the subfamilies Potoroinæ and Macropodinæ, can be recognized; but the relationship between them is not clear. Some authorities have gone so far as to suggest that each has arisen independently from a phalangeroid stock. It seems clear that no division of the recent phalangerids could have given rise to either subfamily. Within the groups the author gives reasonable phylogenetic lines. To the four generally recognized subfamilies, the author adds a fifth for the reception of certain extinct species, the Palorchestinæ. He recognizes and defines 107 distinct forms falling into 22 genera. A considerable literature has grown up around the question of the specific identification of the kangaroo recorded by Captain Cook, and, after a review of this and other evidence, the author concludes that the animal in question is *Macropus canguru canguru*, a north-eastern subspecies, the south-eastern equivalent of which is *Macropus canguru major*.

Radar Training Devices

AT a meeting of the radio section of the Institution of Electrical Engineers on November 2, Mr. G. W. A. Dummer presented a paper entitled "Aids to Training —The Design of Radar Synthetic Training Devices for the R.A.F.". In this paper, the author describes how, during the War, work was conducted by the Trainer Design Group at the Telecommunications Research Establishment, in the development of equipment used by the Royal Air Force for training operators, navigators and controllers in radar techniques. With the introduction of each new radar system, a simple synthetic trainer was designed concurrently. As operational experience was gained on the equipment, a more complex crew trainer was developed; this provided accurate presentation of a moving synthetic target or targets, and complete operational practice with a record of the trainee's errors. Approximately seventy different types of trainers were developed for the various radar systems, varying in scope from the provision of simple synthetic echoes to a complex device such as the reproduction on the ground of a complete night-fighter interception in the air. The fundamental principles necessary for the control of synthetic targets in two and three dimensions are discussed in the paper, the presentation of which was illustrated by an extended cinematograph film. With the end of the War the urgent necessity for training devices declined, and comparatively few trainers are being designed at the present time. In the discussion at the meeting, however, various speakers pointed out the need of this type of equipment for training the crews and operators of civil aviation services.

Distance of Canopus

MR. O. R. WALKEY has investigated the distance of Canopus (α Carinæ) by a new line of approach (*J. Brit. Ast. Assoc.*, 58, No. 6; 1948). The results obtained for this star vary considerably, some of the derived parallaxes being more than five times those of others. Mr. Walkey approaches the problem from the secular parallax of the star, a star's proper motion being frequently a fair criterion of its distance, and the radial velocity of Canopus provides a clue in the present case. Accepting results he has obtained for the apex of the solar motion (*Mon. Not. Roy. Ast. Soc.*, 106, No. 4; 1946) and also for the velocity of the sun, the antapex of this motion, R.A. 90·2°, Dec. −28·7°, is just 24° north of Canopus, and as the recessional radial velocity of the star is 20·8 km./sec., we may regard it as stationary within the velocity framework. The proper motion of Canopus in R.A. is given as $0{\cdot}0020^{s} \pm 0{\cdot}0012^{s}$ in G.C., and the large probable error in R.A. should, Mr. Walkey thinks, warrant the simplicity of considering the motion in declination alone in the investigation. This is 0·017″ + 0·0015″ towards the solar antapex, and applying the correction for galactic rotation it becomes 0·0126″ ± 0·0015″. If this represents the crosswise reflex of the sun's motion from the antapex, the absolute parallax of Canopus is 0·0071″ ± 0·00009″. Adopting a final parallax of 0·007″ or a distance of 450 light-years, the absolute magnitude of the star is −6·6. It is significant that this distance finds confirmation in Charlier's determination of the distance of the centre of the brighter *B*-type stars lying in Carina (*Medd. Lund.*, Series ii, 14; 1916. 34; 1926). The revised and higher luminosity basis, of one magnitude brighter than that used by Charlier for the given *B* stars, places their centre at a distance represented by a parallax of 0·0072″.

International Union of Biological Sciences

THE programme of symposia, organised with the help of Unesco by the International Union of Biological Sciences, started in November 1947 with a symposium on trace elements in plant physiology, held at Rothamsted (see *Nature*, **161**, 364; 1948). The report of this Conference is in the press at Chronica Botanica Co., Waltham, Mass. The second symposium of this series was held during June 14–19, 1948, at Utrecht; it dealt with the theoretical basis of botanical nomenclature and systematics. The full report will also be published by the Chronica Botanica Co. A third symposium was the first International Congress on the Physio-Pathology of Animal Reproduction at Milan; it lasted two days (June 21–22, 1948) and its theme was: "Interactions between Eggs and Sperm". The full report is to be published by its secretary, Prof. T. Bonadonna, Via Fratelli Bronzetti 17, Milan. A symposium on Terminology of Cytogenetics and Genetics was held at Stockholm during July 15–16, 1948. This symposium carried further the work done at the pre-war symposium held in London during August 14–15, 1939. A committee has been formed to supervise the preparation of the full report, which probably will be published as a separate number of *Bibliographia Genetica*. Finally, a fifth symposium was held at Stockholm during August 5–7, 1948, which discussed the scientific foundations of an international organisation for combating agricultural pests. A programme for further work on the subject has been drawn up; and the report of the meeting will be published by the general secretary of the International Union, Prof. P. Vayssière, Muséum d'Histoire Naturelle, Paris.

City and Guilds of London Institute

The report of the Council of the City and Guilds of London Institute for 1947 gives ample evidence of the Institute's growing activities. There has been a large increase in the number of students at the City and Guilds College, particularly postgraduate and research students. In the Department of Technology the total number of candidates examined was 47,807, 7,336 higher than the previous highest total of 40,471 recorded in 1939. Among the regulations and syllabuses for existing examinations which have been revised during 1947 are those of petroleum and petroleum products, electrical engineering practice, road service work and motor-vehicle electrician's work; while among syllabuses at present being considered for introduction later into the examinations conducted by the technology department are courses in works administration subjects for craftsmen, servicing and maintenance for instrument mechanics, and courses for electrical apprentices in iron and steel and other heavy engineering work. Copies of the report may be obtained from Gresham College, Basinghall Street, London, E.C.2.

Exhibition of Radiographs

An exhibition of industrial radiographs will be held at the spring meeting of the Industrial Radiology Group at the Institute of Physics on February 18 and 19, 1949. Entries should be suitable for showing on standard viewing lanterns (mounted prints may also be submitted) and should, wherever possible, be accompanied by photographs or samples of the specimens which they represent. A short description should accompany each entry. Intending exhibitors should apply to the Institute of Physics, 47 Belgrave Square, London, S.W.1, for entry forms.

"Animals of Australia"

The third of the series of natural history booklets has now been published by the Glasgow Art Galleries and Museum. Like the first two of the series, "Animals of Africa" and "Animals of India", the new booklet has been written primarily as an account of the Australian habitat group, one of the large groups in the Mammal Court of the Museum. The booklet contains a simple description of the life and habits of each of the animals as well as a photograph and outline drawing which serves as a key to the display.

Announcements

The president of the Royal Society has appointed the following vice-presidents for the ensuing year: Sir Thomas Merton, treasurer of the Royal Society; Sir Edward Salisbury, biological secretary of the Royal Society, director of the Royal Botanic Gardens, Kew; Sir James Chadwick, master of Gonville and Caius College, Cambridge; Prof. A. C. Hardy, Linacre professor of zoology in the University of Oxford.

Dr. H. Greinacher, professor of experimental physics in the Faculty of Sciences of the University of Berne, has been awarded the Theodor Kocher Prize by the University in recognition of his skill in experimental work, specially for the development of the 'Greinacher circuit', widely used in applied X-rays. This circuit, which was described in 1914 (*Deutsch. Phys. Gesell. Verh.*, **16**, 320; April 15, 1914), is one of the best-known circuits that combine voltage-multiplying with a constant potential.

Dr. F. A. Burchardt, of Magdalen College, has been appointed director of the Oxford University Institute of Statistics, with effect from January 1, in succession to Mr. D. G. Champernowne, now professor of statistics in the University.

Mr. A. W. Hendry has been appointed to the University readership in civil engineering tenable at King's College, University of London, as from May 1, 1949. The title of professor of chemical pathology in the University has been conferred on Dr. Jocelyn Patterson, in respect of the post held by him at Charing Cross Hospital Medical School. The degree of D.Sc. has been conferred on Mr. E. R. Leonard, an internal student.

The Langley Memorial Prize, offered by the London School of Hygiene and Tropical Medicine, and open to competition among officers, past and present, of the West African medical departments, has been awarded to Dr. D. Fitzgerald Moore for an essay entitled "Nutritional Eye Disease and Effects of Nutritional Retrobulbar Neuritis".

Trinity College, Cambridge, offers research studentships and Dominion and Colonial exhibitions every year; the next elections will take place in July 1949. Research studentships are open to graduates of universities other than Cambridge who are not more than twenty-six years of age, although in computing his age a candidate may deduct any period of war service. The exhibitions are open to undergraduates as well as those wishing to undertake research. Applications, to be sent through the head of the candidate's university, must reach the Senior Tutor, Trinity College, Cambridge, not later than May 1, 1949.

Two Christmas Lectures, for older children, will be delivered at the Institution of Electrical Engineers by Dr. P. Dunsheath, under the general title "Electricity: a Giant Harnessed". The Lectures will be given on December 29 and 30 at 3 p.m.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

X-Ray Line Broadening in Cold-worked Metals

It is known that X-ray line broadening in cold-worked metals appears to tend towards a limiting value as the amount of deformation increases. A possible cause of this might be self-annealing. If, as is very probable, line broadening is due mainly to internal strains, self-annealing would lead to strain release or recrystallization as soon as the internal strains reach a critical magnitude, which, of course, would depend on the temperature.

Since self-annealing must be insignificant at the temperature of liquid nitrogen, the limit to the line broadening ought to be very much higher or absent in metals cold-worked at this temperature if it is due to thermal recovery or recrystallization. In this case, moreover, the increased line breadth observed after deformation and subsequent X-ray exposure at a low temperature would fall to the room-temperature value after keeping the specimen at room temperature for the time needed for an X-ray exposure.

In order to test whether line broadening is influenced in this way by self-annealing, we have taken back-reflexion X-ray photographs from wire specimens plastically deformed in torsion. The progress of the broadening of the (311) line with deformation is shown in Fig. 1 for high-conductivity copper. The low-temperature results were obtained by deforming and exposing the specimens while liquid nitrogen was flowing over them. Further measurements after warming up to room temperature have shown that no appreciable recovery occurs within several weeks.

For commercially pure aluminium deformed at either temperature (Fig. 2), the line breadth decreases slowly on keeping the specimen at room temperature; however, the recovery of the line breadth is still incomplete after several weeks.

The absence of a significant decrease of the line breadth within the time needed for the deformation of the specimen and the subsequent X-ray exposure shows that the limit to the line broadening cannot be due to recovery or recrystallization. With metals that show rapid recovery of mechanical and other properties at room temperature, of course, recovery may limit the line breadth to lower values than would be attained in its absence. Thus, Hutchison[1] has recently found that the line broadening observed with high-purity aluminium deformed and exposed at the temperature of liquid air disappears when the specimen is brought to room temperature. This is in accord with the fact that high-purity aluminium is self-annealing and even recrystallizes rapidly at room temperature.

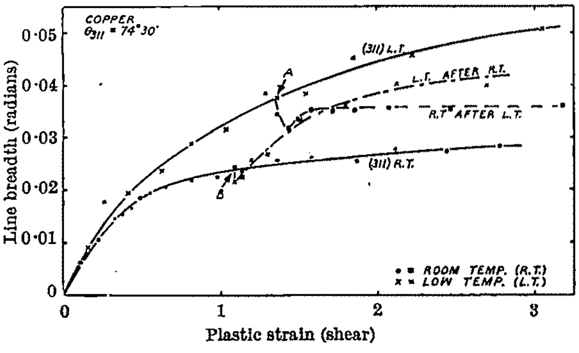

Fig. 1

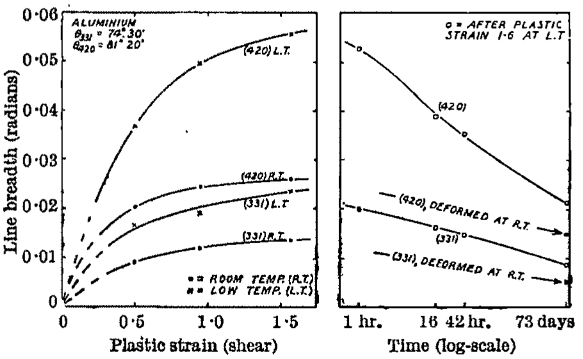

Fig. 2

Our observations support the view put forward by van Arkel and others[2,3] that line broadening, being due to internal stresses, is limited by the circumstance that the shear stress cannot rise beyond the yield stress of the material (which depends on the preceding plastic strain). Obviously, the hydrostatic component, and, therefore, the total value of the microscopic local stresses, cannot be of a higher order of magnitude than the local shear stresses. Figs. 1 and 2 show that, within the strain-range studied, the line breadth does not definitely converge towards a constant value; the line breadth curves merely become flatter with increasing strain, as yield stress-strain curves do.

It seems surprising that the stresses responsible for the line broadening are of the order of the macroscopic yield stress, whereas the 'theoretical shear strength' and the stresses around the dislocations must be of a higher order of magnitude. The answer seems to be that stresses of the order of the 'theoretical shear strength' never occur, except in the centre zone of dislocations; new dislocations arise from existing ones by some multiplication mechanism[4,5] (for example, by the glide process jumping from one glide plane to another). The dislocations, however, cannot contribute much to a Debye–Scherrer ring, for several reasons. First, the total volume of the highly stressed regions around the dislocations is small compared with the volume of the specimen; then, the range of strains around the dislocation is so large that the corresponding strain broadening extends over a very large angle; and, finally, there must exist an extreme small-size broadening, since the size of the coherently diffracting regions in a dislocation cannot amount to more than a few interatomic spacings. The high stresses around the dislocations, therefore, contribute mainly to the background in the X-ray photographs, while the line broadening is due to stresses of the order of the macroscopic yield stress. If other factors contributing to the background (impurities, thermal movement) can be eliminated, the density of the background may give a measure of the density of dislocations in the material.

Photo-elastic stress measurements in plastically deformed transparent crystals[6,7] also show that most of the volume (the glide packets) is not stressed beyond the macroscopic yield value; the volume occupied by the thin glide zones (between the glide packets), where the high stresses are concentrated, is very small.

The close connexion between line broadening and yield stress is shown by experiments in which the temperature was changed during the deformation. In Fig. 1, the broken curve resulted from deformation at room temperature, after the specimen had been strained up to point A in liquid nitrogen. After a small initial dip, the curve of the line breadth tends with increasing strain towards that for a specimen deformed entirely at room temperature. Similarly, the line-breadth curve of a specimen strained to the point B at room temperature, and from then on in liquid nitrogen, tends towards the curve for deformation in liquid nitrogen from the beginning. After a change of temperature, the line breadth tends towards the values characteristic of the new temperature, in general, only if additional deformation is carried out, but not spontaneously in the course of time (unless the material shows general effects of self-annealing). The same behaviour was observed by J. Los[8] for the yield stress of copper and aluminium deformed alternately at low, and at room, temperature.

M. S. PATERSON
E. OROWAN

Cavendish Laboratory,
Cambridge. Oct. 14.

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Recording of Charged Particles of Minimum Ionizing Power in Photographic Emulsions

SINCE the announcement of a photographic emulsion of sufficient sensitivity to record unmistakably the tracks of electrons[1], interest has centred on the possibility of achieving further increases in sensitivity, the recording of the complete tracks of *any* charged particle being the ultimate aim[2,3].

A singly charged particle, with a velocity of the order of 90 per cent of that of light, has the lowest ionizing power that a charged particle can possess. The energy of an electron, when it possesses this minimum ionizing power, is between 500 and 1,000 keV., and the residual path-length in the emulsion of such an electron will be between 800 and 2,000 μ, assuming a stopping power to electrons of 2,000 for the emulsion. The present commercially-available electron-sensitive plates (Kodak *NT2a*) will record tracks of electrons with energies of up to 80 keV., the residual path-length[4], in the emulsion, of an electron of 80 keV. being about 30 μ. Since the ionizing power of such an electron is approximately three times that of the minimum, an emulsion with a threefold increase in sensitivity over that of *NT2a* is required in order that tracks of particles of minimum ionizing power should be recorded.

The experiments which are being made in these Laboratories already show that such substantial increases in speed over that of the *NT2a* emulsion are possible that we are encouraged to believe that sensitivity to minimum ionizing power can be attained. The accompanying photomicrographs were obtained from γ-ray experiments on 200-μ thick coatings of an experimental emulsion. They show tracks never before realized, and their great interest is regarded as sufficient to justify their description at this early stage in the evolution of such emulsions.

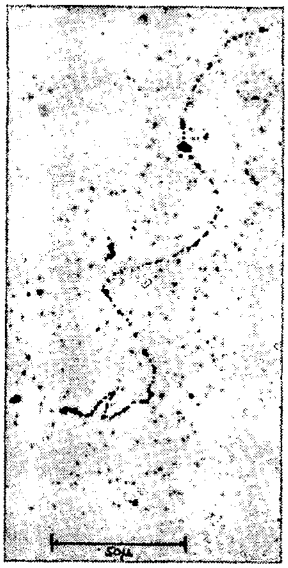

Fig. 1

Owing to the high scattering which electrons undergo in the photographic emulsion, particularly towards the end of their range, complete tracks ending in the emulsion, with a length of the order of 1,000 μ, will be very rare. A further difficulty in obtaining a complete recording in the emulsion of high-energy electron tracks is that the production of secondary electron tracks is very frequent, and, again due to the high scattering of electrons, the chance that all the secondary electron tracks will end in the emulsion is very small.

Thus, although a 1,000-μ track of an electron which comes to rest in the emulsion would be the more conclusive evidence that the minimum ionizing power could be recorded, such a track has not yet been

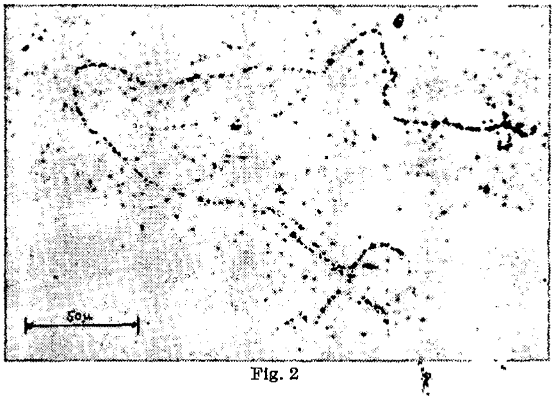

Fig. 2

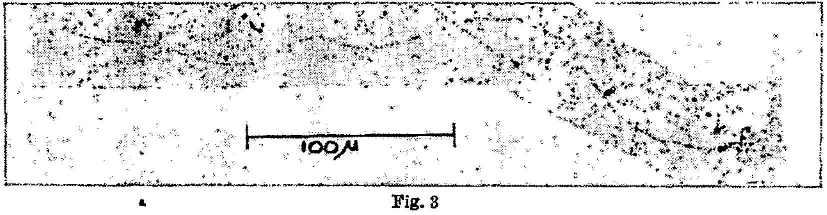

Fig. 3

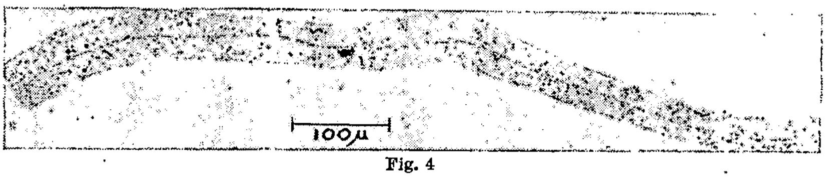

Fig. 4

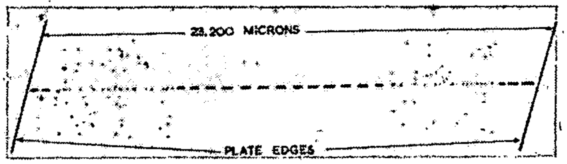

Fig. 5

found, and the accompanying selection of photomicrographs has therefore been chosen to demonstrate the sensitivity of this emulsion.

Fig. 1 is a photomicrograph of an electron track 240 μ long which ends in the emulsion, and was selected because no secondaries are formed and the scattering perpendicular to the emulsion plane is small. Fig. 2 is a photomicrograph of an electron track 350 μ long which has secondaries at the low-energy end, but otherwise is singularly free from such tracks. There is a confused bunch near the beginning of this track; but there is some doubt as to whether all these tracks are associated with that of 350 μ or not. The capability of the emulsion to record a complete electron track of 350 μ is, however, amply demonstrated. Fig. 3 is a photomicrograph of an electron track 400 μ long, which probably ends in the emulsion with the formation of at least one secondary, and which shows appreciable scattering throughout the whole of its recorded range. Fig. 4 is a photomicrograph of a track, very probably made by an electron, which is 830 μ in length, and shows some scattering throughout the whole of its recorded path. It does not end in the emulsion. Fig. 5 is a photomicrograph of a track which passes completely through the emulsion from one edge of the plate to the other. This track is perfectly straight, has a total length in the emulsion of 23,200 μ, and a constant grain-density throughout the whole of this length. Although the possibility cannot be ruled out that the particle producing this track was not an electron, such tracks have frequently been found in emulsions of this sensitivity after exposure to gamma rays, whereas the corresponding unexposed control has been free of them. In general, the tracks are shorter than those recorded here, as the chance that the particle makes such a small angle with the plane of the emulsion that it remains in the emulsion from one side of the plate to the other is very small; but similar tracks of 5,000 and 10,000 μ have been observed.

It is considered that these photomicrographs provide very strong evidence that an emulsion capable of recording the tracks of charged particles of any energy has been produced.

I wish to express my gratitude to Dr. D. T. King, of the H. H. Wills Physical Laboratory at Bristol, for selecting the tracks shown in Figs. 1, 2 and 5, and for helpful discussions on their interpretation; also to Miss P. Dyer of the same Laboratory for preparing the photomicrographs and mosaics for these figures, and to Mr. Cooke of the Kodak Laboratories for preparing the photomicrographs and mosaics for Figs. 3 and 4. This letter is based on work carried out under contract to the Atomic Energy Research Establishment, Ministry of Supply, whose permission to publish is gratefully acknowledged.

R. W. BERRIMAN

Kodak Research Laboratories,
Wealdstone, Harrow,
Middlesex. Nov. 15.

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Absorption and Dispersion of Ultrasonic Waves in Acetic Acid

IN a recent communication, Pinkerton[1] has shown that for frequencies less than 70 Mc./sec. the absorption of ultrasonic waves in acetic acid can be attributed to a relaxation mechanism arising from the perturbation of a molecular equilibrium by the ultrasonic vibrations. His measurements were carried out in the frequency range 7·5–67 Mc./sec. and confirmed the earlier results by Bazulin[2].

Pinkerton concludes that, in accordance with the theoretical work of Kneser[3], the pressure absorption coefficient, α, for a frequency of excitation $f (= \omega/2\pi)$, can be described in terms of the relaxation time, τ $(= 1/2\pi f_m)$, by the equation

$$\begin{aligned}\alpha/f^2 &= \frac{\alpha_1}{f^2} + \frac{A}{1+\omega^2\tau^2}, \\ &= \frac{\alpha_1}{f^2} + \frac{A}{1+(f/f_m)^2}\end{aligned} \tag{1}$$

where the component α_1/f^2 ($= 155 \times 10^{-17}$ sec.^{2} cm.$^{-1}$ for a temperature of 17·5° C.) represents the absorption due to viscosity, heat conduction, and any further possible relaxation process occurring above 100 Mc./sec. (Strictly, A can only be treated as a constant if the velocity dispersion is small, as is here the case (Fig. 3).) Equation (1) can be rewritten

$$(\alpha/f^2 - \alpha_1/f^2) = \frac{\alpha'}{f^2} = \frac{A}{1+(f/f_m)^2}, \tag{2}$$

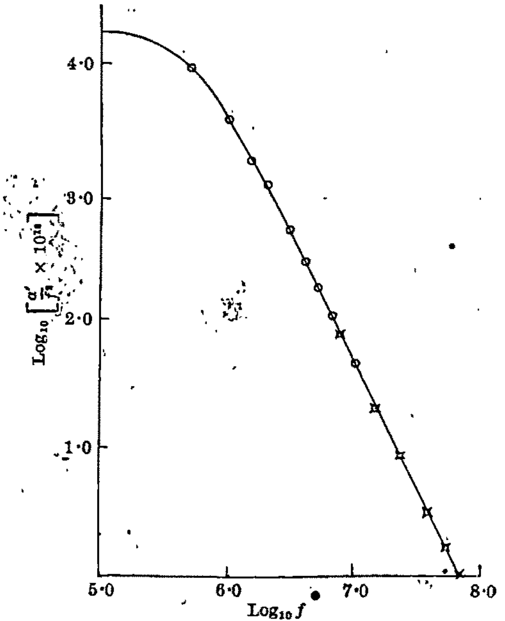
where α' represents the contribution to the absorption due to the relaxation mechanism under investigation. If v is the velocity of propagation, the quantity

$$\mu = \alpha'\lambda = \frac{Avf}{1+(f/f_m)^2} \tag{3}$$

attains a maximum value at the frequency

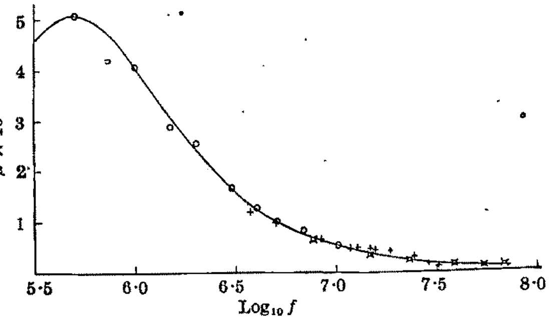
$$f = f_m = \frac{1}{2\pi\tau}. \tag{4}$$

Pinkerton estimates that, for a temperature of 17·5° C., f_m should be around 2×10^6 c./s. This is, however, below the lowest frequency employed in



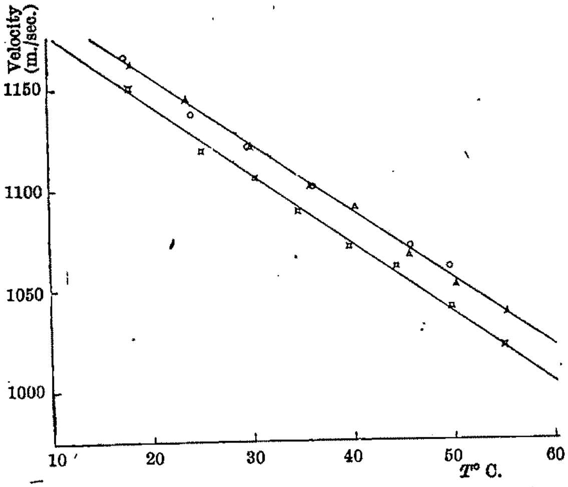
⊙—⊙—, Authors' results; □—□—, Pinkerton

Fig. 1. Absorption in acetic acid. Calculated curve for 17·5° C.



⊙—⊙—, Authors' results; □—□—, Pinkerton; +—+—, Bazulin

Fig. 2. Calculated curve showing the variation of $\mu = \alpha'\lambda$ with frequency at 17·5° C.



⊙—⊙—, 5 Mc./sec.; △—△—, 4 Mc./sec.; □—□—, 0·5 Mc./sec.

Fig. 3. Velocity dispersion in acetic acid

his experiments, and we have now extended the measurements to obtain values for the absorption in the frequency range 0·5–9·8 Mc./sec.

A pulse technique has been used[4,5,6] which enables the velocity of propagation to be measured[7] in addition to the absorption coefficient. From equations (2) and (3)

$$\frac{1}{\alpha'} = \frac{1}{A}\left[\frac{1}{f^2} + \frac{1}{f_m^{\,2}}\right]. \qquad (5)$$

The value of A and a first estimate of f_m can therefore be derived from a plot of $1/\alpha'$ against $1/f^2$. A more reliable estimate of f_m can be calculated from the slope of the line obtained by plotting $\sqrt{A/\frac{\alpha'}{f^2} - 1}$ against frequency. The values are as follows:

$T°$ C.	$\frac{a_1}{f^2} = \left[\frac{a}{f^2}\right]_{f \gg f_m}$ sec.^{2} cm.$^{-1}$	$A = \left[\frac{\alpha'}{f^2}\right]_{f \ll f_m}$ sec.^{2} cm.$^{-1}$	Frequency for maximum μ	
			1st estimate	2nd estimate
17·5	155×10^{-17}	$175{,}000 \times 10^{-17}$	$0{\cdot}500 \times 10^6$ c./s.	$0{\cdot}501(2) \times 10^6$ c./s.

The curves of Figs. 1 and 2 have been obtained by substituting these values in equations (2) and (3) respectively, and it will be seen that there is good agreement between the experimental points and the calculated curves.

Corresponding to the maximum in μ, a dispersion of the velocity has been recorded, as shown in Fig. 3. The values of the velocity above 4 Mc./sec. were all found to coincide with the upper line, whereas the lower line gives the results at the lowest frequency of measurement; the values for the intervening frequency-range lie between these two extremes. The maximum change in velocity to be expected from Kneser's theoretical calculations is given by

$$\frac{\Delta v}{v} \approx \frac{\mu_{\max}}{\pi} \approx 1{\cdot}6 \text{ per cent at } 17{\cdot}5° \text{ C.}$$

The value obtained is slightly less than this, the discrepancy being attributed to the limited accuracy of the velocity measurement.

Spakowski[8] has previously reported a velocity dispersion in acetic acid; but his values are about 10 per cent greater than the present measurements indicate.

The temperature dependence of f_m and $\mu_{\max}$ has been studied in conjunction with Pinkerton, and it is hoped to publish these results at a later date. We wish to thank Mr. Pinkerton for having provided his experimental values for inclusion in Figs. 1 and 2.

John Lamb
J. H. Andreae
R. Bird

Electrical Engineering Department,
Imperial College, London, S.W.7.
Oct. 28.

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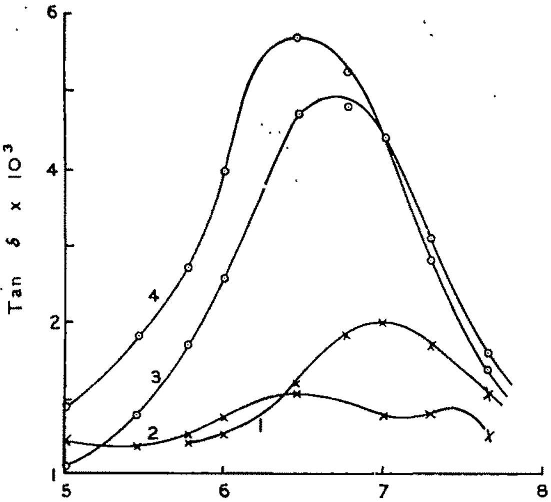
Dielectric Relaxation-Times of Solid Solutions of Aliphatic Long-Chain Esters and Ketones in Paraffin Wax and *n*-Hexacosane

In the search for relationships between electrical properties and the chemical and physical structures of solid dielectrics, the experimental investigations by Jackson[1], Sillars[2] and Pelmore[3] are of considerable interest. These workers incorporated small quantities of aliphatic long-chain esters in paraffin wax and measured the dielectric loss (tan δ) of the resulting mixtures over a range of frequencies, the inverse of the angular frequency (ω) for the maximum tan δ giving the relaxation time (τ) of the ester molecules. This work was extended by Fröhlich[4] in a theoretical study of a model comprising a crystalline paraffin hydrocarbon in which a small proportion of the molecules was assumed to be replaced by molecules of a polar compound, such as a ketone or ester, of a shorter chain-length. The transition of the polar molecules from one position of the equilibrium to another having opposite dipole direction required the crossing of an energy barrier which increased in proportion to the chain-length. This led to an equation for the relationship between the relaxation time and chain-length, in which some of the constants were determined from the experimental results referred to above.

As paraffin wax is not a simple crystalline structure, it was thought desirable to conduct experiments using a pure hydrocarbon as the non-polar medium. An investigation is therefore being made in this laboratory of the relaxation times of various polar compounds in both paraffin wax and *n*-hexacosane



Dielectric loss curves for 0·1-m. solutions of: (1), decyl laurate in paraffin wax; (2), decyl laurate in n-hexacosane; (3), laurone in paraffin wax; (4), laurone in n-hexacosane

($C_{26}H_{54}$). The results for the ketone, laurone ($C_{23}H_{46}O$), and an ester of similar chain-length, decyl laurate ($C_{22}H_{44}O_2$), are shown graphically in the accompanying figure. The curve for decyl laurate in paraffin wax is of the type obtained by Jackson[1] and Sillars[2] with the ester, cetyl palmitate. The corresponding n-hexacosane system, however, gave an unsymmetrical curve showing no definite relaxation-times. This difference in dielectric behaviour is probably associated with the presence or absence of amorphous regions in the two solvents, since this is the chief difference in their physical structures. The paraffin wax – decyl laurate system would thus be a solution in which the molecules of the latter fit loosely into amorphous regions in the solvent, whereas the n-hexacosane mixture may not be a true solution but a eutectic consisting of n-hexacosane interspersed with aggregates of ester molecules.

In contrast to the esters, the ketone, laurone, gave a normal-shaped curve in n-hexacosane, and hence it is likely that this system is a true solid solution, of the type postulated by Fröhlich, in which the polar molecules enter the crystal structure by replacing hydrocarbon molecules. In the paraffin wax medium, also, the laurone molecules probably occupy crystalline positions, since the maximum frequency value is lower than for the ester of similar chain-length, indicating a higher energy-barrier between the two equilibrium positions of the molecules. The results discussed above were in agreement with the data obtained from measurements with other esters of the C_{22} series, and also with the ketone, myristone ($C_{27}H_{54}O$), and esters of similar chain-length.

From these results it seems that Fröhlich's model applies exactly to solid solutions of the type formed by ketones in a pure hydrocarbon. In determining the constants in the relationship between relaxation-time and chain-length, however, reference was made to the experimental evidence from the solutions of the 'amorphous centre type' formed by esters in paraffin wax. Although their behaviour is similar to that of the ketone solutions, the application of the relationship to the latter would require modification of the constants involving the energy barriers between equilibrium positions of the polar molecules.

The measurements of tan δ were made with a Q-meter, using a sample-holder similar to that described by Hartshorn and Ward[5]. During measurement the temperature was 22° C. (± 0·5° C.).

More complete results of this programme will be published elsewhere.

R. J. MEAKINS

Division of Electrotechnology,
Council for Scientific and
Industrial Research,
Australia.

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Variation of Standard Electrode Potentials with Temperature

GILBERT[1] has recently directed attention to the desirability in corrosion studies of being able to compare directly potentials measured at different temperatures.

The standard electrode potential of the silver/silver chloride electrode has been measured over a temperature range 0–60° C. by Harned and Ehlers[2], and they have shown that their results obey the empirical equation:

$$E^\circ_{(T)} = b + c(T - 298) + d(T - 298)^2 + f(T - 298)^3,$$

T being the absolute temperature, and b, c, d and f constants the values of which have been determined.

The value of E° at any temperature calculated from this equation represents, however, only the value of this potential balanced against the standard potential of the hydrogen electrode *at the same temperature*;

that is, $$\underset{(T)}{E^\circ} = \underset{(T)}{E^\circ_{Ag/AgCl}} - \underset{(T)}{E^\circ_{H}}.$$

In order to make any absolute comparison, it is necessary either (*a*) to calculate or determine experimentally the absolute change of E°_H with temperature, or (*b*) to assume this change to be zero. Gilbert has pointed out the difficulties of determining this change experimentally, and has asked whether assumption (*b*) may be made.

The following argument based on an analysis of the processes which take place in a cell of the type shown below would appear to make it clear that the potential of the standard hydrogen electrode (as that of any other electrode) does vary with temperature. (A cell rather than an individual electrode has been considered because of the doubt that exists in the conception of the absolute potential of a single electrode.)

Consider the cell

$$\begin{array}{c|c:c|c}
\multicolumn{1}{r}{-} & & & \multicolumn{1}{l}{+} \\
H_2 & H^+ \ (a = 1) & H^+ \ (a = 1) & H_2 \\
1 \text{ atm.} & \text{Temp. } T_1 & \text{Temp. } T_2 & 1 \text{ atm.} \\
\multicolumn{1}{r}{E_1} & & & \multicolumn{1}{l}{E_2} \\
 & \text{I} & \text{II} &
\end{array}$$

Assume that current flows in the outside circuit from the electrode at T_2 to that at T_1, and that all thermo-electric effects in the leads and the effect of the liquid junction potential have been eliminated. At electrode I, hydrogen passes into solution as hydrogen ions, and at electrode II the reverse process occurs.

The E.M.F. of the cell may be expressed as follows:

$$E = \frac{1}{F}\left\{[\tfrac{1}{2}(D_{\mathrm{H}_2})_{T_1} + \tfrac{1}{2}T_1\,\Delta S_1 - NeI - (W_{\mathrm{H}+})_{T_1}] - [\tfrac{1}{2}(D_{\mathrm{H}_2})_{T_2} + \tfrac{1}{2}T_2\,\Delta S_2 - NeI - (W_{\mathrm{H}+})_{T_2}]\right\},$$

where D_{H_2} is the heat of dissociation of hydrogen, that is, decrease in heat content, and ΔS the corresponding entropy change at the temperature shown; I represents the ionization potential of hydrogen, and $W_{\mathrm{H}+}$ the free energy of solvation of 1 gm.-ion hydrogen ions at the temperature subscribed. In so far as the constituent parts of the E.M.F. may be considered as belonging to the two electrodes individually, the potential of the hydrogen electrode at temperature T_1 is represented by the terms in the first square bracket, and that of the hydrogen electrode at temperature T_2 by the terms in the second.

The free energy terms considered above are unquestionably functions of temperature, and it follows, therefore, that the potential of the hydrogen electrode changes with temperature.

The above analysis of the electrode process, which is essentially that used by various authors including Butler[3], neglects, of course, all thermo-electric effects in the metal leads in the outside circuit and the contribution to the E.M.F. of the liquid junction potential, both of which effects would, it is presumed, be considerable.

M. H. Everdell

University,
Nottingham.
June 29.

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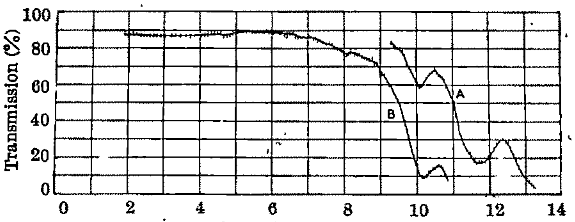
Absorption of Magnesium Oxide in the Infra-Red Region

In 1935 Barnes, Brattain and Seitz[1], investigating the absorption of magnesium oxide in the infra-red, reported some forty or so fine absorption lines in the range from 6 μ to 15·6 μ. In 1934 Fock[2], using fumed magnesium oxide, had reported the eigen-frequency to be at 17·3 μ, with subsidiary maxima at 14·8 μ, 6·8 μ and 25 μ, but no fine structure. Such a fine structure was hitherto unknown for face-centred cubic crystals, though it has been reported for quartz[3] and calcite[4]. The theory advanced by these authors to explain the fine structure is based on the interaction of crystal vibrations as originally suggested by Born and Blackman[5]; but the assumptions which lead to the details of the fine structure do not appear to be correct[6].

This fine structure does not seem to be consistent with any form of lattice theory of infra-red absorption, and a further investigation, therefore, appears to have both theoretical and practical interest.

The curves reproduced here are typical results in the range up to 14 μ for specimens of different thickness. Values of the percentage transmission of cleaved specimens of artificially grown magnesium oxide, obtained from the same firm which supplied Barnes, Brattain and Seitz, were taken at a mean separation of 0·07 μ, using a large rock-salt prism spectrometer. Each point is the mean of two results obtained from two separate runs through the spectrum, and in no case did the values at any one wave-length differ by more than 2 per cent. Each result in each run is the mean of three results taken consecutively. Experiments showed that by using a Welsbach mantle as the source of radiation, the scattering within the apparatus is negligible; but that with a Nernst filament as a source some five to ten per cent of the radiation at 11 μ was due to scattering from the high-energy peak in the spectrum of the Nernst filament.



Curve *A*, specimen 0·075 mm. thick; curve *B*, specimen 0·467 mm. thick. Slit-width covers a band of approx. 0·1 μ. Vertical lines indicate probable error

It will be seen that the fine structure reported by Barnes, Brattain and Seitz has not been confirmed. Two distinct subsidiary maxima have been found, one at 10·10 μ and the other at 11·7 μ.

The curves for various thicknesses are consistent with each other, that is, they all give the same value for the extinction coefficient at any one given wave-length. This is not the case in the results of Barnes, Brattain and Seitz, where the detailed shape of the absorption spectrum differs considerably for specimens of different thickness. Further, the curve for a specimen of 75 μ thickness (curve *A*) shows that it becomes practically opaque beyond 13·3 μ, while a specimen of the same thickness was found by Barnes, Brattain and Seitz to have at least 10 per cent transmission up to 15·6 μ, indicating that there must have been considerable scattering of the short wave-length radiation from their source, which was a heated platinum strip.

Preliminary results in the region from 14 μ to 25 μ show that the eigen-frequency is at 17·3 μ, as reported by Fock, with subsidiary peaks at 14·8 μ and 24·2 μ. The absorption maximum at 6·8 μ, found by Fock, has not been confirmed, and is probably due to absorbed water, as a cleaved specimen left out in the air for some weeks showed an absorption at 6·5 μ, which vanished as soon as the specimen was cleaned by rubbing with clean chamois leather.

To sum up, the fine structure observed by Barnes, Brattain and Seitz has not been confirmed. The eigen-frequency is at 17·3 μ, and there are subsidiary maxima on the short wave-length side of the eigen-frequency at 10·1 μ, 11·7 μ and 14·8 μ, and at 24·2 μ on the long wave-length side.

I should like to thank Dr. L. Kellner for suggesting the problem, supervising the practical work and giving much advice, and Dr. M. Blackman for advice and discussion.

J. C. Willmott

Imperial College of Science and Technology,
London, S.W.7.
July 16.

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Systematization of Certain Binary Metallic Equilibrium Diagrams

As part of an attempt to systematize the knowledge of factors which influence the form of binary equilibrium diagrams, we have examined the available data on binary systems in which no intermediate compounds are formed. This corresponds to a state of affairs where the electrochemical effect[1] is small, and if those systems characterized by a 100 per cent range of solid solubility are ignored, the systems considered fall into two distinct classes; namely, those in which a region of liquid immiscibility is encountered (Fig. 1), of which aluminium–potassium is an example, and those which are characterized by the existence of a eutectic (Fig. 2), of which bismuth–cadmium is an example.

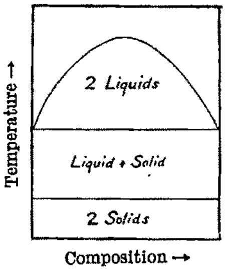

Fig. 1

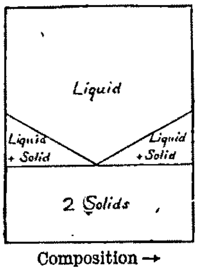

Fig. 2

Fig. 1. The aluminium–potassium type of diagram
Fig. 2. The bismuth–cadmium type of diagram

In Fig. 3 we have plotted the size factor of each system, as defined by the relation

$$\text{size factor} = \frac{L - S}{S} \times 100,$$

where L is the closest distance of approach of atoms of the larger atomic species in crystals of the pure element and S is the corresponding value for the smaller atomic species, against a 'temperature factor' $\frac{\Delta\theta}{\frac{1}{2}(\theta_1 + \theta_2)}$, where $\Delta\theta$ is the difference between the melting points of the elements and θ_1 and θ_2 are the melting point temperatures on the absolute scale.

Fig. 3 may conveniently be divided into three regions, A, B and C. In region A, where the size-factor and temperature-factor are limited by the values 30 per cent and 0·175 respectively, all systems are of a simple eutectic type (Fig. 2), in which the eutectic point is moderately near the centre of the composition scale. In region B, where the size-factor is everywhere greater than 30 per cent, we find that the two-liquid system predominates. It is, however, quite clear that although a large size-factor strongly favours the formation of a two-liquid type of diagram, size-factor is not the only controlling effect: in region C, for example, there is an approximately equal number of two-liquid and eutectic-type diagrams distributed randomly throughout the region. Moreover, in region B, the system germanium–lead is an outstanding exception to the general rule that a size-factor of more than 30 per cent is associated with a two-liquid type of diagram. This system[2] is characterized by a fairly flat liquidus curve and by having the eutectic point very near the composition of one of the pure metals; and if compared with Figs. 1 and 2, it may be regarded as being of an intermediate type.

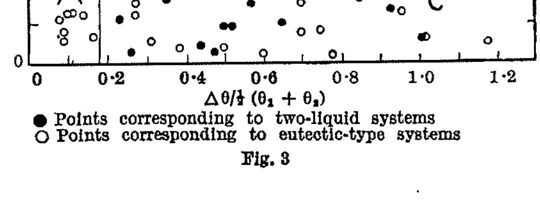

Fig. 3

In view of the existence of this intermediate type of diagram, it is of interest to examine more closely the form of the eutectic-type diagrams in region C. In this region, as the temperature-factor increases from 0·175 to 0·4, the eutectic point moves progressively away from the centre of the composition scale and the diagrams approximate to the form of that for germanium–lead. When the temperature factor is greater than 0·4, the diagrams tend to be of the intermediate type already discussed.

It has not, in the present investigation, been possible to elucidate the factors which control the formation of two-liquid or eutectic-type diagrams in region C of Fig. 3; but it is clear that within this zone a large temperature-factor tends to be associated with a eutectic diagram of the intermediate type.

H. J. AXON

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston.

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Instability in Pipe Flow

WHEN considering the conditions necessary for the stability of laminar flow in a cylindrical pipe, it may be assumed that the following quantities are involved: transverse velocity gradient (dv/dx) at the point considered; distance (x) of the point from the wall; and kinematic viscosity (ν) of the liquid.

The dimensionless group arising from these quantities is

$$G = \frac{(dv)}{(dx)} \frac{x^2}{\nu} = x \cdot \frac{d}{dx} ({}_xRe) - {}_xRe,$$

where ${}_xRe$ is the localized Reynolds number $\frac{vx}{\nu}$.

In fully developed laminar flow the maximum value of G occurs when $x = d/3$, where d is diameter of pipe; and this maximum value is

$$G_{\text{max}} = \frac{8\bar{v}d}{27\nu} = \frac{8}{27}\, Re.$$

From the generalized velocity-distribution curves (for the flow near the entrance to a pipe) given by Nikuradse[1], it may be shown that the value of G_{max} increases downstream, as shown in Fig. 1, where X is downstream distance from the entrance. A value of about 2,000 is frequently assumed for the critical Reynolds number: the corresponding value of G_{max} is about 592.

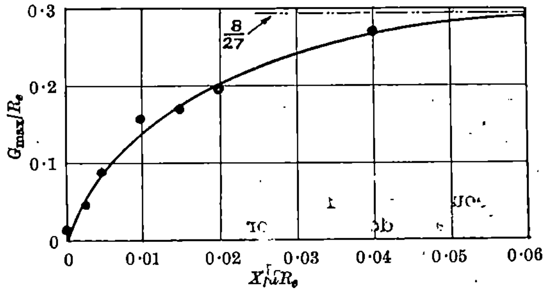

Fig. 1

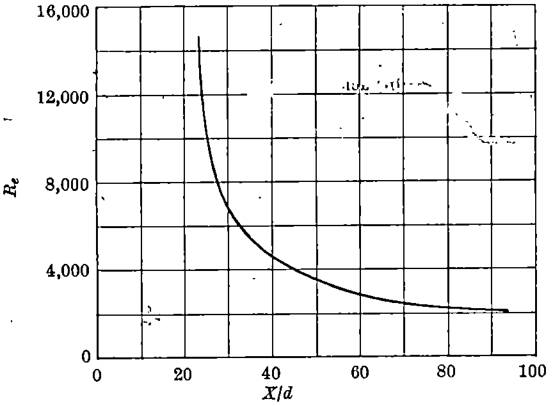

Fig. 2

Fig. 2 shows the variation of the position of the 'point of instability' ($G = 592$) as a function of Reynolds number (Re). From Fig. 2 it appears that this 'point of instability' approaches the entrance as the Reynolds number is increased.

The precise shape of the curve in Fig. 2 can, of course, only apply to flow examples in which the generalized velocity-distribution curves of Nikuradse are actually obeyed.

In Fig. 2, with flow at a constant Reynolds number, the position of the 'point of instability' is fixed. If disturbances arrive at this point, the flow should become turbulent; but if the disturbances have died away before they reach this point, laminar flow should persist. These inferences have an obvious bearing on the so-called 'higher critical' phenomena.

R. B. WHITTINGTON
E. W. S. ASHTON

Engineering Department,
University of Manchester.
July 1.

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Fish Farming in the Belgian Congo

DR. C. F. HICKLING[1] recently gave a survey of fish farming in the Middle and Far East. He mentioned that the best results were obtained in Africa with species of *Tilapia* (Percomorphi, Cichlidæ). The study of fish-farming problems being one of the principal objects of the Fisheries Research Station at Elisabethville (Belgian Congo), it may be of interest to describe some of our observations and results.

Before trials of fish culture were made in the Belgian Congo, it was already known that some species of *Tilapia* lent themselves more or less to pond-culture. Local species were used in different parts of Central Africa: *Tilapia nigra* Gthr. in Kenya[2] and *Tilapia kafuensis* Blgr. in Northern Rhodesia[3]. In the Union of South Africa, trials were made with *Tilapia mossambica* Peters, *Tilapia Sparmani* A. Smith, *Tilapia nigra* Gthr., *Haplochromis moffati* Cast., and *Serranochromis thumbergii* Cast.[4]. The results published concern mostly the growth and the biology of these fish. Data about production are rather scarce. At the Station of Chilanga (North. Rhod.) a pond stocked with *Tilapia kafuensis* Blgr., where the fish were intensively fed, gave a production equivalent to 1,200 lb. per acre per annum (1,342 kgm. per hectare per annum).

Since 1943, trials with indigenous species of fishes of the Congo Basin have been undertaken in different parts of the country, especially in Elisabethville. Those scattered trials, by private enterprises, proved that some species of Cichlidæ are growing and breeding well in ponds. Unfortunately, the experiments were made with mixtures of different species.

The Mission Piscicole du Katanga (1946–47)[5] repeated the experiments, taking care to separate the species involved. Carrying on the work of the Mission Piscicole du Katanga, the Fisheries Research Station, Elisabethville, got some very interesting results.

Tilapia sparmani A. Smith and *Tilapia nigra* Gthr. (introduced previously from Kenya), although breeding in ponds, did not give satisfactory results. The best results were obtained with *Tilapia macrochir* Blgr. and *Tilapia melanopleura* Dum. We already know something about their breeding[6].

Like two good pond-fishes of the Far East, *Osphronemus olfax* Blkr. and *Ctenopharyngodon idellus* Cuv. and Val., *Tilapia melanopleura* Dum. is a plant-eater; two hundred fingerlings took no more than ten months to eliminate from a pond of 7 ares (0·17 acre) a dense vegetation of *Leersia hexandra.* The fish like also *Potamogetum, Hydrilla, Lagarosiphon,* etc., and eat very well boiled sweet potatoes, banana foliage and other greenstuff. T. Vaughan Jones[7], who last February, after a visit to our Station, took some fingerling *Tilapia melanopleura* to the Station at Chilanga, was able to confirm these observations.

Our experiments further indicate that *Tilapia melanopleura* is adaptable to different waters and withstands handling. *Tilapia macrochir* Blgr. is principally a plankton-eater. It does not eat weeds but likes the micro-organisms fixed upon it. Artificial feeding with mill waste gives excellent results.

Both species seem to have the same rate of growth (up to 250 gm. eleven months after being spawned). It is therefore not surprising that high yields can be obtained with these species. A pond of 85 ares (about 2 acres) was manured in July 1947 and 121 *Tilapia macrochir* weighing 10 kgm. put in. From March 1948 the fishes were fed with maize waste. Eleven months after the beginning of the experiment 4,000 kgm. of fish were collected, which is equivalent to 5,135 kgm. per hectare per annum (4,574 lb. per acre per annum).

It is easy to understand the economic value of these fishes in countries where food is rather scarce. They immediately transform the plankton and green plants into valuable foodstuffs. No materials of food value for man are needed for their artificial feeding. The two species, being of complementary feeding habits, are able to use a great part of all the available food in a pond. Their breeding habits are sufficiently different to avoid competition between them. Although we have already very interesting results with mixed populations, the ratio of the two species is not yet fully determined for ponds of different productivity.

It may be of interest to direct attention to the fact that *Tilapia melanopleura* Dum. is a good agent in malaria control. The fish eliminate the floating and semi-submerged vegetation, which are breeding places of the malaria-carrying *A. gambiæ* and *A. funestus*. Further, the fry eat mosquito larvæ.

All over the country the cultivation of both these *Tilapia* is growing rapidly. Nearly all the ponds and dams are stocked with fry coming from the *Tilapia*-strains of this Station. Some fingerlings have already been sent abroad.

Further details concerning the biology and the culture of these *Tilapia* will be published in the annual report of the Station.

A. F. DE BONT

Fisheries Research Station,
Elisabethville,
Belgian Congo.

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Amino-Acids in the Hæmolymph of the Dragon-fly Nymph, *Aeschna cyanea*

ALTHOUGH it is well known that the non-protein nitrogen content of insect hæmolymph is high and that a large proportion of it is present as amino-acids, few investigations have been made as to their nature. Florkin and Duchateau[1] showed that the hæmolymph of *Dytiscus marginalis* contained small quantities of histidine and tyrosine, and reported the absence of arginine, tryptophane, phenylalanine and cystine. A more thorough analysis by Ussing[2] revealed the presence in the blood of *Melolontha vulgaris* of lysine, arginine, histidine, tyrosine, leucine, valine, tryptophane and almost certainly hydroxyproline. The latter is also present in the blood of *Oryctes nasicornis*.

We have investigated the hæmolymph of *Aeschna cyanea*, using the technique of partition chromatography on filter paper of Consden, Gordon and Martin[3].

Small quantities of blood (about 3 mm.^{3}) run on a partition chromatogram, using water-saturated phenol as solvent, gave coloured spots with ninhydrin, the R_F values of which (0·38 and 0·55) corresponded with those of glycine and alanine. With increased amounts of blood, spots corresponding in position to leucine or *iso*leucine, valine and proline were found.

To detect the presence of amino-acids occurring in smaller amounts, concentrated extracts were prepared by evaporating the blood from one larva (about 100 mm.^{3}) to dryness in a vacuum desiccator, suspending in about 15 mm.^{3} of 60 per cent alcohol, centrifuging, and using the supernatant solution. Thus the amino-acids were concentrated while the protein and most of the inorganic salts remained undissolved. The nitrogen content of the whole blood was determined by an ultra-micro-Kjeldahl method on a small sample (0·7 mm.^{3}) removed before concentration. A typical result was: total nitrogen, 529; protein nitrogen, 311; non-protein nitrogen, 218 mgm. per cent. Amino-acids identified: serine, glycine, lysine, alanine, tyrosine, valine, leucine or *iso*leucine, proline.

Since proline is easily recognized by its ninhydrin colour and because the R_F values were sometimes lower than expected, values for every spot were recalculated using the proline spot as standard (R_P value = 1·0).

The results were confirmed by running simultaneously a blood extract, and a blood extract to which was added one or more of the suspected amino-acids.

The results for a number of different animals are summarized in the accompanying table.

R_P-values at room temperature

Amino-acid	Pure amino-acid	Pure amino acid in blood	Blood extract (animal 15B)	Blood extracts: average for 16 runs
Serine	0·36	0·36	0·37	0·36
Glycine	0·45	0·44	0·44	0·44
Lysine	—	0·55	0·54	0·53
Alanine	0·63	0·64	0·65	0·65
Tyrosine	0·70	0·72	0·75	0·72
Valine	0·85	—	0·87	0·86
Leucine or *iso*leucine	0·94	—	0·94	0·93
Proline	1·00	—	1·00	1·00

From these experiments and those with untreated blood it appears that glycine, alanine, valine and leucine are present in the greatest concentration. Proline and tyrosine occur in moderate amounts and serine and lysine in small quantities.

Confirmation of these results was provided by the two-dimensional technique using phenol and collidine as solvents, except that no serine was demonstrated. Arginine and lysine are possibly present, and relatively large amounts of a substance, possibly a peptide, which runs at the same speed as alanine in phenol but somewhat slower in collidine.

Further experiments are in progress on the blood of other insects, and attempts are being made to obtain quantitative results.

RICHARD RAPER
JOHN SHAW

University of Durham,
King's College,
Newcastle-upon-Tyne.
July 14.

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Growth of *Culex molestus* under Sterile Conditions

Aedes ægypti and *Culex pipiens* are the only two mosquitoes which have hitherto been reared from egg to adult under sterile conditions. It is interesting to note that the autogenous *Culex molestus* can also be bred without difficulty on sterile media. The following media were found suitable for this purpose (all experiments were carried out at a temperature of 28° C.).

(1) Dried or fresh yeast (autoclaved) 1·2 gm. to 15 ml. distilled water to which 25 eggs of *C. molestus* were added under sterile conditions. On this medium the mosquitoes developed from eggs to adult in 10·5–13 days; but the adults were not viable.

(2) Water, dried yeast and the following vitamins: thiamin, riboflavin, pantothenic acid, niacin, pyrid-

oxin, folic acid (each 10 γ per ml.), biotin (0·14 γ per ml.). This was the optimum medium, and the development from egg to adult took 7·5 days. The mosquitoes were viable. Obviously 1·2 gm. of the best samples of yeast available did not contain sufficient of the above factors to produce viable adults.

(3) Liver extract and dried yeast (autoclaved) (Trager's medium for *A. ægypti*). Development from egg to adult took 14 days, and the adults were viable. Water extract of the same yeast and liver extract allowed development from egg to adult in 20 days; but the adults which emerged were not viable.

(4) Water, glucose (0·1 per cent), a mixture of salts (0·2 per cent), casein hydrolysate (2 per cent), the above-mentioned vitamin B complex (but with only 7·5 γ biotin per ml.) and ascorbic acid (150 γ per ml.). Although development on this medium was relatively slow (eggs to viable adults in 25 days) it proved to be the most suitable for studying the nutritional requirements of all stages of *Culex molestus*. Thus in the absence of pantothenic acid, all other factors being present, there was no development beyond the first instar; in the absence of thiamin, riboflavin or pyridoxin the larvæ die in the second instar; in the absence of folic acid, the larvæ reach the fourth instar but never pupate. In the absence of niacin, the whole developmental cycle lasts 42 days, and the adults are viable. In the absence of biotin the cycle lasts 36 days, but the adults are not viable. Ascorbic acid is not essential for complete development of viable mosquitoes, but in its absence the cycle is prolonged to 29 days.

It is interesting to note that the viable females raised on sterile media were autogenous and laid eggs in the absence of any kind of nutrition. Full details will be published elsewhere.

I wish to thank Prof. S. Adler for his advice and interest in this work.

E. P. LICHTENSTEIN

Department of Parasitology,
Hebrew University,
Jerusalem.
April 4.

Receptor Organs in Tunicata

NOTHING was known of tunicate receptors before 1899, when Herdman[1], in his description of *Ascidia*, mentioned a few structures that might act as receptors, but gave no proof or details. Lorleberg[2], on the other hand, stated in 1907 that in *Stylopsis* "there is complete lack of sense cells". Hecht[3] could not find any receptor organs besides the tentacles and margins of the siphons. Das[4] showed for the first time definite receptor cells in the test and mantle. He demonstrated red pigmented cells which act as photoreceptors. Besides these, the tentacles and dorsal tubercle have been mentioned by various workers as having definite receptor functions. I have found a new structure in *Ciona*, in the intersiphonal region, which appears like an eye-spot and is definitely a photoreceptor. No mention of this structure is found in the various accounts of *Ciona* given by different authors. This eye-spot can be easily seen when the atrial aperture is wide open. It lies on the wall of the mantle just behind the base of the atrial siphon on its dorsal aspect. It is specially conspicuous in dark-adapted animals.

I have made investigations on the receptor organs and the responses of the ascidians *Ciona, Ascidiella, Styelopsis* and *Herdmania*, to mechanical stimulation, gravity, light, temperature and osmotic pressure, a complete account of which is being published elsewhere. The main receptors in Tunicata are as follow:

1. *Tangoreceptors:* (*a*) cells scattered in the non-vascular areas of the test, especially the test of the siphons; (*b*) cells covering the ampullæ in the vascular areas of the test; (*c*) marginal cells, specially sensitive to vibrations of water or substratum, of the siphons; (*d*) tentacles. Stimulation of (*a*), (*b*) and (*c*) causes direct reflexes, while stimulation of (*d*) causes a crossed reflex.
2. *Photoreceptors:* (*a*) red pigmented squamous epithelium of the siphonal lining in all tunicates; (*b*) red-pigmented epithelium of the vascular ampullæ in Pyuridæ; (*c*) eye-spot in *Ciona*.
3. *Gusto- and olfacto-receptors:* (*a*) tentacles react to dilute acids, alkalis and different concentrations of sea-water; (*b*) dorsal tubercle—probably both for smell and taste (Metcalf and Hunter[5]).
4. *Rheoreceptors:* margins of the siphons—not only do the siphons bend to face a water-current, but they also bend upwards against gravity.
5. *Thermoreceptors:* the cells lining the siphons are very sensitive to changes in temperature, although the tentacles must also be an aid to the tunicate in registering temperature.

I have also demonstrated that, contrary to what was believed hitherto, Tunicata have positive as well as negative responses.

S. M. DAS

Department of Zoology,
University, Lucknow.
June 30.

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Site of Action of D.D.T. and Cause of Death after Acute D.D.T. Poisoning

EXPERIMENTS were carried out with *Periplaneta americana* and *Rana esculenta*, after injection with a D.D.T.-emulsion. Action-potentials from the n. cruralis (= 5th nerve, Pringle) of the second thoracic ganglion of *Periplaneta* were recorded with a special pre-amplifier and a cathode-ray oscillograph. No differences were found between normal and D.D.T.-treated animals in the following preparations: (1) crural nerve only connected with the second leg; (2) crural nerve only connected with the second thoracic ganglion, which was isolated from the other ganglia and from all peripheral nerves. Hence the D.D.T. causes no increase of spontaneous activity of the sense organs of the leg, nor of spontaneous motor-activity from the isolated ganglion. However, when the reflex path was intact (or partly intact—crural nerve connected with second leg and second thoracic ganglion), the action-potentials of D.D.T.-treated animals showed an abnormal increase in frequency.

These facts suggest that the specific action of D.D.T. is a facilitation of synaptic transmission. A direct proof of this assumption can be given with a 'spinal frog', where the homolateral contraction of the m. gastrocnemius was recorded after stimulation of the peripheral stump of the n. ischiadicus, and the contralateral reaction (through the spinal cord) after stimulation of the central stump of the same nerve. It is well known that a contralateral response does not follow one single induction shock; two or even more shocks being necessary to activate the motoneurones. After D.D.T. treatment, however, one single stimulus, even a weak one, induces a high contralateral contraction. This phenomenon was studied in a wide variety of experiments, with different kinds of stimulation. These experiments show that the specific cause of D.D.T. symptoms is a facilitation of synaptic transmission. The question arises whether this fact can explain the cause of death after D.D.T. poisoning.

The answer is given by the same kind of experiments, carried out at a later stage of poisoning. The preparations then fail to give any contralateral response, even after faradic stimulation, while stimulation of the peripheral stump of the sciatic nerve (of the same animal) causes a normal reaction. Thus, a period of synaptic facilitation is followed by a synaptic block. This synaptic inhibition is, of course, not restricted to the sciatic region of the spinal cord, but represents a general blocking action of D.D.T., which causes the death of the animal.

The production of central inhibition could also be recorded with *Periplaneta*, although it takes a longer time to become perceptible. Besides the action of D.D.T. on the central nervous system, there is evidence of a specific action on the myoneural junctions or on the muscles of the leg of the cockroach. This will be discussed elsewhere.

On the other hand, D.D.T. had no specific action on the sense organs of the leg of *Periplaneta* or *Rana* (either skin-receptors and proprio-receptors), or on the peripheral nerves, or on the electro-encephalogram of *Rana*.

Experiments to detect any action of D.D.T. on the spontaneous activity of the nerve cord of *Periplaneta* are in progress, although the facts mentioned above make the existence of such an action improbable.

These investigations were carried out under the auspices of the National Council for Agricultural Research (Toegepast Natuurwetenschappelijk Onderzoek). Details of the work will be published elsewhere.

D. Dresden

Laboratory of Comparative Physiology,
University, Utrecht.

Aug. 4.

Occurrence of *Acanthocephalus ranæ* Schrank. in Great Britain

Acanthocephalus ranæ Schrank. (= *Echinorhynchus ranæ* Schrank. = *Echinorhynchus hæruca* Rudolphi.), the only known Acanthocephalan parasite of the frog, has rarely been found in Great Britain. The only known recorded occurrences are by Elmhirst[1], who found it in the common frog *Rana t. temporaria*, and Baylis[2], who records its occurrence from Westmorland in a 'newt' and in the common toad.

Twenty-seven specimens were discovered in the duodenum of a single frog (*Rana t. temporaria*) during a routine dissection in November 1947. Unfortunately, frogs from two localities were mixed before examination, and the infected frog may have come from either Carnki (Cornwall) or from Newdigate (Surrey). Nineteen of the individuals were measured while still alive, and were found to consist of both males and females; males 7·0–10·0 mm., females 17·0–35·0 mm. Of the nineteen individuals determined, seven were males and twelve females. Mature eggs were present in all the females examined, and were extruded from one specimen on removal to saline. None of the males had the bursa copulatrix extruded, and all were hanging free in the lumen of the duodenum when discovered.

In the few individuals examined, the number of proboscis hooks and longitudinal hook-rows corresponded with the results of Lühe (*vide* Meyer[3]) for German specimens—females having 18 longitudinal rows and the males 13 longitudinal rows, with four to six hooks in each row—rather than with the figures given by Van Cleave and Porta (*vide* Meyer[3]). Van Cleave found in four individuals examined 12 longitudinal rows with six to seven hooks in each row, and this appears to agree with Porta's figures[4].

Although the recorded instances of the occurrence of this parasite seem to be rare, this may be due to lack of observation. In Germany and Austria the parasite is common in newts, toads and salamanders, as well as in the common frog. Heavy infections in *Rana t. temporaria* L. (as much as 50 per cent) occur in Germany[3]; but it appears to be much less common in France and Italy. It has been recorded only once in North America (Van Cleave[4]) from *Diemyctylus viridescens* at Baltimore, Maryland. Van Cleave considered the parasite to be rare in North America, as subsequent examination of Amphibia failed to reveal further specimens. This rarity is possibly correlated with the absence of the secondary host *Asellus aquaticus* L., which though common throughout Europe has been recorded in America only in Labrador and at Hopedale[5]. *A. ranæ* was recorded from the Dnjepr by Kostylew (*vide* Meyer[3]), in 1926.

It is hoped that further research and more careful observation of British Amphibia will throw more light on the distribution of this interesting species.

R. Phillips Dales

Queen Mary College,
University of London.

July 16.

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Colpomenia sinuosa (Mert.) Derb. et Sol. in Scotland

I wish to record the finding of *Colpomenia sinuosa* (Mert.) Derb. et Sol., near Stornoway in the Isle of Lewis. The plants were found growing in shallow pools on *Corallina officinalis* L. at Aignish, on the Broad Bay side of the Eye Peninsula in July 1947.

The first record of this alga in Scottish waters was made by Dr. M. D. Dunn[1], who found it at St. Andrews in the summer of 1938. As it is now known to occur all round the Irish coast[2], these two Scottish records show that it may also be found elsewhere on the coast of Scotland.

I would be pleased to hear of any other Scottish stations for this alga, so that its distribution in Scotland may be known.

Helen Blackler

Gatty Marine Laboratory,
University,
St. Andrews,
Fife.

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Abnormal Serum Protein in Parenchymatous Liver Diseases

Several colloidal serum reactions have been proposed during recent years for revealing damage of the liver parenchyme: the cephalin-test (Hanger), the colloidal gold and thymol tests (Maclagan) and the colloidal benzoin and shellac tests[1]. Most authors suppose that increased gamma-globulin forms the basis of these tests, but it has been suggested that beta-globulin may be responsible, too.

In fractionation experiments with variable concentrations of alcohol at low temperature (5–10° C.), we found that normal sera caused precipitation only in alcohol concentrations higher than 20 per cent; sera of hepatic cases, on the other hand, gave precipitations in 5–10 per cent alcohol. No precipitation occurs when alcohol is diluted with 0·9–10 per cent sodium chloride or when twice-distilled water is added without alcohol, or when the *p*H of the diluted alcohol is less than 5·5.

The protein fraction precipitated with 10 per cent alcohol is insoluble in water, but is readily soluble in 0·9 per cent sodium chloride; it is partly precipitated with 30 per cent saturated, and completely precipitated with 50 per cent saturated, ammonium sulphate. Saturated sodium chloride solution precipitates the greater part of it. The iso-electric point is about *p*H 5·5. The tryptophane content varies between 3·0 and 3·8 per cent. The serum concentration of this fraction, present in all cases of parenchymatous hepatic damage, amounts to 1–3 per cent, forming a considerable part (30–50 per cent) of the total globulin.

The purified fraction gives positive colloidal gold, benzoin and Takata tests of the same intensity as does the corresponding quantity of serum; with the remaining, non-precipitable protein, colloidal tests give negative results. The effect of the isolated fraction on thymol turbidity is somewhat less than that caused by the corresponding quantity of serum. In Weltmann's coagulation test, on the other hand, the isolated fraction is coagulated in presence of 0·1 per mille calcium chloride; the higher values (0·2–0·4 per mille calcium chloride) obtained with total serum are the consequence of some unknown factor hindering coagulation.

A. Fischer
C. Sellei
M. Bretán

Second Medical Clinic,
University, Budapest.
July 15.

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Increased Muscle Phosphorylase Activity in the Starved Rat

It was shown earlier that glucose uptake in the isolated rat diaphragm was reduced after a period of non-carbohydrate, high-fat diet[1], and that a spontaneous regulation of food intake took place in animals shifted from such a diet to a high-carbohydrate diet[2]. These physiological changes occurring after a period of carbohydrate deprivation, together with many other observations after starvation or fat-feeding by other investigators, suggest that the kind of foodstuff taken by the animal (or human subject) determines in some way the metabolic pattern.

It is known that a decrease in insulin content of the pancreas is found after starvation or following a fat diet[3]. Many observations seem, however, to point to the fact that the change in the metabolic pattern can take place independently of the hormonal status, for example, the dependence of the glucose-tolerance curve[4,5] and the rate of depletion of glycogen stores[6] on the previous carbohydrate intake in the hypophysectomized animal. It is conceivable that a difference in cellular enzymatic activity is found in different metabolic conditions.

To investigate this problem we have undertaken a study of muscle phosphorylase activity in fed animals, in starved animals, and in animals on diets containing different amounts of carbohydrate. The results obtained in fasting animals will be given briefly here.

Phosphorylase activity was studied by the method of Cori, Cori and Green[7], determining the liberation of phosphate during the process

glucose-1-phosphate → glycogen + phosphate.

A crude extract of rat muscle was made after freezing with liquid air. The extract was filtered, adjusted to *p*H 6·1, and dialysed against running tap water. The dialysed extract was diluted with a weak solution of cysteine and added to tubes containing glucose-1-phosphate, glycogen and cysteine-glycerophosphate buffer. To some tubes adenylic acid was added. The tubes were agitated for one hour at 31° C. in a Warburg bath. After treatment with trichloracetic acid and filtering, the phosphate formed during the incubation period was determined as the difference between a zero value and a 60-min. value. The protein content of the enzyme extract was estimated by the biuret method, standardized against human serum. In each experiment the muscle phosphorylase activity was observed in one fed and one fasted animal.

The effect of fasting is shown in the accompanying table. The activity, both with and without adenylic acid, is consistently higher in the fasted animals.

Muscle phosphorylase activity in fed and fasted rats

	Fed			Fasted			
Number of experiment	Phosphorus liberated (γ) 1*	Phosphorus liberated (γ) 2†	Protein in reaction mixture (mgm.)	Phosphorus liberated (γ) 1*	Phosphorus liberated (γ) 2†	Protein in reaction mixture (mgm.)	Duration of fast (days)
1	132	256	—	708	862	—	2
2	80	304	5·8	304	278	6·2	3
3	34	56	5·6	174	214	5·4	2
4	170	540	5·2	618	632	5·2	3
5	33	75	5·8	284	412	5·4	1
6	12	170	6·4	198	282	5·8	5
7	54	246	6·6	374	744	6·6	2
8	44	146	5·6	164	298	6·0	2

*Without added adenylic acid. †Adenylic acid added.

We are not suggesting, at present, any definite explanation for the higher phosphorylase activity in the starved animals. Studies are now being conducted on the phosphorylase activity during refeeding after fasting, in animals on diets containing different amounts of carbohydrate, and in animals shifted over from a low- or non-carbohydrate diet to a diet containing large amounts of carbohydrate (starvation diabetes). It is proposed to investigate other enzyme systems in intermediary carbohydrate metabolism, for example, the hexokinase system and the system of oxidative phosphorylation in animals on different dietary regimes.

The results obtained appear to indicate profound changes in the pattern of intermediary carbohydrate lism depending upon the previous food intake animal. They may help towards a better tanding of the factors governing the metabolic ys on different diets, and especially the many ccumulated on the effect of fasting or fat- on carbohydrate metabolism. In general, stress the importance of ascertaining the onal status of the animal in carrying out tic studies.

tailed report will appear elsewhere. We wish ess our appreciation to Prof. E. Lundsgaard s interest and helpful counsel in conducting experiments.

KNUD LUNDBÆK

rtment of Medical Physiology,
Jniversity of Copenhagen.

EWALD S. GORANSON

Department of Physiology,
University of Toronto.
July 7.

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ple Method for Direct Comparison of the ssant Effect of the Barbiturates on the Respiration and Circulation

26, Knaffl-Lenz[1] introduced a method for the of digitalis preparations by determining the lethal dose on intravenous injection in tized guinea pigs. The method, which may for all kinds of cardiac glucosides, has since official in, for example, Britain[2] and Sweden[3]. g to this procedure, the solution to be tested uced into the vena jugularis under constant and at constant speed (either from a burette Aariotte stopper or with a motor-driven apparatus). The lethal dose is determined observation of the cardiac standstill (con- e details of the procedure, see, for example, nss Bech[5] and Goldberg[6]). The number of equired is determined by the degree of one wishes to give the results; this may ted with the help of the usual statistical

r method can also be used for comparison ressant effect of the barbiturates on the and circulation. The guinea pigs in this næsthetized with urethane. The dose re- roduce cessation of the respiration may be by direct observation, although a self- device is, of course, also possible. When ceases, the dose and time are noted, the opened and artificial respiration by a prepared connexion between the trachea ing pump is started. The cessation of ivity is observed as in the Knaffl-Lenz the dose and time required are noted. quired for the cessation of respiration tivity are thus determined on one and l. The concentration of barbiturate, in solution in the form of an alkali t the dose required for the cessation vity will be about 1 ml. per 100 gm. body-weight. The suitable rate of injection will then be approximately 0·5 ml. per min.

Doses required to produce cessation of respiration and circulation in guinea pigs after intravenous injection of some common barbiturates

Barbiturate	Concentration (per cent)	No. of animals	Dose for respiratory standstill (R) (ml./100 gm. body-weight)	Dose for cardiac standstill (C) (ml./100 gm. body-wt.)	R/C (as percentage)
Sodium 5-*iso*-amyl-5-ethyl-barbiturate ('Amytal sodium')	2·75	17	0·18±0·019	0·75±0·019	24
Sodium *N*-methyl-cyclo-hexenylmethyl barbiturate ('Evipal sodium')	2·2	7	0·055±0·015	0·98±0·039	6
Sodium *iso*propyl-β-brom-allyl-N-methyl-barbiturate ('Narkotal')	2·2	14	0·055±0·0042	0·72±0·030	8
Sodium 5-ethyl-5-(1-methyl-butyl)-thio-barbiturate ('Pentothal sodium')	1·2	9	0·058±0·0057	1·02±0·048	6

A simple method for such comparisons is of great practical value, since it has proved that the depressant effect of the barbiturates on the respiration has shown a tendency to increase if their duration of action is diminished.

In the accompanying table are given the results of a number of experiments using the method described. 'Amytal', with its moderate duration, has been compared with intravenous anæsthetics of ultra-short duration, such as 'Evipal', 'Narkotal' and 'Pentothal'. The depressant effect on the respiration of the last three preparations when injected intravenously is, as seen from the table, both absolutely and relatively in a totally different class from that of 'Amytal'. The dose required for cessation of circulation is in the case of 'Amytal' about four times as great as the dose inhibiting the respiration, while the corresponding value for the three other compounds is about fifteen times.

The importance of artificial respiration after cessation of spontaneous respiration under intravenous barbiturate anæsthesia is demonstrated, in short, in an extremely striking way. The margin between cessation of respiration and cardiac activity respectively brought about by compounds of the 'Amytal'-type is not as favourable for a successful treatment with artificial respiration, although this is far from insignificant. For these preparations, which are chiefly used in ambulant practice and are administered by mouth, the considerably smaller absolute toxicity on the respiratory centre is of all the greater importance. It is, of course, as a matter of fact, this form of toxic effect which determines the practical usability of the ordinary hypnotics.

STEN WIEDLING

Central Laboratories,
AB Astra,
Södertälje, Sweden.
June 20.

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Esterification of Phthalic Anhydride with Primary Alcohols at Room Temperature

In a recent publication[1], some investigations on the esterification-rate of dibasic acid anhydrides with primary alcohols at room temperature were recorded. From the results of titration of acid anhydrides dissolved in the cold in primary alcohols, using a solution of potassium hydroxide in the alcohol as titrating agent, it was concluded that mono-ester formation was instantaneous and quantitative, being so rapid that comparison of rates of reaction was impossible.

We have attempted to utilize this apparently instantaneous reaction in the preparation of certain half-esters of phthalic acid, but soon discovered that the expected product was only obtained in very small yields, if at all. Even after prolonged periods, substantial amounts of unchanged phthalic anhydride were recovered from the mixture. Titration of the mixture by the method of Siegel and Moran did, however, give results in agreement with the formation of a half-ester.

We consider that these apparently contradictory findings become reconciled if the esterification reaction is catalysed by the addition of the titrating agent. It is therefore incorrect to conclude that mono-esterification of a dibasic acid anhydride with a primary alcohol proceeds instantaneously and quantitatively at room temperature, as it only does so after the addition of potassium hydroxide, that is, in the presence of a catalyst.

F. J. Bristow

Imperial Chemical Industries, Ltd.,
(Paints Division),
Wexham Road,
Slough.
July 14.

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Photolysis of Organic Disulphides

The reactions following light absorption by pure organic disulphides in solution have not been studied, although the reactions are of great importance in the chemistry of wool, affecting both felting and shrinkage of the wool[1,2]. Similar reactions occur in irradiated milk[3] and in petrol[4].

The absorption spectra of diphenyl-, di-*o*-tolyl-, and di-*p*-tolyl- disulphides were found to be similar. Absorption occurred below *c.* 3,000 A., with $\lambda_{\max.} =$ 2,450 A.

Solutions of all three in organic solvents, as well as cystine in 3 per cent hydrochloric acid, were exposed to filtered light from a 125-W. mercury vapour street lamp from which the glass envelope had been removed. Measurements of the light flux by uranyl oxalate actinometry gave results in good agreement with those obtained using a thermopile–galvanometer combination. It was found that the disulphides were converted into the corresponding thiols, identified by the melting points of their metallic derivatives and estimated by amperometric titration with silver nitrate. The solvent was variously alcohol, *n*-hexane and ether.

In view of the theory[1,2] which accounts for the acidity developed in irradiated wool by the presence of sulphuric acid produced from hydrogen sulphide, which in turn came from a disulphide by chemical reaction, tests were made repeat determine whether hydrogen sulphide was in these reactions also; but no trace of any w Nor was sulphur a product, air having been from the reaction vessel.

The quantum yield of thiol formation was 0·003 for diphenyl-, di-*o*-tolyl- and disulphides respectively, and 0·020 for c hydrochloric acid. It was independent perimental error (*a*) of the nature of the a (*b*) of the concentration of the disulphide, the nature of the solvent used. The lo for the cystine is explained by the simu liberation of ammonia in this case[5].

The following mechanism is adequate if a radical *R*—S— be assumed formed, as has been in another case[6]. Free-radical formation is ene ally possible with light of wave-length less 4470 A., taking the energy of the SS bond 63·8 k.cal./mole.

$$\begin{array}{lcl} R\text{—S—S—}R & \xrightarrow{h\nu} & R\text{—S—S—}R^{*} \\ R\text{—S—S—}R^{*} & \rightarrow & 2\,R\text{—S—} \\ R\text{—S—} + M & \rightarrow & R\text{—SH} \\ R\text{—S—S—}R^{*} + M & \rightarrow & R\text{—S—S—}R, \end{array}$$

where *M* is a solvent molecule. Reaction *D* the fact that the quantum yield of thiol fo is less than 1. Its value indicates that an a molecule has one chance in 44 of decomposin it is deactivated by collision.

I am indebted to the Commonwealth Committee for a grant which made possible chase of equipment used.

W. E.

Department of Chemistry,
University, Sydney.
July 5.

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"Pre-Natal Physiology"

In his comprehensive and excellent rev Joseph Barcroft's "Researches on Pre-N which appeared in *Nature*, 159, p. 383, Dr Marshall makes the following statemen regard to the matter of permeability the a that, contrary to the views of Flexner, the number of layers in the fœtal barrie perfect is the fœtus at birth, . . .". Or his book, Sir Joseph states that my colle were interested in placental permeability placental 'efficiency'. I should like to po we have made no statements about a p tion between placental stru of the fœtus at birth, and therefore conflict with Sir Joseph's views o

Lou

Department of Embryology,
Carnegie Institution of Washington,
Baltimore, Maryland.

ATOMIC ENERGY AND SOCIETY

conference of the Atomic Scientists' Asso- on on "Atomic Energy and Society" and Energy and the Scientist" was held in the Hall, London, on October 30. A number of shed men of science addressed the con- and their speeches were followed by a general While there was general agreement ons of scientific fact, the different speakers idely different interpretations upon the ational and international difficulties with control, secrecy and individual freedom, reflected to a large extent their different cal outlooks. Prof. R. E. Peierls in his open- emarks emphasized that the Association as does not adhere to any particular political sophy; its primary function is to spread a ledge of the facts and to provide a platform discussion.

spects for the use of atomic energy in peace eviewed by Prof. M. H. L. Pryce. Radioactive s, manufactured in atomic piles, have already of great value, particularly in medicine and gical and chemical research, for tracing the of reactions by the principle of marked atoms. pplications require relatively small quantities pactive materials; the present Harwell pile be able to satisfy all European needs. On the and, for the generation of electric power in es sufficient for industrial purposes, much quantities of fissile material would be needed ities that could readily be used for the tion of bombs if required. Many technical s remain to be solved before atomic power an be put into operation, and it is not yet that adequate supplies of the nuclear fuel obtained, either by separation of uranium- natural uranium or by the process of ' from uranium-238, or from thorium. ic age may still be half a century away.

M. S. Blackett gave what he described as itten' analysis of the probable effects of ombs in future warfare. For some time to mbs would be delivered to their targets by onal aircraft, which would presumably have e hundreds of miles over enemy territory, o attack by much faster jet fighters. With ament of at least ten planes for each target mutual protection, the number of aircraft to launch a surprise 'annihilation' raid a country's industrial centres would be thousand; preparations for an attack on scale could be detected and would lead to The effect of a single atomic bomb was nt to about 2,000 lb. of ordinary bombs; e than 1,000,000 lb. of bombs were dropped pe in the Second World War without es causing Germany to surrender. Russia far more severely than that from the German on, yet was able to fight on to victory. Thus, Blackett's opinion, it cannot be assumed bombs would bring rapid or even eventual war', and to embark on a conduct diplomacy by using it be very dangerous and could only despair.

aker was Sir George Thomson, who of the prolonged negotiations for atomic energy which had taken place in the United Nations Atomic Energy Commission and in its technical committee, on which he was the British representative. Only once was this committee able to sign a unanimous report; but this report did contain the vital statement that control is technically feasible. For the rest there had been interminable wrangling. The Russians would begin with obviously impossible demands, such as the one that the United States should destroy its stock-pile before control was established, and then make grudging concessions so late that the other Powers had some cause for doubting their sincerity. Nevertheless, Sir George thinks it is essential to continue the attempt to establish control, so that a country might have at least the security of a few months warning if an attack with atomic bombs was being prepared against it.

Prof. N. F. Mott referred to the need for maintaining contact so far as possible with scientific workers in the U.S.S.R. and other countries. He agreed with Prof. Blackett that the use of atomic bombs would not bring speedy victory in another war, and pleaded for moderation and a spirit of compromise in the negotiations. The extremists were beyond the reach of argument; but ordinary people could be made to understand that there are common needs transcending all our differences.

In the discussion that concluded the first session, Dr. E. U. Condon, a welcome visitor from the United States, commented on the widespread belief that military strength is our only defence against Communism. He believed it is equally important to have a positive social policy, to show in practice that Western democracy provides a better and happier way of living. Other speakers asked Prof. Blackett to elaborate some of his points, and there was both criticism and defence of his allegedly 'pro-Soviet' outlook. The question of the control of bacteriological weapons was also raised: Sir George Thomson replied that he believed control would be far more difficult in that case, and that it would probably be best to make a beginning with atomic energy by itself.

The second session of the conference was concerned with the effect which the development of atomic energy has had upon the individual scientific worker. Prof. Peierls described the difficult position which many men of science now occupy. On one hand, they are entrusted with secret information that affects national security; on the other hand, they belong to the international community of science, which is pledged to the free exchange of ideas. It has been possible to maintain this dual role only because at present the information which has to be kept secret does not have any particular bearing on the fundamental problems which interest the pure scientist. Information must be either secret or wholly international; it cannot be restricted, for example, to the west of the Iron Curtain. The participation of Eastern scientific workers in helping to solve our fundamental problems would always be welcome, even though they, like ourselves, might not be permitted to discuss certain things. We must accept the professional work even of individual scientific men whose personal political integrity may be in doubt; and in Britain, while the military authorities must decide whom they can trust with military secrets, scientific workers doing ordinary academic work should have the same freedom as other citizens, if individual liberty is to be preserved.

Sir Henry Dale described the progressive restrictions which have been imposed on the freedom of science in the last fifty years, in consequence of its increasing military importance. He said that the ideal of complete freedom should be strenuously maintained, and that in the present difficult circumstances the boundary between the free and the secret knowledge should be kept as sharp as possible. One of the most distressing features of the present time, he said, is that scientific men in some countries are required not merely to conform to a political orthodoxy but also to uphold specific scientific doctrines for political rather than scientific reasons. A notorious instance is the genetics controversy in the U.S.S.R., in which the opponents of Lysenko, in particular Vavilov, have been dismissed from their posts or disappeared. Where scientific men are bound in their professional views by political considerations, scientific co-operation is obviously impossible.

Dr. E. H. Burhop considered that the type of interference with individual freedom represented by the Thomas Committee on Un-American Activities is a serious danger in the Western world. The conference ended with a lengthy discussion, devoted largely to the points raised by Sir Henry Dale on scientific freedom in the U.S.S.R. and on the merits of Soviet genetics.

H. R. ALLAN

THE PLACE OF BIOLOGY IN A CURRICULUM*

By PROF. H. GRAHAM CANNON, F.R.S.

IN the teaching of biology there are two sharply defined aspects: there is the study of the structure of organisms correlated with their functioning, leading to knowledge of human physiology and the relation of man to the animal and plant kingdom. This may be looked on as a factual aspect while, on the other hand, there is the study of evolution and all that it implies and involves. This may be regarded as a cultural aspect.

To take the factual aspect first. If there is one thing more than any other with which a child is intimately associated it is with its own body. Its body should become its immediate concern, and all school children, whatever other subjects they may study, should be taught to understand in a simple manner its mechanism and structure. But this is far from being the case, for we still live in an age of extraordinary prudery in which it is improper to discuss anatomical and functional details. This is brought out only too clearly when it is realized that there are no words in ordinary use to describe such natural processes as defæcation or micturition, and as regards the parts of the body, there are no names in ordinary use for the external genital organs. Any words there may be are considered completely vulgar. Now a general elementary study of the human body taken as an ordinary subject for study, quite apart from the educative value that the child derives from knowing what happens inside its own body when, say, a meal is taken, or when a schoolboy collapses exhausted after a hundred yards sprint—quite apart from this, the mere fact of taking this sort of study along with his history or his language or his science would make him feel that here is something quite ordinary and not in any way exceptional. He will then feel free to discuss biological things, things about himself, in an open manner, just as he would without hesitation discuss a problem of mechanics or history. In many schools it is the custom to have a visiting teacher, often a doctor, who appears spasmodically to give short courses of lectures to the older students on what is sometimes called 'personal hygiene'; but this is all wrong. He comes to talk to the students about sex, and that is where the harm is done. Why should sex be singled out like this? Why separate the gut from the genital system? We professional biologists do not, and neither do university biological students. It is this separation of the problem of the human body from the other subjects of study that tends to reinforce the Victorian prudery that we have inherited and to retain those awkward complexes resulting from suppressions which are the curse of adolescent education.

Now as regards biology as a cultural subject, this is the aspect that I consider of such value to the student who is to specialize on the Arts side. All syllabuses, whether good or bad, start from the 'lower' or structurally simple and lead up to the 'higher' or complex advanced types. If this evolutionary story is properly dealt with, not as a series of separate steps but rather as a gradual unfolding from simple beginnings of the complex organisations that we see at the top of the tree, then a student derives a new conception of life as a whole. He realizes that it is not only animals and plants that have evolved, but also all other things such as food and clothes, houses and motor-cars and, more important still, mental and social activities. Civilization, in fact, that he sees around him, he realizes is something that has gradually evolved and which he has inherited. The effect of this broad outlook on his other subjects cannot be over-estimated. How often is a student at school learning a language made to understand that that language has evolved? Or, worse still, how often is the school-child, working at some narrowly circumscribed period of history for the School Certificate examination, impressed with the fact that history *is* the evolution of mankind?

These, then, are the two main reasons why I consider biology should be a subject taught throughout the school and to all types of children. It is considered proper by all educationists that certain fundamental subjects such as arithmetic and English form an absolutely necessary part of any school curriculum. Has not the time arrived when it is just as important that the school-child, or the adult, for that matter, should know how his own body and his own society work as that he should know how to calculate compound interest or speak the king's English?

The views I have put forward are nothing more than ideal views. So long as schools are tied down and cramped in their style by having to conform to syllabuses of matriculation boards or standards of university scholarships, it is clear that it is not possible to devote the necessary time and teaching man-power to deal with biology as I have indicated. In 'modern' schools, however, where public examinations are not the determining factor in the teaching curriculum, there is some hope that a broad treatment of biology may be possible.

There is another and most important direction in which valuable biological teaching can be carried out, and that is in adult education. What I have said of the value of a biological outlook to the school-child applies *a fortiori* to the adult. But here again, extramural university teaching is largely bound up with the Workers' Educational Association. This excellent educational organisation, however, is hampered by the constitutional custom that the adult students *ask* for whatever classes they feel they want. As a result, adult education has come to be looked on as largely a development of the Faculty of Arts. The grown-ups ask for subjects such as psychology and economics, that naturally appear to them to bear directly upon their own lives. They do not realize that the subjects they choose are, as often as not, far beyond their mental capacity; in fact, as some of us think, they are beyond the capacity of the ordinary undergraduate. If they could be encouraged to study in a simple and broad manner the elements of biology, then a great step forward could be made in education generally.

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* Part of an address at a joint session of Sections D and L of the British Association meeting at Brighton on September 14.

CHROMATOGRAPHY FOR GENERAL CHEMICAL ANALYSIS

ORIGINALLY used for coloured substances, chromatography has been extended to deal with a wide range of colourless materials, by the use of suitable coloured derivatives or of indicators. Sugars and related substances form an important class of this kind, for which chromatography has proved to be a powerful analytical tool, particularly within the last ten years.

Messrs. Binkley and Wolfram* have themselves made important contributions to the subject, and their pamphlet appears at an appropriate time, when work in this field is expanding so rapidly; it provides carbohydrate investigators with an up-to-date historical review and practical details of the techniques involved. The first section of this pamphlet gives a simple general description of the adsorption chromatogram, with various details, such as selection of adsorbents, construction and operation of the chromatogram and location of zones after development. The second section provides a comprehensive review of the literature up to the end of 1947. Most of this section deals, of course, with adsorption chromatography, since it is only very recently that partition chromatography, particularly on paper, has been applied to the sugars. The third section describes with experimental details some of the applications of chromatography to sugars; for example, resolution and quantitative estimation of mixtures, purification, control in the production of technical sugar products and end-group assay.

Similar in size and presentation, "Introductory Notes on Chromatography"† covers a much wider field, including vitamins, alkaloids, chlorophylls, carotenoids, vegetable and mineral oils, amino-acids, inorganic ions and many other substances. Some of the applications are given detailed treatment in order to illustrate methods suitable for use in analogous cases. A useful list of references is given, most of which occur within the last ten years, and, as in the case of the first pamphlet, most of the chromatography described is of the adsorption type. This pamphlet succeeds in condensing a great deal of information into its forty pages and will be found useful as an introduction to the well-known textbooks on chromatography.

Workers in both academic and industrial fields will find information of value in these two pamphlets, which are clearly written and attractively produced. Those who have not already adopted chromatographic techniques will be encouraged to do so after reading them. Chromatography may well prove to be indispensable in many investigations.

During the past year, the range of separations has been greatly widened by the partition chromatogram and by chromatograms which are neither clearly adsorption nor partition. Among recent advances in chromatography may be mentioned the use of dinitrophenyl derivatives of amino-acids and peptides, the use of radioactive isotopes, and the employment of new kinds of supporting media or modifications of existing media in partition chromatograms for the purpose of dealing with non-aqueous solvent systems. The present period is thus one of rapid development, and it is therefore desirable that information on the most recent advances in chromatography should be made available from time to time and with little delay. Perhaps this information might be issued in the form of pamphlets similar to those reviewed here.

R. CONSDEN

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* "Chromatography of Sugars and Related Substances," by W. W. Binkley and M. L. Wolfram. (Scientific Report Series No. 10. Sugar Research Foundation, Inc., New York.)

† "Introductory Notes on Chromatography." (British Drug Houses, Ltd., Poole.)

NEW CHEMICAL LABORATORIES AT UNIVERSITY COLLEGE, DUBLIN

By PROF. T. S. WHEELER

THE honours degree courses in science in University College, Dublin, have recently been extended by one year so as to require four years of post-matriculation work. After three years, the student sits for a general degree examination in three subjects, and if he passes and attains an honours level in a subject is admitted to the honours school in that subject. A number of students, however, who wish to become chemists pass the general degree examination at a level in chemistry insufficient to qualify for admission to the honours school. For those and for other students, who though qualified for honours study feel attracted towards industrial chemistry, there has been instituted a course which extends over one year and leads to a diploma in chemical technology. To provide accommodation for the two types of fourth-year students two new chemical laboratories have been opened (see *Nature*, November 13, p. 768), the Ryan Laboratory for honours degree students and the Nolan Laboratory for those taking chemical technology.

The Ryan Laboratory commemorates the late Prof. Hugh Ryan, who was professor of chemistry in the College during 1899–1931 and who initiated honours degree teaching there. The laboratory has a floor area of 460 sq. ft. and will accommodate up to ten students; as formal lectures to honours candidates are limited to five per week, a large proportion of the students' time is spent in the laboratory. There is no specialization between the three main branches of chemistry in the fourth year, and in the Ryan Laboratory normal advanced work in inorganic and organic chemistry is carried out; practical physical chemistry is done in a special laboratory. Emphasis is laid on quantitative inorganic analysis and on organic preparations involving modern methods of reduction, oxidation, condensation and so on. Short courses are also given on the application of semi-micro methods in both branches of chemistry. A reasonable variety of modern physico-chemical apparatus is available, the equipment including an absorptiometer (Spekker), a spectrophotometer (Coleman), microphotometer and spectroscope (Hilger), a chromatographic apparatus, an ultra-violet lamp and electrometric titration apparatus. A special feature is made of vacuum distillation; there are in the department molecular stills and various pumps, including a mercury pump combination (Towers) giving pressure of the order of 1 millibar. A laboratory fractionation column (Todd) has an efficiency of fifty theoretical plates. Each student gets an opportunity of making himself acquainted with the manipulation of the various pieces of apparatus.

The lecture courses and associated reading for the honours degree follow normal lines; electronic theory may perhaps be regarded as a special feature. The students attend a series of lectures extending throughout the year in which the quantum mechanics of the hydrogen atom, bond formation, the periodic table and atomic structure, and applications of electron theory in organic chemistry are discussed in some detail. It has been found that the three-year general course, which includes physics and mathematics to a good pass-degree standard, is useful to the student in reading modern theoretical chemistry.

Students who obtain an honours degree may enter the research laboratories to work for the M.Sc. degree; the work normally occupies one year. Various themes are studied; but at present the main work involves a study of the mechanism of base-catalysed reactions of the Claisen type with special reference to transformation reactions (see, for example, *Proc. Roy. Dublin Soc.*, 24, 291; 1948).

The Nolan Laboratory (floor area 1,000 sq. ft.) is called after the late Prof. T. J. Nolan, who was professor of chemistry in the College during 1932–45. Prior to his comparatively early death, he had in conjunction with Prof. M. A. Hogan, professor of mechanical engineering, worked out the details of the course in chemical technology, but owing to the War was unable to make arrangements for the institution of the course. The laboratory contains apparatus to illustrate various unit chemical processes; this includes a centrifuge, a high-pressure (350 atmos. at 350°) autoclave of 5 litres capacity equipped with a stirring device and gas inlet (Cook), a 'Pyrex' glass fractionating column 3 ft. high, a steam-heated pan, a filter press, grinding equipment, high-temperature and vacuum ovens, and metering apparatus. Low-pressure steam and the other usual services are provided. The students receive lectures on the unit chemical operations which they study in the laboratory. At least half their time is spent in the Engineering Department of the College, where they have lecture courses on thermodynamics, materials of construction, workshop practice, fuel technology and electrotechnology. They also have practical instruction in the foundry, workshop, drawing office, and fuel and electrical laboratories.

In connexion with the planning of both the academic and industrial courses, it is desired to acknowledge valuable advice received from the heads of departments of a number of universities and colleges in Great Britain and from the Institution of Chemical Engineers.

PREHISTORIC FLOODING IN THE SOMERSET LEVELS

THE post-glacial history of the Somerset Levels has been the subject of considerable published work by Prof. H. Godwin and his collaborators in the pollen-analysis of peat; but a new series of "Studies of the Post-Glacial History of British Vegetation" reveals such a dramatic story as to appeal to more than specialists alone, although pollen-analysis and the study of macroscopical remains provide the scientific background of dating.

The unearthing and investigation of four distinct trackways through the raised bogs which lie between the Polden Hills and Wedmore Ridge are described in the first paper by Prof. A. R. Clapham and Prof. Godwin (*Phil. Trans. Roy. Soc. London*, B, 233, 233–273; 1948). Each is of particular interest, for, although appearing to be roughly contemporaneous, all represent different types of construction. The Meare Heath trackway is composed of transverse baulks of timber (mostly oak), many of which are perforated by mortise holes holding sharpened vertical piles. Long squared wooden stringers formed the margins of the track and indicate the use of wheeled traffic. The Shapwick Heath trackway, on the other hand, is of brushwood kept in place by stakes of various origins but including beech. Another trackway at Westhay is constructed from birch stems, the majority of which are laid longitudinally together with shaped, vertical stakes driven in to pin loose brushwood which prevented lateral displacement of the timbers. The shape of the axe-cuts on these timbers indicates a Late Bronze Age dating which is confirmed by other archæological remains. The Blakeway Farm trackway consists of overlapping faggots of very straight hazel poles which there is every reason to believe were derived from trees grown in a woodland system similar in its effects to present-day coppicing.

Each trackway was built upon the surface of a dry *Sphagnum-Calluna* bog; but in every case this appears to have been overwhelmed by flooding with the eventual formation of eutrophic *Cladium* fen. It is especially significant that they appear to have been submerged before suffering much hard wear, and a dramatic picture is drawn of the calamitous flooding of river- and lake-side colonies which caused a mass-evacuation over the improvised tracks.

The complementary paper by Prof. Godwin (*Phil. Trans. Roy. Soc. London*, B, 233, 275–286; 1948) concerns the correlation between climate, forest-composition and prehistoric agriculture in the Somerset Levels. The most intense phases of agricultural activity appear to have occurred in the Middle and Late Bronze Ages and between Middle Iron Age and Middle Romano-British times, each being terminated by flooding of the raised bogs. Climatic change and not agricultural clearance is held to be the cause of changes in forest composition at the first flooding. The general nature of 'recurrence surfaces' is discussed, and it is pointed out that active bog-growth ceased in Romano-British times; but again this appears to have been the result of flooding by base-rich or brackish water and not an effect of Roman drainage schemes. The striking abundance of the remains of *Scheuzeria palustris* at the flooding surfaces contrasts strongly with its great scarcity at the present day (which is greater even than Prof. Godwin mentions, the species being extinct in

England according to a forthcoming paper by Dr. W. A. Sledge in *Watsonia*).

Finally, a probable Early Iron Age dating for the monoxylous 'Shapwick Boat' is based upon the pollen-analysis of a sample of peat taken from the boat, and rounds off very neatly these outstanding contributions to the history of primitive man and his environment in Somerset. H. G. BAKER

PLASTICS INDUSTRY IN SCOTLAND*

THE reconstituted Committee on Plastics appointed by the Scottish Council (Development and Industry) was appointed to inquire further into the extent to which the industry is being developed in Scotland to meet requirements, to suggest what further action is required to meet the situation, and to consider in particular the possibilities of meeting the basic requirements of the industry from raw materials in Scotland. In its final report, the Committee states that while more firms are now manufacturing finished materials from moulding powders obtained from elsewhere, and the engineering industry is in a position to tackle the highly specialized side of mould fabrication without difficulty, no developments of any kind have occurred in the manufacture of the ingredients of the moulding powders. No plastics industry can be firmly established in Scotland while these raw materials have to be imported, and the supply of coal-tar phenol and cresols is quite inadequate to meet the needs of the plastics and other industries of the United Kingdom.

The Committee recommends, therefore, that the Ministry of Supply be reminded of the urgent need for synthetic phenol, and that ample benzene and sulphuric acid are available in Scotland for the purpose. The supply of toluene is also adequate, and the sulphonation process is regarded as more attractive. Royal ordnance explosives factories in the west of Scotland appear to offer the most convenient sites for the manufacture of these phenols, and the Committee also recommends that the Director of Ordnance Factories should be informed accordingly. The Tar Research Association should be invited to explore methods for efficient recovery of such products as *o*-xylene and naphthalene for phthalic anhydride manufacture, and the Ministry of Supply should also be asked to consider the possibility of manufacturing methyl alcohol in Scotland as soon as the fertilizer situation is relieved.

The increasing use of plastics of the polyvinyl chloride, methacrylate and other types focuses attention on the unsaturated gases, acetylene and ethylene. The oil-refining and shale-oil industries could produce large volumes of ethylene and propylene in plant now available in Scotland, and the Committee accordingly recommends that the plastics and chemical industries should be advised that adequate amounts of unsaturated gases of the required purity for the manufacture of plastics and of antiseptics, insecticides, detergents and synthetic rubbers could be made available from the petroleum-refining and shale-oil industries and from coal carbonization in Scotland. Ethylene could also be recovered from coke-oven gas without seriously affecting the calorific value of the gas for most industrial purposes, and the Committee recommends that the coke manufacturers be encouraged to investigate this possibility.

Since five per cent of the estimated power of the hydro-electric schemes set apart for calcium carbide manufacture would make a substantial contribution to the needs of the plastics industry in Scotland for acetylene, it is recommended finally that the Secretary of State be informed of the urgent need of an established carbide industry in Scotland for chemical as well as engineering purposes. The Committee concludes by pointing out that the rapidly increasing developments in the manufacture of flexible plastic materials emphasizes the need for a wide range of suitable plasticizers, none of which is at present made in Scotland.

The economic aspects of the whole situation are not discussed in this report; this may well draw serious criticism from the economists for neglect of an essential factor.

THE NATIONAL FOUNDATION FOR ADULT EDUCATION

THE National Foundation for Adult Education has now been constituted since January 1947 and, besides its quarterly bulletin, *Foundation Papers*, has published various supplements dealing with subjects of immediate importance to its corporate members.

One supplement, "Voluntary Agencies in Adult Education", contains a summary of the aims and activities of voluntary bodies working in the field of adult education. Since there is no up-to-date and comprehensive directory of adult education, the information contained in this supplement should be of particular use to local education authorities in coming to grips with the development plans for further education which they have been asked to prepare. "Voluntary Agencies in Adult Education" will also be useful as a reference for individuals who are interested in various aspects of adult education. The supplement contains no reference to the work of university extra-mural departments and tutorial class committees, and it is intended that these should be considered in a later supplement.

The second supplement, called "Sources of Visual Aid Material: For use in the Adult Teaching of History and Contemporary Affairs", has been compiled by the deputy director, Extra-Mural Department, University of Manchester. The information has been collected partly at the request of the Association of Tutors in Adult Education and partly to meet the needs of tutors of the Manchester University Extra-Mural Department. It should also be useful to leaders of discussion groups and others concerned with adult education classes. The booklet contains a list of maps and charts, films, filmstrips, lantern slides and other pictorial material which would be suitable for adult classes of a general historical and geographical nature, and also a list of material suitable for teachers dealing with particular periods and countries.

Another supplement, "Accommodation for Adult Education: Some Examples and Suggestions", discusses an issue which presents difficulties to all the co-operating parties in adult education. A recent pamphlet of the Ministry of Education stated that: "Up and down the country there are a few colleges for further education which are housed in worthy buildings of dignity and beauty. But these are oases in the desert. For the most part there is a great dearth of educational accommodation of every kind from college to village hall, and further education, whether formal or informal, full-time or part-time, has at present to contend with most unsuitable premises." The National Foundation for Adult Education began in 1947 to collect information about the present availability of accommodation, and in this pamphlet it has brought together examples of improvisation at various levels, together with examples of more permanent provision. A short directory of the new short-term residential accommodation has also been included.

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* Final Report of the Committee on Plastics: Plastics in Scotland. Pp. 16. (Edinburgh: Scottish Council (Development and Industry), 20 George Street, 1948.) 2*s*.

Because the literature about them is both brief and, in the main, out of date, some notes are included on the Cambridgeshire village colleges. These are one of the few working examples of combined educational provision, a subject which is being discussed in some detail to-day by the majority of local education authorities. The pamphlet should be useful in stimulating local education authorities and voluntary organisations to make a more searching examination of local possibilities for making more premises 'inter-available'. T. H. Hawkins

FORTHCOMING EVENTS

Tuesday, December 28

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Sir Frederic Bartlett, F.R.S.: "The Mind at Work and at Play—Experiments in Psychology".

(Further Lectures on December 30, January 1, 4, 6 and 8.)

Wednesday, December 29

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 2.30 p.m.—Mr. James Fisher and Dr. Ludwig Koch: "Exploring Britain's Islands". (Christmas Meeting for Young People.)

Thursday, December 30

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 3 p.m.—Mr. J. Melville: "Big Ships and their Docks—1, Building Big Ships". (Christmas Lectures to Boys.)

(Further Lectures on Monday, January 3, and Tuesday, January 4.)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Research Officer, and Research Officers (3), in the Pasture Research Division of the Department of Agriculture and Lands, Southern Rhodesia—The Secretary to the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (December 31).

Scientists (with University qualifications in one or more of the subjects of physics, chemistry, zoology, engineering, botany, agriculture, physiology and hygiene) as assistants to the Director (Science), Festival of Britain 1951—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.321/48A (December 31).

Lecturer in the Electrical Engineering Department—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (January 1).

Research Fellowship in the Department of Chemical Engineering and Applied Chemistry—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (January 1).

Engineer II (unestablished) at a Ministry of Supply Research and Development Establishment, to take charge of experimental work in testing explosives and demolition equipment, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.569/48 (January 7).

Physical Chemist to take part in an investigation of tissue proteins and related problems—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3 (January 11).

Professor of Astronomy—The Dean, Faculty of Science, Fouad I University, Cairo, Egypt (January 15).

Graduate with research experience in Organic Chemistry, for micro-analytical work, including teaching and research—The Registrar, The University, Liverpool (January 15).

Senior Lecturer or Lecturer in Anatomy—The Registrar, The University, Sheffield (January 22).

Chair of Philosophy in the University of Bern—Die Kantonale Erziehungsdirektion, Münsterplatz 3a, Bern, Switzerland (January 31).

Director of Research of the Australian Leather Research Association, Sydney—Mr. A. Harvey, Craigieburn, Duppas Hill Road, Croydon, Surrey.

Botanist in the East African Tsetse Reclamation Department, Kenya—The Director of Recruitment, Colonial Service, Colonial Office, Great Smith Street, London, S.W.1.

Honours B.Sc. Physicist for Radiotherapy Department—The Administrative Officer, Royal Berkshire Hospital, Reading, endorsed 'Appointment of Physicist'.

Entomologists (2) in the Department of Agriculture, Kenya—The Director of Recruitment, Colonial Service, Colonial Office, Great Smith Street, London, S.W.1.

Soil Survey Officers (3) in the Gold Coast to supervise the collection of information about the soils of the forest region in that territory—The Director of Recruitment, Colonial Service, Colonial Office, Great Smith Street, London, S.W.1.

Biochemist to the Reading Group of Hospitals—The Administrative Officer, Royal Berkshire Hospital, Reading, endorsed 'Appointment of Biochemist'.

Junior Graduate for biochemical work at Elstree, Herts—The Secretary, Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W.1.

Cerealist for the Directorate-General of Agriculture, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18187/3C.

Physicist to investigate physical properties of dairy products, especially liquid milk—The Secretary, National Institute for Research in Dairying, Shinfield, Reading.

Assistant Engineer or Technician to assist in the maintenance of several 200-kilovolt X-ray installations—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx.

Physicist (preferably with some research experience) to study rheological properties of yarns and filaments—The Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.

Technician, (Grade II) in the Department of Civil Engineering—The Secretary, University College, Gower Street, London, W.C.1, quoting 'Civil Engineering/1'.

Chair of Zoology—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Question: a Journal. Edited by H. Westmann. Vol. 1, No. 1, July 1948: The Critical Problem in Human Relationships Today. By G. Wilson Knight, Herbert Read and Dr. J. H. Oldham. Pp. 87. (Published for the Present Question Conference, Ltd.) (London: Hammond, Hammond and Co., Ltd., 1948.) 2*s.* 6*d.* net. [238

The Identification of Textile Materials. (Handbooks of Textile Technology, No. 3.) Pp. 12+14 plates. (Manchester: Textile Institute, 1948.) 5*s.* [238

National Building Studies. Bulletin No. 2: Painting New Plaster and Cement. By H. M. Llewellyn and H. J. Eldridge. Pp. iv+21+9 plates. 1*s.* net. Special Report No. 3: Sand-Lime Bricks. By G. E. Bessey. Pp. v+58+3 plates. 1*s.* 3*d.* net. (London: H.M. Stationery Office, 1948.) [238

Ministry of Education and the Scottish Education Department. Ministry of Education Pamphlet No. 12: UNESCO and a World Society. Pp. 46. (London: H.M. Stationery Office, 1948.) 1*s.* net. [248

British Standard 1170: 1947. British Standard for Treatment of Water for Marine Boilers (with a Section on Engineering Factors). Pp. 96. (London: British Standards Institution, 1947.) 10*s.* 6*d.* net. [268

Other Countries

The Waipoua Forest: the Last Virgin Kauri Forest of New Zealand. By W. R. McGregor. Pp. 80. (Auckland: The Author, Department of Zoology, University College, 1948.) 5*s.* [238

Physics To-day. (Monthly.) Vol. 1, No. 1, May 1948. Pp. 40. (New York: American Institute of Physics, 1948.) 50 cents; annual subscription, 5 dollars. [238

Smithsonian Institution: United States National Museum. Bulletin 194: An annotated Checklist and Key to the Amphibia of Mexico. By Hobert M. Smith and Edward H. Taylor. Pp. iv+118. (Washington, D.C.: Government Printing Office, 1948.) 50 cents. [238

Annual Report of the All-India Institute of Hygiene and Public Health, Calcutta, 1944–45. Pp. viii+56. (Calcutta: All-India Institute of Hygiene and Public Health, 1948.) [248

International Chamber of Commerce. Brochure No. 126: Administrative Assistance for Tax Collection and Assessment (Council Resolution, June 1948); Report of the I.C.C.'s Committee on Taxation on the League of Nations Model Bilateral Convention (London Draft). Pp. ii+22. (Paris: International Chamber of Commerce, 1948.) [248

Catalogues

Murfume DDT and Azobenzene Smokes for Horticultural Use. Pp. 4. (Wheathampstead: Murphy Chemical Co., Ltd., 1948.)

Catalogue of New Books on Mathematics, Physics, Astronomy and Meteorology. Pp. 40. (London: H. K. Lewis and Co., Ltd., 1948.)

Catalogue of New Books on the Biological Sciences. Pp. 36. (London: H. K. Lewis and Co., Ltd., 1948.)

Airborne Beam-Approach Receiver *Type AD*86. (Ref. SL.37.) Pp. 4. BBC-Marconi Ribbon Microphone *Type AXBT*. (Ref. SL.36.), Pp. 8. 3 kW. Transmitter *Type TGM*651. (Ref. SL.35.) Pp. 4. Telegraphy-Telephony Transmitters *TGM* 571 and *TGS*571. (Ref. SL.17/2.) Pp. 4. Receiver *Type CR*300. (Ref. SL.4/2.) Pp. 4. Receiver *Type CR*100/2. (Ref. SL.1/2.) Pp. 4. (Chelmsford Marconi's Wireless Telegraph Co., Ltd., 1948.)